MASTER

R&D's approaches of gathering customer needs intelligence
exploiting customer-facing functions in new product development

Borsboom, V.J.E.

Award date:
2015
R&D’S APPROACHES OF GATHERING CUSTOMER NEEDS INTELLIGENCE:

EXPLOITING CUSTOMER-FACING FUNCTIONS IN NEW PRODUCT DEVELOPMENT

by

V.J.E. Borsboom

BSc Industrial Engineering and Management Science – TU/e 2013
Student Identity Number 0657650

in partial fulfilment of the requirements for the degree of

Master of Science
in Innovation Management

Supervisors:
Dr. ir. W. (Michel) van der Borgh, Eindhoven University of Technology
Prof. dr. E.J. (Ed) Nijssen, Eindhoven University of Technology
Dr. M.H. (Michael) Kolk, Arthur D. Little Benelux N.V.
M. (Martijn) Eikelenboom, Arthur D. Little Benelux N.V.
J.F. (Jeroen) van Dorp, Arthur D. Little Benelux N.V.
Subject headings: R&D, customer-facing functions, new product development, business-to-business market orientation, customer needs intelligence, new product commercial success, qualitative research
Abstract

Prior new product development (NPD) research has revealed that marketing is a valuable input for market intelligence on customer needs (customer needs intelligence) for R&D in their process of finding and assessing new applications for products. However, still many NPD projects do not meet their commercial expectations after launch, because of an insufficient link with the market. Nevertheless, some organizations are better at innovating than others by, for example, adopting a better market orientation. Therefore, this study extends prior research and examines the various functions from which R&D gathers input to apply in their new product designs - through direct contact with customers, and specifically, through customer-facing functions (e.g. marketing, sales, services) - that result into new product success. Drawing on a literature review and 32 qualitative interviews with project leaders of recently completed NPD projects, this study identified four overall R&D customer needs intelligence gathering approaches: (1) the direct R&D approach, (2) the indirect dominant and (3) indirect multiple customer-facing functions approach, and (4) the combined approach. The results indicated several moderators that influence the positive relationship between the approaches and its new product success. Moreover, the findings show moderators that increased the overall success of the corresponding dissemination of and responsiveness to customer needs intelligence for all approaches. This study argues that, besides the traditional role of marketing in providing strategic market intelligence in NPD, more operational customer-facing functions – such as sales, sales engineering, and technical service – can be a valuable input for R&D, when exploited in the right way and under the right conditions. The findings provide implications for NPD project teams and identify areas for further research.
Management Summary

This thesis report presents the results of a graduation research project that explored the importance of customer-facing functions (e.g., marketing, sales, and technical services) in new product development (NPD) processes of Research and Development (“R&D”) – driven, innovative companies, and was executed as a collaboration between the Eindhoven University of Technology and the consultancy firm Arthur D. Little.

Thesis Motivation

Despite its proven performance, new products fail more often than desired in the market after launch. However, some organizations are better at innovating than others, as Arthur D. Little also shows in their multiple two-yearly Global Innovation Excellence survey. A common cause for a product innovation’s commercial failure is a lack of alignment with customer’s needs. Many researches have shown that a market orientation can improve the new product performance of organizations. A market orientation has three indicators – market intelligence generation, dissemination, and responsiveness – and three elements – customer orientation, competitor focus, and cross-functional coordination or cooperation. We concentrate on the customer orientation element, and thereby on the generation (acquisition) of, dissemination (sharing or communication) of, and responsiveness (application) to customer needs intelligence (CNI).

In NPD, R&D relies on other, primarily customer-facing functions to provide them with CNI. Nonetheless, in existing literature, especially the role that the more strategic customer-facing function marketing plays in providing R&D with CNI has been investigated. Surprisingly, the role of other, more operational customer-facing functions, such as sales and services, is nearly neglected. Little is known on the different ways or approaches of how R&D functions gather their required CNI through different customer-facing functions other than marketing and which approaches work best under which conditions. Therefore, the research question of this study was,

Which approaches can R&D use to gather customer needs intelligence during new product development (NPD) projects, and what are associated contingencies for dissemination and responsiveness of the whole NPD project team, that will lead to commercial success of new products?

Since market intelligence gathering is even harder for B2B organizations B2B NPD projects were the focus of this study.

Literature Overview

The literature research focused on three main subjects: (1) NPD and its processes, (2) market orientation in NPD, and (3) the different roles that R&D and the customer-facing functions in carrying out the market orientation concept in NPD. The literature search found that R&D can have three general approach of generating CNI: directly from the market, through one distinct customer-facing function, and through multiple customer-facing functions. Customer-facing functions that are acknowledged in literature as an input of CNI for R&D are marketing, which role is highly researched, sales, which role is scarcely researched, and services, which role is hardly researched. Moreover, literature acknowledges cross-functional cooperation as highly important in NPD, but how the multiple customer-facing function approach should be adopted, and the respective roles of the different functions are not described.
METHODOLOGY
This study adopted an exploratory, qualitative, multiple case study research method. The selected cases were the units of analysis, which represented recently completed NPD project, excluding extremely incremental and extremely radical product innovations. In total, 32 cases were selected from 15 companies within eight industries. The data was gathered by semi-structured face-to-face, in-depth interviews with project leaders. 28 interviews were selected as critical incidents, i.e. 13 projects that resulted in commercial success and 15 in commercial failure, and four interviews discussed the general processes within organization on the relevant subject. Interviewees were asked about their project team’s practices in generation, dissemination and responsiveness to CNI, the influence of their practices on new product success or failure, and the respective roles of the different functions in these practices. The data was analyzed by using a software tool for qualitative data coding (NVivo) and by conducting 32 within-case analyses, as well as a cross-case analysis.

RESULTS
The results showed four different overall approaches of how CNI is gathered by R&D functions that result into new product success, extending the expectations from literature. The approaches exploit customer-facing functions (CFFs) in different ways. Moreover, a fourth important hybrid sales engineering function was found as CFF to often provide CNI to R&D, who are often experts in the application of the organization’s (mostly modular) products or systems. They can also be called application or system engineers, integration or product managers. They combine two abilities, technological knowledge and interpersonal skills, and can therefore serve as an effective bridge between commercial and technological knowledge. Moreover, structural and process moderators were found that determine the effectiveness of an approach on new product success. The results are described below and depicted in the overall conceptual framework in Figure 1.

R&D’s CNI gathering approaches

1. The direct R&D approach: the R&D function independently gathers CNI directly from customers, without help or support from CFFs. Commonly, these direct discussions occur between engineers instead of with the commercial functions on the customer’s side.
2. The indirect dominant CFF approach: one CFF is mainly responsible for, i.e. dominant in, providing R&D with required customer needs intelligence. The dominant function acts as “gatekeeper”: They decide whether or not to share information that came in from customers or through other functions.
3. The indirect multiple CFF approach: R&D uses several channels through which they indirectly gather CNI. Commonly, each function has a specific role in generating different aspects of the customer needs.
4. The combined approach: both R&D itself and one or more customer-facing functions in direct contact with R&D, are responsible for generating customer needs intelligence. Customer needs intelligence processing becomes a genuine cross-functional effort.

Additionally, interviewees indicated to that the different CFFs, which apparently, is a functional role that also R&D can adopt (in approach 1 and 4), are often used for generating particular aspects of CNI, depending on their functional background, expertise and customer relations.
The four approaches vary in R&D’s reliance on direct customer input to their reliance on indirect CFF input for R&D, as showed in Figure 1. All approaches have upsides as well as downsides. Direct customer input allows R&D to interpret the customer needs intelligence first-hand, which can be beneficial in complex, high-tech projects. Input from customer-facing functions allows for taking into account non-technical needs and commercial aspects (e.g. timing of delivery, price, legal issues) in NPD projects. Moreover, R&D can take advantage of the CFFs’ expertise in market research and their close relationships with customers.

**Structural moderators**

Secondly, the results showed structural moderators that determine the effectiveness of an approach, i.e. strengthen the relationship between an approach and new product success under certain conditions. These three moderators are: (a) the dispersion of requirements engineering skills between R&D and CFFs, (b) the product roll out strategy, and (c) configuration of the technology and customer needs tacitness.

The dispersion of requirements engineering skills between R&D and CFFs refers to the ability of a or several of those function(s) to identify, specify, negotiate and translate customer needs into product requirements. This creates four combinations of the extent to which R&D and/or the CFFs possess requirement engineering skills. Table 1 shows how the different conditions of the moderator strengthen the relationship between an approach and its new product success.
Requirements engineering skills

<table>
<thead>
<tr>
<th>R&amp;D</th>
<th>CFFs</th>
<th>CNI gathering approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Commonly low</td>
<td>1. Direct R&amp;D Approach</td>
</tr>
<tr>
<td>High</td>
<td>High (for a particular selection)</td>
<td>2. Combined Approach</td>
</tr>
<tr>
<td>Low</td>
<td>Commonly low</td>
<td>3. Indirect Multiple CFF Approach</td>
</tr>
<tr>
<td>Low</td>
<td>High (for particularly one)</td>
<td>4. Indirect Dominant CFF Approach</td>
</tr>
</tbody>
</table>

Table 1: Relation between dispersion of skills and CNI gathering approaches

Second, the data also revealed four product roll out strategies, related to four main types of target market selections, that determine the effectiveness of an approach: (i) one specific (lead) customer, i.e. an engineering-to-order project, (ii) a small selection of customer with a specific need, i.e. a niche market project, (iii) a larger market with an overall need, i.e. a mass market project, and (iv) an expanding target market after the product was designed for a specific customer or small select group of customers, i.e. a phased roll out project. Table 2 shows how the different product roll out strategies strengthen the relationship between an approach and its new product success.

<table>
<thead>
<tr>
<th>Product roll out strategy</th>
<th>CNI gathering approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customized, engineer-to-order</td>
<td>1. Direct R&amp;D Approach</td>
</tr>
<tr>
<td>Phased roll out (from lead user(s) to broader market)</td>
<td>2. Combined Approach</td>
</tr>
<tr>
<td>• Niche market (involve sales, service, and/or sales engineering)</td>
<td>3. Indirect Multiple CFF Approach</td>
</tr>
<tr>
<td>• Mass market (involve marketing)</td>
<td></td>
</tr>
<tr>
<td>• Niche market (specifically sales, service, and sales engineering)</td>
<td>4. Indirect Dominant CFF Approach</td>
</tr>
<tr>
<td>• Mass market (specifically marketing)</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Relation between different product roll out strategies and CNI gathering approaches

The tacitness of needs in this case indicates the extent to which the needs from the customer’s and/or the technology side in the market are generally implicit, unclear, undefined and uncertain, compared to more explicit, expressed or identified. The configuration of the extent to which the customer and/or the technology needs are tacit, determines which function should be involved in customer needs intelligence gathering. Table 3 shows how the different configurations strengthen the relationship between an approach and its new product success.

<table>
<thead>
<tr>
<th>Tacitness of customer and technology needs</th>
<th>CNI gathering approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer</td>
<td>Technology</td>
</tr>
<tr>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

Table 3: Relation between configuration of tacitness of needs and CNI gathering approach
Process moderators

Moreover, the data revealed that all four approaches are positively affected by integrating four factors considering the dissemination of and responsiveness processes NPD projects. Dissemination of CNI refers here to the communication and sharing of the intelligence between R&D and the relevant CFFs, and is enhanced by: (I) formal and informal processes for intelligence sharing, since formal dissemination is needed to insure quality and storage of intelligence, and informal dissemination is needed for development speed and time-to-market, and (II) continuous inbound and outbound customer and technology intelligence sharing, which implies stepping away from the “magical gap” of isolated R&D development. Secondly, responsiveness to CNI refers here to the actual use of the intelligence by R&D, and is enhanced by: (III) the objectivity of customer needs intelligence, which implies that CNI should be fact-based rather than opinion-based, and (IV) continuous and iterative verification and validation loops by actual customer usage or experience with the product (- concept): adopt rapid protocept, simulations, and/or mock up or prototype testing.

CONCLUSION & RESEARCH IMPLICATIONS

To answer the research question, R&D has four overall approaches to gather customer needs intelligence in NPD projects, of which the effectiveness of the distinct approaches is determined by three structural moderators as market, project and organization characteristics of the NPD project at hand, and the effectiveness of all approaches is determined by four process moderators, that lever the dissemination of and responsive to CNI of R&D within the NPD team. Next to these specific contingencies, all approaches have practical advantages, pitfalls and key success factors. The research adds to market orientation and NPD literature by providing a comprehensive conceptualization of four R&D functions’ approaches to gathering customer needs intelligence that resulted in commercial success. It thereby moves away from a predominant focus of only marketing providing R&D with market intelligence towards a more overall strategic consideration of when to use which R&D functions’ approach to gather CNI for developing their products. Furthermore, the research presents practitioners with a roadmap for aligning product features to customer needs in a most effective way, with three overall recommendations:

1) Adopt the right, customized approach per NPD project.
2) Include the right customer-facing functions as input, considering their expertise, but assuring their requirement engineering skills for the particular project.
3) Increase the overall probability of new product success by improving general dissemination and responsiveness processes.

Finally, the research had some limitations that offer opportunities for future research. Most importantly, based on the resource dependence theory, future research could investigate whether and why organizations change R&D’s gathering approach during NPD projects. In addition, future qualitative comparative analysis (QCA) research could identify if the conditions of the three structural moderators can be mapped, and therefore provide optimal combinations of conditions that together are linked to an CNI gathering approach. This would have implications for the way and which functions organizations should train in certain skills.
Acknowledgements

While finishing this thesis report that presents the research I conducted at Arthur D. Little, I am also finishing my master’s degree in Innovation Management at the Eindhoven University of Technology. I would like to thank the people who helped me in realizing this thesis project. Of course, I am hereby also ending my time as a student. I have to say, looking back, I had an amazing time that I could never forget. But I could have never done that alone. Therefore, I like to also thank people who have helped me made this time so amazing and have helped me to get where I am now.

First, I would like to start with my thesis supervisors at both the university (TU/e) and Arthur D. Little (ADL). I very much appreciate all the time they have spent in helping me carrying out this rather unordinary thesis project. Specifically, I would like to thank my first supervisor Michel van der Borgh for all his time and help, especially in the gathering and analysis of my results, for stimulating me to think outside the box and keep reevaluating what I wrote down, by really go into depth on the data himself. It definitely helped me to be able to extract as much value out of the data and the research subject as possible. Secondly, I thank Michael Kolk for his support in approaching and convincing companies to participate in my research, and for sharing his extensive experience in conducting management studies that I could apply in mine. Finally, I want to thank Jeroen van Dorp for stimulating me to speed up my whole research process (which could be rather lonely sometimes) and always willing to think along with me. Furthermore, a special thank you to Martijn Eikelenboom at ADL and my second supervisor Ed Nijssen at the TU/e, for providing their critical and honest points of view towards the end of my project, that have increased the quality of the results even more. I have learned so much professionally, but also about myself, from both parties.

Second, I would like to express my gratitude to Chris Otten, my IT hero, who saved me many many weeks of work after technology had (again) let me down. I really appreciate your immediate help and confidence in fixing it for me.

Third, I want to thank my Briljant girls and all my other friends for all the happy and not-so-happy memories we made the last years: for what we learned from each other, how we laughed and cried together, and how you have made my life around studying so much fun!

Fourth, I would like to thank my team Snowsports Academy Racing and all the kids and parents for the awesome time we had. You were all the best distraction for studying ever. I have learned so much as a coach and as especially as a person, while doing something I am most passionate about.

And last, but so not least, I would like to thank my mother, father, brother and Daan for all their support. help, patience, pep talks, for giving me their honest and blunt opinions no matter when I asked them, and for making me laugh when I needed to. You all know me so well, and I can only hope I can do the same for you!

Vreni Borsboom
Amsterdam, July 2015
# TABLE OF CONTENTS

Abstract .................................................................................................................................................. i
Management summary ......................................................................................................................... ii
Acknowledgements ............................................................................................................................... vii
List of abbreviations ............................................................................................................................. x

1. **INTRODUCTION** ............................................................................................................................ 1
   1.1. Thesis Motivation .......................................................................................................................... 1
   1.2. Business context of the study ...................................................................................................... 3
   1.3. Thesis Relevance .......................................................................................................................... 4
   1.4. Thesis Outline ............................................................................................................................. 5

2. **LITERATURE OVERVIEW** ............................................................................................................ 6
   2.1. New product development ........................................................................................................ 6
       2.1.1. New product development process ...................................................................................... 7
       2.1.2. New product Development success ................................................................................... 8
   2.2. Market Orientation in new product development .................................................................... 8
       2.2.1. The indicators of market orientation ................................................................................... 9
       2.2.2. Proactive market orientation ............................................................................................... 12
       2.2.3. Cross-functional cooperation and communication ............................................................... 13
   2.3. The role of R&D and the CFFs in carrying out the market orientation concept in NPD ........ 14
       2.3.1. The roles of R&D and the CFFs in NPD ............................................................................. 15
       2.3.2. R&D’s customer needs intelligence gathering in NPD ....................................................... 16
       2.3.3. R&D’s dissemination of intelligence in NPD ....................................................................... 20
       2.3.4. R&D’s responsiveness to customer needs intelligence in NPD ........................................ 20
   2.4. Conclusion .................................................................................................................................... 20

3. **METHODOLOGY** .......................................................................................................................... 24
   3.1. Research Question ..................................................................................................................... 24
   3.2. Research Methodology ............................................................................................................. 24
       3.2.1. Research Design .................................................................................................................... 24
       3.2.2. Data Collection ..................................................................................................................... 27
       3.2.3. Data Analysis and Interpretation ......................................................................................... 28
4. CONCEPTUALIZATION OF OVERALL FRAMEWORK ........................................... 30
   4.1. Conceptualization of R&D approaches of gathering customer needs intelligence .......... 30
   4.2. The moderating role of structural characteristics ................................................. 39
   4.3. The moderating role of process characteristics .................................................... 48

5. DISCUSSION .................................................................................................................. 53
   5.1. Conclusion: Answering the research question .......................................................... 53
       5.1.1. The direct R&D Approach ............................................................................. 54
       5.1.2. The indirect dominant CFF approach ............................................................. 54
       5.1.3. The indirect Multiple CFF approach ................................................................. 55
       5.1.4. The combined approach ................................................................................. 56
       5.1.5. The moderators .............................................................................................. 56
   5.2. Implications .............................................................................................................. 57
       5.2.1. Theoretical Implications ............................................................................... 57
       5.2.2. Managerial implications: recommendations for practice .................................. 58
   5.3. Limitations & Directions for future research ............................................................ 59

6. REFERENCES .................................................................................................................... 61

7. APPENDIX ...................................................................................................................... 69
   Appendix A: The Interview Guide ................................................................................. 69
   Appendix B: Final Codebook ......................................................................................... 75
   Appendix C: Illustrative Quotes ..................................................................................... 77
   Appendix D: Examples of Within-case Analyses ............................................................. 80
   Appendix E: The Cross-case Analysis table ................................................................. 88
   Appendix F: Frequency of mentioned constructs ......................................................... 90
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPD</td>
<td>New product development</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Research and development</td>
</tr>
<tr>
<td>CFF</td>
<td>Customer-facing function</td>
</tr>
<tr>
<td>MI</td>
<td>Market intelligence</td>
</tr>
<tr>
<td>CNI</td>
<td>Customer needs intelligence</td>
</tr>
<tr>
<td>IT</td>
<td>Information technology</td>
</tr>
<tr>
<td>QCA</td>
<td>Qualitative comparative analysis</td>
</tr>
</tbody>
</table>
1. INTRODUCTION

This thesis report presents the results of a graduation research project that explored the importance of customer-facing functions (e.g., marketing, sales, and technical services) in new product development processes of Research and Development (hereafter “R&D”)-driven and innovative companies, and was executed as a collaboration between the Eindhoven University of Technology and the consultancy firm Arthur D. Little. The research has a dual objective of aiming to contribute to (1) the academic knowledge on new product development, and to (2) to Arthur D. Little’s core strengths in innovation management.

Nowadays, organizations can hardly escape the need to innovate in order to be able to respond to the fast changing customer demands and lifestyles, and to exploit the opportunities offered by the rapidly evolving technology and changing market places, structures and dynamics (Baragheh, 2009). The successful development and market introduction of new products and services is crucial for the survival of an organization, especially in today’s globally competitive business environment (Judson et al., 2006). However, despite its proven importance, an analysis of a Product Development and Management Association (PDMA) Best Practices study (Barczak et al., 2009) observed that new product development (referred to as NPD from now on) fails more often than desired due to a lack of alignment with the market. The problems seem to be quite widespread, since they show that new product success rates have remained stable since 1990, with 59% of commercialized new products considered successful. Furthermore, only 14% of the initially generated ideas become a commercial success. From this, it can be concluded that still too many product innovations result into commercial failure after launch.

Businesses need market intelligence - which is broadly defined as the process of acquiring and analyzing information in order to understand the market of both existing and potential customers - to assess the current and future needs, preferences, attitudes and behavior of the market (Kohli & Jaworski 1990; 1993) as well as new technological knowledge that is generated by the R&D department (Ernst et al., 2010) during NPD, to be able to identify future needs, and to better serve customer with new products that satisfy those needs. However, many organizations still struggle to leverage their market intelligence management, and develop and commercialize market-oriented products (van Raaij & Stoelhorst, 2008). In recent years, there has been an increased focus on the relationship between market orientation and new product performance (Carbonell & Escudero, 2010). In general, a strong market-oriented organizational culture is an effective means for achieving new product performance (Guenzi and Troilo, 2007). Nonetheless, still a lot can be gained in how to exactly optimize NPD processes and new product performance, since as Arthur D. Little’s two-yearly Global Innovation Excellence survey (Arthur D. Little, 2013) also confirms, some organizations are more successful in innovating than others. The question remains, why are they better? We know little about how top innovating R&D functions successfully utilize market intelligence compared to others. This will be the main focus of this study.

1.1. THESIS MOTIVATION

As Kohli and Jaworski (1990; 1993) and Narver and Slater (1990; 1995) conclude, a market-oriented organizational culture is not solely the responsibility of the marketing department. In fact, companies must disseminate (e.g. communicate) market intelligence throughout the organization and all departments must respond (e.g. apply the insights) consistently. However, market orientation literature does not yet
describe how organization should put these processes in place, i.e. what every department within the organization should do in this matter. Since, over time, organizations became increasingly complex, a need for specialization of functions arose. However, business processes, such as NPD as the focus of this study, should be a multifunctional program, where different functions have to work together to be able to accomplish the required tasks (Crawford & Di Benetto, 2008). Thus, for NPD processes, the specialization of the different functions leads to the need for integration among functions because each department holds a specific set of information required for the NPD process (Kohli & Jaworski, 1990; 1993; Narver & Slater 1990; Slater & Narver, 1994; 1994b; Ernst et al., 2010, Urban & Hauser, 1993).

Therefore, in many top innovating firms, cross-functional teams for NPD are a given (Crawford & Di Benetto, 2008). As Homburg et al. (2002) describe in a study on key account management, next to the different tasks and activities that need to be performed, cross functional teams should decide on the actors of the activities, i.e. who does it? NPD activities should be assigned to different functions within the team.

The same goes for R&D’s activities during NPD. Next to their own efforts in collecting relevant technology information, R&D people have to (partly) rely on other functions within the organization for gathering market intelligence, and applying this knowledge to design and develop new products (Ernst et al., 2010). In this particular process, the market intelligence on customer needs (compared to a focus on competitors or other environmental factors (Narver & Slater, 1994b)) is most important. This aspect of market intelligence is from now on referred to as customer needs intelligence (CNI). Moreover, the extent to which R&D disseminates and responds to CNI is similarly likely to influence new product performance. However, in current literature, mainly the role of R&D and the role of the marketing function providing R&D with market intelligence as actors in market orientation in NPD is discussed (Wong & Tong, 2012; Stock & Reiferscheid, 2014; Griffin & Hauser, 1996; Massy & Kyriazis, 2007).

Research insights on which function to involve besides marketing, and what their exact role should be remain scarce. Specifically, the role of other, more operational customer-facing functions – such as sales or technical services – is unclear. This is surprising, as they could provide very valuable insights on customer needs, due to their strong and operational link to individual customers (Helm et al., 2014).

Another motivation for researching the role of customer-facing functions in using customer needs intelligence in NPD derives from the results of Arthur D. Little’s most recent Innovation Excellence Survey among 350 companies globally, which present that the top 10% innovators declare to mobilize the whole organization to develop, prioritize, and select new ideas, not just R&D or marketing. Moreover, they use their internal sources, such as the sales force and customer service, in a more structured way in their business intelligence processes within innovation than the rest. However, the survey does not reveal how these internal sources are used by top innovators compared to the rest.

Apparently, R&D can have more ways, or approaches, of obtaining CNI than just through marketing. Therefore, this research aims to find successful approaches for organizations, and in particular the R&D function, to gather, disseminate and respond to customer needs intelligence to be able to design, develop, and commercialize new products, and thereby increase the success of their NPD efforts.

Based on the thesis motivation, the main objective of this research is:

To develop a framework of potential approaches to enhance R&D’s effectiveness in applying market intelligence in new product development, and therefore, increase the probability of a new product’s commercial success.
1.2. BUSINESS CONTEXT OF THE STUDY

As explained before, this research is conducted at global management consultancy firm Arthur D. Little. Firstly, a general description of Arthur D. Little as a company will be given to present an indication of the context of this research. The subsequent section describes in more detail Arthur D. Little’s specific practices on innovation and new product development to explain the relevance of Arthur D. Little as a research partner in this project.

ARTHUR D. LITTLE

Arthur D. Little was founded in 1886. As the world’s first consultancy firm, Arthur D. Little has been at the leading edge of innovation for more than 125 years. Their mission is to help their clients in permanently reinventing their business models. As their Global CEO states: “Our firm’s deep industry knowledge, linked to our strong expertise in strategy, technology and innovation, helps us solve our clients’ most complex business issues whole delivering sustainable results to their businesses”.

Today Arthur D. Little employs around a thousand employees over 29 offices in 22 countries in Europe, North and South America, the Middle East and Asia. They operate in a variety of industries, with each their own industry specialists. These industries are, amongst others, Automotive, Telecommunications, Information, Media & Electronics (TIME), Energy & Utilities, Healthcare, Manufacturing and Chemicals. Recent publications by Arthur D. Little were for example in the Automotive industry - on the CO2 Emissions Challenge, in the Energy & Utilities industry – on the ‘new normal’ for oil and gas prices – and in the Manufacturing industry – on Arthur D. Little’s holistic and networked approach for next-generation product cost management.

The services they provide for organizations can be categorized into several functional areas: Strategy & Organization, Operations Management, Technology & Innovation Management, Corporate Finance, Information Management and Sustainability.

This research is conducted at the Dutch office of Arthur D. Little, which is located in Amsterdam. The Amsterdam office is particularly active in the Chemicals, TIME and Oil & Gas industries.

INNOVATION AND NEW PRODUCT DEVELOPMENT AT ARTHUR D. LITTLE

This research falls under the Technology & Innovation Management (TIM) capability of Arthur D. Little. Arthur D. Little finds that innovation is of utmost importance if you want to outperform your competitor. Typical TIM offerings to clients would be on reasons to innovate, ranging from most to least common: innovate for growth; build innovation capabilities; master technological challenges; innovate for costs and competitiveness; and to become global and agile. Common innovations projects would to enhance a client’s innovation performance, to support an R&D post-merger integration, or to support a client’s Product Life Cycle Management.

Several big TIM projects run continuously within Arthur D. Little. Every two years, Arthur D. Little conducts the Innovation Excellence Survey. This is a cross-industry global benchmark of innovation departments, with currently many hundreds of companies who have already participated. It resulted into Arthur D. Little’s Innovation Excellence model, which serves as a framework that captures all aspects of

---

successful innovation. Effectively gathering and utilizing market intelligence is of course one aspect on innovating successfully, as many researchers conclude. That is why Arthur D. Little is a very logical and valuable research partner for conducting this research; their knowledge and experience can be used as input for this study, and the output of this study can be used for their future practices.

1.3. Thesis Relevance

In accordance with the dual aim of this research (as explained in section 1.1.), it has a twofold relevance: a theoretical relevance for the current academic knowledge base and a practical or managerial relevance for Arthur D. Little as well as for their client base and equally innovation-driven companies.

Theoretical Relevance

This study provides a synthesis of the scarcely described approaches in academic literature of how R&D effectively gathers, disseminates, and responds to CNI in NPD projects, and complements them with findings from a qualitative field study with 32 NPD projects in 15 R&D-and innovation-driven B2B organizations to develop an overall conceptualization of market orientation approaches for NPD in B2B markets. Therefore, it extends market orientation literature with a more detailed description of the specific functional roles. Especially, the academic literature on the roles that customer-facing functions should play in this aspect of NPD, besides the role of the R&D and marketing departments, is scarce (Ernst et al., 2010; De Jong et al., 2014). Therefore, we build on the research of Ernst et al. (2010) that a R&D – sales cooperation is positively linked to overall NPD project performance in the discovery and development phases and enrich then with insights from a qualitative field study to define more valuable functions that can serve as input for R&D and the approach of how to utilize the information from that function. Specifically, we will research contingencies to the different overarching approaches, which are factors that determine the approach that is most effective under certain conditions. Moreover, it demonstrates that the different approaches represent different levels of how intensely R&D functions should be involved themselves in the process of gathering market intelligence on customer needs in NPD projects. Finally, this study extends the knowledge on general market orientation levers for strengthening an organization’s overall NPD processes.

Practical and Managerial Relevance

The managerial relevance of this research is diverse. First, the framework is broadly applicable to a wide range of B2B NPD situations and provides guidance to B2B suppliers on how to effectively utilize CNI and strengthen their market orientation. From a managerial standpoint, strengthening an organization’s overall NPD process is relevant for a B2B organization’s overall performance, because as Crawford & Di Benedetto (2008, p. 7) quote: “A successful new product does more good for an organization than anything else that can happen”. Moreover, this study will provide guidance for B2B organizations incorporating a market orientation that would fit their NPD projects, depending on their project and market conditions, by researching the corresponding contingencies. That makes this research very relevant for a wide range of innovation-driven organizations or organizations that want to become more innovative. Second, this research adds to the understanding of under which conditions a certain approach is most effective. From a B2B organization’s standpoint, it is important to know these conditions, since involving the wrong input for R&D might result into commercial disappointment of the product innovation, while NPD investments are commonly high investments and successes are crucial for survival of the organization (Crawford & Di Benedetto, 2008).
Additionally, there will be a specific managerial relevance for all companies that cooperated in this study. In total, 15 organizations participated in this research. They will all receive a company-specific report, which will show them the overall takeaways of the research, but also their revealed strengths and weaknesses in these practices. In other words, it will guide them in adopting the right approach in future NPD projects and provides them with learning points on their current innovation processes, in order to help them increase the probability of their future new products’ commercial success.

Finally, it strengthens Arthur D. Little core strategic competence of innovation and guides them in following their mission of helping clients to permanently reinventing their business model.

1.4. Thesis Outline

In the remainder of this report, the several steps of conducting a research are structured through the subsequent chapters. First, in chapter 2, an overview of the extensive literature review that was conducted for this research will be given, and the specific gaps in the academic literature to be addressed will be identified. The research design and methodology of the field study that was chosen on the basis of the outcomes of the literature review will be described in Chapter 3. In Chapter 4, an overview of the results of this field study is provided and they will be analyzed. Finally, in Chapter 5, the thesis is concluded with the main conclusions, theoretical and managerial contributions and directions for future research. The appendices include the interview guide, examples of the analysis procedures and a skeleton of a typical company specific report that will be sent out to the different organizations that participated in this research project. An overview of the contents of every chapter of this thesis will be given in Table 4 below.

<table>
<thead>
<tr>
<th>Chapters</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chapter 2: Literature overview</td>
<td>• New product development theory</td>
</tr>
<tr>
<td></td>
<td>• Market orientation in new product development</td>
</tr>
<tr>
<td></td>
<td>• The roles of functions in carrying out market orientation in NPD</td>
</tr>
<tr>
<td></td>
<td>• Conclusion and research gaps</td>
</tr>
<tr>
<td>Chapter 3: Methodology</td>
<td>• Research questions</td>
</tr>
<tr>
<td></td>
<td>• Research design</td>
</tr>
<tr>
<td></td>
<td>• Data collection</td>
</tr>
<tr>
<td></td>
<td>• Data analysis and interpretation</td>
</tr>
<tr>
<td>Chapter 4: Analysis of results</td>
<td>• Conceptualization of R&amp;D approaches</td>
</tr>
<tr>
<td></td>
<td>• Contingencies of approaches</td>
</tr>
<tr>
<td></td>
<td>• Leveraging activities</td>
</tr>
<tr>
<td>Chapter 5: Discussion &amp; conclusions</td>
<td>• Main conclusions</td>
</tr>
<tr>
<td></td>
<td>• Theoretical implications</td>
</tr>
<tr>
<td></td>
<td>• Managerial implications</td>
</tr>
<tr>
<td></td>
<td>• Limitations</td>
</tr>
<tr>
<td></td>
<td>• Direction for future research</td>
</tr>
<tr>
<td>Appendix</td>
<td>• Interview guide</td>
</tr>
<tr>
<td></td>
<td>• Illustrative Quotes</td>
</tr>
<tr>
<td></td>
<td>• Within case analysis example</td>
</tr>
<tr>
<td></td>
<td>• Cross-case analysis example</td>
</tr>
</tbody>
</table>

**TABLE 4: LIST OF CONTENTS PER THESIS CHAPTER**
2. LITERATURE OVERVIEW

Current research has been focusing on the role of market information data in NPD, and especially on how the marketing department is involved in this process. Research has shown that the marketing department is highly important in generating market intelligence for NPD, which refers to the process of acquiring and analyzing information in order to understand the market of both existing and potential customers, to assess the current and future needs, preferences, attitudes and behavior of the market (Wren et al., 2000; Narver & Slater, 1995), but it does not suffice (Kohli and Jaworski, 1990; Judson et al., 2006; Langerak et al., 2004). The marketing department is important as it operates on a strategic level, in which they examine the broader picture with long-term implications for the overall business and take on more of a bird’s eye view, with activities as market trend analysis, market segmentation, and opportunity assessment (Ernst et al., 2010). Furthermore, including operational customer-facing functions (CFFs) such as the sales or technical services functions, who are in direct contact with customers on an ongoing basis, in NPD also increases focus on the customer, and provides specific customer information. (Homburg & Jensen, 2007; Ernst et al., 2010; Judson et al., 2006; Malshe & Biemans, 2014). In contrast to the marketing department these departments function more on an operational level. As such, these functions have more specific market knowledge about particular customers and competitors (Homburg & Jensen, 2007). In B2B organizations the role of the these CFFs is important, due to the typically smaller client base and closer contact with those customers (Fu et al. 2010). Surprisingly, the literature about this matter is scarce.

Moreover, various studies have shown that cross-functional cooperation and communication between functions is a key success factor in NPD (Troy et al., 2008; Cuijpers et al., 2011 De Luca & Atuahene-Gima, 2007). However, mainly the cooperation and communication between R&D and marketing has received a lot of attention in academic research (Ernst et al., 2010). There is little literature on the cross-functional cooperation between R&D and the more operational customer-facing functions sales and services.

Therefore, the goal of this literature overview is to provide an overview of the literature on the role customer-facing functions, next to marketing and R&D, in new product development with respect to gathering market intelligence. It starts with describing new product development and its processes, research on market-oriented organizations, and integrates both literature fields. After this, we address the typical individual roles of the R&D, marketing, sales, and (technical) services functions in carrying out a market orientation in NPD, and moreover, the cooperation and communication processes between these function, i.e. their interfaces, in this matter.

2.1. NEW PRODUCT DEVELOPMENT

Utterback and Abernathy (1975, p. 642) define product innovation as “a new technology or combination of technologies introduced commercially to meet a user or a market need.” New product development refers to the complete process of bringing a new product to the market. It is described as the transformation of a market opportunity into a product available for sale (Krishnan & Ulrich, 2001). Ringen et al. (2012) classify product innovation based upon two dimensions: “new to the company” and “new to the market”. A product that is “new to the company” refers to a product that the company never
produced or sold before, but might be offered by its competitors. Products that are “new to the world” are the first of their kind. Ranging within these two dimensions, the following matrix in table 5 shows six distinct product categories that are commonly used to classify new products.

<table>
<thead>
<tr>
<th>low</th>
<th>“Newness to the market”</th>
<th>high</th>
</tr>
</thead>
<tbody>
<tr>
<td>low</td>
<td>Cost reduction</td>
<td>Repositioning</td>
</tr>
<tr>
<td>“Newness to the firm”</td>
<td>Product Improvement</td>
<td>Additions to existing lines</td>
</tr>
<tr>
<td>high</td>
<td>New product lines (new to the firm products)</td>
<td>New to the world products</td>
</tr>
</tbody>
</table>

**TABLE 5: CLASSIFICATION OF PRODUCT INNOVATIONS (RINGEN ET AL. 2012)**

### 2.1.1. NEW PRODUCT DEVELOPMENT PROCESS

Nonetheless, new product development is risky and uncertain (Cooper, 2001). Since the early nineties, research has been done on the phenomena of new product development processes, because it was believed to be necessary for effective new product development (Griffin, 1997; Cooper, 1994; Cooper et al., 2001). The new product development process typically consists of several activities that firms employ in the complex process of delivering new products to the market. Every new product will pass through a series of stages from ideation through launch. Across management literature and different firms, the new product development process is segregated in many different ways, with different numbers of phases (or stages) and different labels for these stages. There is no one size fits all idea-to-launch process for new product development in today’s fast moving world, but it generally consists of three major stages: concept development, product development and implementation (Ernst et al., 2010). Also, the segregation into more than these three main stages process is not applicable to every organization. Likewise, in a research of Durmusoglu and Barczak (2011), it is stated that the PDMA (Product Development & Management Association) recommend adopting this three-phased decomposition, and, moreover, it is used in other recent empirical studies as well (Durmusoglu & Barzcak, 2011; Malshe & Biemans, 2014; Ernst et al., 2011; Cooper, 2008). Below, the activities firms typically perform in every of those three stages are explained, as described in Durmusoglu & Barczak (2001), Cooper (2008) and Ernst et al., (2010).

**THE DISCOVERY PHASE**

This phase is also called the fuzzy front-end phase, in which companies start to identify and select market opportunities, by collecting and analyzing customer requirements. New product ideas that align the opportunities with customer needs are generated. It also involves further refinement of the most promising ideas into product concepts before they will enter the next phase of development. The collection of customer information is very critical in this early stage. Typically, product concepts are tested with customers, in order to create a clear description of the selected product requirements that will be developed. A project budget and planning will be set up in this stage as well.

**THE DEVELOPMENT PHASE**

In this phase the product requirements and specifications that were defined in the previous phase are translated into a final design, which is then converted into a concrete product that is ready to launch. What matters most in this stage is receiving feedback from customers on the technical product design. This phase also involves testing the product (prototype), both internally and with (a selection of) customers. It
is also the phase during which the marketing plan is sketched and a thorough business analysis is made before moving into launch.

**THE COMMERCIALIZATION PHASE**

Here, the firm decides to market the product. In this phase, the formulation, execution, and synchronization of the launch are performed. During commercialization, the production ramp up, training of the sales forces, purchasing of media time and space, and the development of media messages are also carried out. After sales support and monitoring competitors reactions are also part of this phase.

### 2.1.2. NEW PRODUCT DEVELOPMENT SUCCESS

Evidently, the goal of an new product development process is introducing successful new products in the market (Barczak et al., 2009). A firm can assess the success or failure of a new product development project in any (or all) of many terms, including customer satisfaction, financial return, and technical advantage (Griffin & Page, 1996). Similarly, measures of new product success can be classified into three main categories: (1) financial objectives (profit, margins, sales, payback period (ROI), costs), (2) customer based objectives (market share, customer satisfaction, customer acceptance, unit volume goals), and (3) technical objectives (competitive advantage, speed to market, met performance specs) (Montoya-Weiss & Calantone, 1994; Griffin & Page, 1996). The financial and market share objectives may both be considered as *commercial performance or success*. The commercial success of a new product refers to the new product providing economic profit to the organization (Greg & James, 1997). In other words, the money returned is greater than all the money invested in creating the product.

### 2.2. MARKET ORIENTATION IN NEW PRODUCT DEVELOPMENT

Market-orientation is an important contributor to new product success (Atuahene-Gima, 1995). Many researches have positively linked market orientation to new product performance (e.g. Wren et al., 2000; Baker & Sinkula, 1999; Pelham & Wilson, 1996; Slater & Narver, 1994a; Atuahene-Gima, 1995). It refers to the organizational culture, that most effectively and efficiently creates the necessary behaviors for the creation of superior value for buyers and, thus, continuous superior performance for the business” (Narver & Slater, 1990). Market oriented firms have a long term instead of a short term perspective, create customer value instead of customer satisfaction, unravel latent needs instead of simply voiced needs, and have a creative orientation instead of an adaptive orientation. For a long time, and still by some organizations or industries, it was and is believed that new product success is the result of technology push (Slater & Narver, 1994b). However, more and more organizations realize that innovation and new product success result from being market-driven (Narver et al., 2004). In a best practices research in NPD, Kahn et al. (2012) found that ongoing market research is needed to anticipate and identify future needs and problems. It can, and should, be done in all three stages of NPD: the discovery, development, and commercialization phase (Cooper et al., 2014; Kahn et al., 2012).

The starting point of being a market oriented firm is *market intelligence* (Kohli & Jaworski, 1990; Wren et al., 2000). Market intelligence (MI) is defined broadly as the *process of acquiring and analyzing information in order to understand the market of both existing and potential customers, to assess the current and future needs, preferences, attitudes, and behavior of the market* (Kohli & Jaworski, 1990; 1993). An invention of a new product technology in R&D surely creates an opportunity for innovating,
but an innovation, however, has no commercial value until its market is identified. A firm needs to understand the market situation, which includes, amongst others, (potential) customers, (potential) competitors and market trends, to determine their best target markets, the most suitable product design, and their most optimal marketing strategy (Christen et al., 2009). Continuous feedback from the market using the methods of MI is needed as a key input to production that makes the practice of ceaseless innovation possible.

To determine the degree to which a firm is market oriented, three basic components must be identified. The organization-wide generation of market intelligence, the dissemination of the intelligence across departments and organization-wide responsiveness to it, is referred to as Market Orientation (MO) (Kohli & Jaworski, 1990; 1993). Below, a short description of each indicator in the NPD context will be given.

### 2.2.1. The indicators of market orientation

**Market Intelligence Generation**

Market-orientation starts with generating market intelligence, which, as explain before, refers to the process of acquiring and analyzing information in order to understand the market of both existing and potential customers, to assess the current and future needs, preferences, attitudes and behavior of the market (Wren et al., 2000; Narver & Slater, 1995). MI is a broader concept than just the verbalized, explicit needs and preferences of customers to identify the products or attributes of products that are most valued by customers. It includes an analysis of changing conditions in customers’ industries, and the impact that those conditions have on the needs and wants of customers. Although it should include exogenous factors such as government regulation and legislation, technology, competitors and other environmental forces to make an organization really market-oriented as well, this study only focuses on the customer-orientation aspect of market orientation, since it exerts more positive influence on new product success than a competitor orientation (Narver & Slater, 1994b; Wong & Tong, 2011). Moreover, intelligence on customer needs is directly usable for R&D in the design of their products. We will call this type of market intelligence on customer needs *customer needs intelligence*. Secondly, NPD teams should focus on future (un-verbalized) needs of customers as well, since it might take years to develop and market a product that will satisfy those needs. Organizations have to anticipate those needs, in order to be able to fulfil them once the customer starts asking for it.

There are several mechanisms to generate customer needs intelligence. Traditional market research in the front-end stages of the new product development process generally includes determining the market size and market trends, the market segmentation and competitors, and performing a SWOT analysis. Also, the marketing effectiveness can be measured, which typically include a customer analysis, a competitor analysis, a risk analysis, product research (investigating which products can be produced with the available technology at that time) and Marketing Mix Modelling. Market research in the front end of an innovation process is usually qualitative. In later stages, quantitative measures take over. Key activities are estimating the selling price, testing the product and its packaging at for example trade shows, customer focus groups or interviews, selling the product in a test market, advertising research, brand positioning, and distribution channel research. Also after launch, the market must still be monitored with market research (Kahn et al., 2012).
The more sophisticated firms use techniques that involve customers in the NPD process. Those techniques involve concept testing, product testing (both internal and external), and market testing to determine the product definition and the response of the customer (Cooper et al., 2002). In line with what Kohli & Jaworski (1990;1993) claim about general market-orientation, Cooper et al. (2002) stated that leading organizations in NPD should use a variety of methods to gather customer needs intelligence, to be able learn customers’ current and unarticulated needs, problems and benefits, the customers’ reaction to (the concept of) the product, market size and potential, and the situation of the competitors. Below, a variety of practices that are incorporated during NPD by the best performing firms compared to the rest of the firms found by Barczak et al. (2009), which is the latest PDMA Best Practices study on trends and drivers of success in NPD practices, is given in Figure 2. A noteworthy conclusion is that all of the market research tools that are used significantly more by the best firms. Moreover, except for trade-off analysis, these tools obtain a more qualitative understanding of potential customers and how they interact with and use the products being developed.

FIGURE 2: BARCZAK ET AL. (2009): MARKET RESEARCH TOOLS USED BY THE BEST VERSUS THE REST

MARKET INTELLIGENCE DISSEMINATION

For an organization to adapt to market needs, generated market intelligence must be communicated, disseminated, and/or sold to other relevant individuals or departments. Dissemination refers to the process and the extent of market information exchange within an organization (Kohli & Jaworski, 1990). Customer needs intelligence dissemination can be formal or informal. Formal intelligence dissemination mechanisms (e.g. reports) should be complemented with informal dissemination mechanisms (“hall talk”) (Maltz & Kohli, 1996; Kohli & Jaworski, 1990; Carbonell & Escudero, 2010), and should be balanced between both the horizontal (between different departments) and vertical transportation of market information. “Informal dissemination mechanisms provide greater openness and clarification opportunities, where formal mechanisms tend to be more credible and verifiably, therefore encouraging the use of intelligence if it is contrary to the receiver’s prior beliefs“ (Carbonell & Escudero, 2001, p. 509). It is believed that IT (Information Technology) use supports collaboration, coordination, and communication amongst NPD team members or enhances the base of knowledge available to an NPD team (Dewett & Jones, 2001; Durmusoglu & Barczak, 2011). Durmusoglu and Barczak (2011)
investigated the use of IT tools in the same three phases of new product development as explained in previous sections of this literature review: discovery, development and commercialization. The results show that different IT tools influence new product performance in different phases of the NPD process, depending on the information and communication needs of that phase. For example, they found that the use of e-mail is associated with a higher new product quality or market performance, but only in the development and commercialization phase. This means that in NPD teams, face-to-face interactions between team members in the discovery phase might be crucial. Another finding is that IT tools used for sharing information, such as e-mail, shared drives or project rooms, and file transfer protocols are more important for new product success in the development phase than in either of the other two phases. Apparently, this phase requires team members from different functional areas to integrate their work more and share more information and problems than in the other two phases. Barczak et al. (2009) also investigated the IT and Team support tools that are used by the best performing companies compared to the rest to better organize and manage the information and data within a NPD project. Figure 5 shows an overview of the mostly used IT tools, and, moreover, to what extent that are used by the best versus the rest. Figure 6 shows the team support tools for stimulating communication and information sharing among NPD team members.

Intelligence dissemination influences more than just new product performance. It is also essential in driving products to launch more rapidly (Gupta et al., 1986; Cooper & Kleinschmidt, 1991). On top of this, Carbonell and Escudero (2010) found that intelligence dissemination has a positive effect on innovation speed.

**MARKET INTELLIGENCE RESPONSIVENESS**

Responsiveness is the action that is needed in response to intelligence that is already generated and disseminated. There are two components of responsiveness: (1) response design, which refers to using market intelligence to develop plans, and (2) response implementation, which refers to the execution of those plans (Kohli & Jaworski, 1990; 1993). *Customer-related responsiveness* refers to “the extent to which an organization responds quickly to customer-related changes” (Homburg et al., 2007, p. 19). For an industrial firm, this includes value-adding activities such as solving customer problems, building relationships with customers and customizing the offer (Pehrsson, 2014).

Since competing companies increasingly have access to the same customer needs intelligence, the use of or responsiveness to market intelligence is very crucial for organizations: Unless it responds to market needs, no results are accomplished (Maltz & Kohli, 1996). It is even more important for business performance than intelligence generation or dissemination (Carbonell & Escudero, 2010). Intelligence generation and dissemination do not directly positively influence new product performance, but indirectly through the mediating role of intelligence responsiveness. It also has a positive effect on innovation speed, but only after a certain threshold is reached (Carbonell & Ecooperscudero, 2010). However, it is important that organizations have a high frequency of responding to market intelligence, since it improves innovation speed and new product performance. To promote the responsiveness among team members, award systems should be changed from completely finance based (such as sales and profits) to partially market based (such as customer satisfaction and the intelligence obtained).
Next to IT tools being really important for information sharing, they are also very helpful in responding to market intelligence, in the form of product design tools (Durmusoglu & Barczak, 2011; Barczak et al., 2011).

2.2.2. PROACTIVE MARKET ORIENTATION

Recent literature on market orientation states that simply translating what customers are able to express is not sufficient; their latent needs must also be taken into account. Narver et al. (2004) claimed that for any business to create and sustain new product success, their market orientation must be responsive as well as proactive, with the latter being even more important. This means that just satisfying expressed needs of customers is not sufficient, and that the latent needs of customer are even more important to address. A similar study of Lamore (2013) supports their finding that a proactive market orientation is more positively related to new product success than a responsive market orientation. However, they found a negative relation between responsive market orientation and new product success. A study by Atuahene-Gima et al. (2005) was initiated by the mixed findings of the effects of responsive and reactive market orientation on new product performance. They conclude that both market orientations have curvilinear effects on new product performance and that effects are moderated differentially by the organizational implementation conditions and marketing function power. As such, the effects of responsive and proactive market orientation are contingent. But how do companies incorporate a proactive market orientation, i.e. find their customer’s latent needs? The approach of discovering latent need has often been associated with the lead user method, various customer co-creation techniques and market experiments (Carlgren, 2013). In the study of Carlgren (2013) different methods for discovering latent needs are given:

- Identifying current needs: an inherent focus on the customer context is essential
  - Extensive user research - proactive techniques:
    - ethnographic methods & activity-oriented observations
  - Co-creation techniques
  - Interpretation in teams:
    - the customer is involved in the interpretation and selection of ideas
  - Sharing contextual knowledge
- Anticipating future needs: understanding emerging trends
  - Collaboratively understanding of emerging trends
  - Creative future thinking
  - Use of foresight methods
- Translating insights on identified needs: an open mind to the problem at hand is needed
  - Visualization techniques for communication and facilitation.

Using proactive market orientation in NPD is line with Cooper’s spiral development (Cooper, 2014) or the effectuation theory (Berends et al., 2014; Bretel et al., 2012). Cooper (2014) states that often customers are not clear on what they want (or need) in the first place, so it’s impossible to get a 100 percent accurate product definition prior to development. As Steve Jobs, never a proponent of traditional market research, famously said, “People don’t know what they want until you show it to them” (Isaacson, 2011, p. 567)” (Cooper, 2014). That is why Cooper developed an idea-to-launch (stage-gate) system for NPD that is more adaptive and flexible, which means that products may be less than 50 per cent defined before going into the development stage, but evolve and adapt to new information as they are developed,
tested, and validated (Cooper, 2014). Such spiral development builds in multiple spirals or iterations that allow experimentation with users. Each spiral consists of (Cooper, 2008):

- **Build**: build something to show to your customers – a prototype, a “protocept”, a simulation, an early beta version.
- **Test**: test that version as soon as possible with customers – ask them what value they see and perceive.
- **Feedback**: assemble feedback from that version of the product from customers or users.
- **Revise**: revise the initial value proposition and the product design based on the received feedback, and start the whole process of build-test-feedback-revise again.

The effectuation theory, which is a specific form of entrepreneurial behaviour and refers to a decision-making process under uncertainty (Brettel et al., 2012). Effectuation in NPD is set out against causation in new product development, which refers to decision-making based on upfront market research to elicit customer preferences and predict future sales (Berends et al., 2014). It is therefore a more prediction-based approach. Under the causation logic, projects are guided clear and stable product definitions. Under the effectual logic, product development would be a more iterative problem-solving process. It is therefore a more action- and control-oriented process, that focuses on existing means to create something new. While causation follows a linear process that seeks to reach the project target as efficiently and with as few surprises as possible, effectuation deals with uncertainty during an R&D project as a crucial source of opportunities (Sarasvathy, 2008).

2.2.3. **CROSS-FUNCTIONAL COOPERATION AND COMMUNICATION: BARRIERS TO MARKET ORIENTATION**

As Narver and Slater (1994b) point out, one of the three elements of a market orientation next to a customer orientation and a competitor orientation, is cross-functional cooperation. Many studies have studied cross-functional cooperation and interfaces in product innovation and new product development (Troy et al., 2008; Cuijpers et al., 2011; De Luca & Atuahene-Gima, 2007). They showed that cross-functional integration increases firms’ innovation performance because it fosters information exchange, enhances the number of potentially useful ideas, and increases flexibility of the workforce. Furthermore, Wren et al. (2000) discovered that the integration of teams is critical to gaining market intelligence, a customer orientation, and ultimately to produce products that will be successful in the market place.

However, research also shows that the interfaces between the several functions within an NPD team hardly hassle-free (e.g. Griffin & Hauser, 1996; Biemans et al., 2010; Homburg et al., 2008). The organizational structure can be a fundamental barrier to implement a market orientation. As can be remarked, reason for the non-existence or non-effectiveness of a market orientation in new product development is the emergence of departments functioning in isolation within an organization. As Bisp (1999) concludes, an organizational structure where functions are distantly linked to the buying public,
i.e. work in silos\(^2\), constrains cross-functional dissemination and hinders the ability to respond to customer needs intelligence. In these situation, there is a lack of interdepartmental connectedness, which presence positively affects market orientation. Organizations where functions work too much in silos, i.e. operate in isolation from other functions, have insufficient and ineffective communication and information sharing, which can cause valuable customer needs intelligence to get lost or not reach the relevant function.

Although the term market-orientation might raise the assumption, Kohli & Jaworski (1990) and Slater and Narver (1994b) claim that market orientation, and especially market intelligence generation, is not the sole responsibility of the marketing department. Neither does it mean that the marketing department is in charge. In fact, companies must disseminate (e.g. communicate) market intelligence throughout the organization and all departments must respond (e.g. apply the insights) consistently (Kohli and Jaworski, 1990; 199; Narver and Slater, 1990; 1995). However, market orientation literature still describes the implementation of a market orientation on a rather abstract and broad level, and treats what should happen in the organization itself as a black box. As a result, it does not specify how these processes should be implemented within the organization, i.e. what the role of the different functions within an NPD team should be when implementing a market orientation in NPD processes. Therefore, the next section will go into more detail on literature that describes which roles the different functions have in NPD, and especially, in how they carry out the market orientation concept in NPD. Since we are focusing on how R&D applies customer needs intelligence directly from the market or through the different customer-facing functions, i.e. marketing, sales, services, we focus on the respective roles of these functions and their interfaces. We therefore also take on the perspective of the R&D function, i.e. how R&D generates, disseminates and responds to customer needs intelligence in NPD.

2.3. **THE ROLE OF R&D AND THE CFFS IN CARRYING OUT THE MARKET ORIENTATION CONCEPT IN NPD**

In researches that discuss cross-functional cooperation with R&D in NPD, still many of them only focus on their cooperation with marketing (Stock & Reiferscheid, 2014). Cooperation or the interface between R&D and marketing is seen as one of the key success factors of new product performance, (Wong & Tong, 2012; Stock & Reiferscheid, 2014; Cuijpers et al., 2011). However, recent studies also indicate the importance of other customer facing functions such as sales and service during different phases of NPD (Ernst et al., 2010; Van der Borgh & Schepers 2014).

The next sections start with general descriptions the roles of R&D and customer-facing functions in NPD. Then, it describes market orientation in NPD from an R&D-perspective, i.e. how the R&D function gathers customer needs intelligence from the market and through the different customer-facing functions, proceeds with how they disseminate in NPD projects and it concludes with how they respond to customer needs intelligence.

---

\(^2\) retrieved on 21\(^{st}\) of July, 2015:
2.3.1. THE ROLES OF R&D AND THE CFFs IN NPD

THE ROLE OF R&D
In NPD, the R&D department is mainly responsible for the generation of new technological knowledge and applying this knowledge to design new products (Ernst et al., 2010). They have dominant responsibility for establishing long-term research directions, keeping alongside competitive technology and identifying and fixing design flaws for future product launches (Griffin and Hauser, 1996). Its focus is usually extremely long-term, compared to other functions.

THE ROLE OF THE MARKETING FUNCTION
In general, the marketing function has dominant responsibility for finding and assessing new applications for products and technologies, trouble-shooting customer problems, producing accurate product literature, and selecting advertising claims (Griffin & Hauser, 1986). Marketing plays crucial role in implementing and successfully managing pronounced market orientation in organizations (Goetz et al., 2013). They are responsible for a wide variety of activities that provide relevant information for the entire NPD process, such as market trend analysis, opportunity assessment, market research, market segmentation, product positioning, and communication (Ernst et al., 2010). Also, they are often responsible for building the business case (Malshe & Biemans, 2014). It that sense, they often are a more strategic customer-facing function, focusing on generating strategic customer needs intelligence. They are more focused on the product itself, since they are mostly responsible for a specific product or product portfolio. Moreover, they are fairly long-term focused, examining long-term implications for the overall business (Ernst et al., 2010).

THE ROLE OF THE SALES FUNCTION
The sales function is typically executed by a frontline employee and is more customer-facing in the literal sense of the word. Sales literature has mainly been focusing on the salesperson-customer interactions, building stable relationships between customers and selling firms based on trust and the avoidance of opportunism and had a strong emphasis on key account management and team selling. Although research on the role of the sales function in launching new products is emerging (e.g., Van der Borgh & Schepers, 2014, Van der Borgh, 2012, Ahearne et al., 2010; Fu et al., 2010), the role of sales has been virtually ignored in other stages of the NPD process (De Jong et al., 2014).

Several researches have indicated numerous reasons why sales can be of additional value as input in NPD (Helm et al., 2014; Ernst et al., 2010; Malshe & Biemans, 2014; Judson et al., 2006). Helm et al. (2014) found that for implementing market intelligence the integration of the sales force within the whole process is crucial lever for an industrial company. Sales has a much stronger and more operational link to individual customers, in contrast to marketing. Therefore, they can help connect marketing to key customers in both the discovery and the development phase (Malshe & Biemans, 2014). Judson et al. (2006) state that sales is well suited for soliciting ‘the voice of the customer’ in NPD. LeMeunier-FitzHugh and Piercy (2006) propose that a sales organization must be valued as a crucial input for critical market intelligence and propose that marketers must demonstrate to salespeople how their market feedback contributes to the firm's strategic activities. Goetz et al. (2013, p. 366) indicated “that the sales function is undergoing transformation and just now realizing the importance of intra-organizational knowledge sharing. Salespeople’s behaviors, which make knowledge available in a form that can be
understood, absorbed, and processed by other members of the organization, are especially important for cross-functional collaboration and communication, which are, in turn, essential elements for organization-wide market orientation [...] In order to improve salespeople’s knowledge-sharing behavior, the sales force should be integrated into the strategic decision-making process (Ahearne et al. 2012) and also needs to assume a more active role in market-related decisions” (Goetz et al., 2013, p. 366).

Sales focuses more on the customer rather than on the product, since they are usually responsible for a certain set of customers, for example in a specific geographical area or a certain industry segment (Ernst et al., 2010). Therefore, sales is more short-term focused than marketing and R&D (Homburg & Jensen, 2007), since its main function is to spot direct and intensive pressures and demands from customer and immediately seeking a fast solution to these problems.

**THE ROLE OF THE SERVICES FUNCTION**

The service function of goods manufacturers are often called technical service. Technical service employees can also be used as a valuable input for collecting customer information. Although not extensively described in literature, frontline service employees can be used to ask customer feedback and use this feedback for product or service improvement (van der Heijden et al., 2013). Because of the nature of their jobs, they are also more operationally customer-facing. Therefore, they have an ideal position to be knowledge brokers between customers and the firm by accessing, filtering, and translating knowledge that is possessed by customers. Service employees whose task is to repair product failures can come up with ideas for improvement by offering new solutions to existing product problems or to increase the overall speed of the recovery process of the product failures. Seemingly, next to their traditional recovery service role - taking corrective actions or initiate product repairs in response to a customer complaint -, service employees can have an innovation or NPD role. However, this role does demand that the service employee starts a dialogue with the customer in which he proactively asks the customer about their experiences with the product instead of just repairing it and leave. This way, the customer might share information which would otherwise have remained unarticulated.

**2.3.2. R&D’S CUSTOMER NEEDS INTELLIGENCE GATHERING IN NPD**

As explained, the R&D ‘s main responsibility is the generation of new technological knowledge and applying this knowledge to design new products (Ernst et al., 2010). They have dominant responsibility for establishing long-term research directions, keeping alongside competitive technology and identifying and fixing design flaws for future product launches (Griffin and Hauser, 1996). However, one of the most important causes for new product commercial failure is the fact that a product innovation is purely product-led (Cooper & Kleinschmidt, 1987). Gupta et al. (1985) refer to it as the simple but really difficult lesson to implement: “Technology alone won’t make successful products. Technological advances should be market driven”. Therefore, R&D should still have a customer-focus by means of a market orientation (Mu & Di Benedetto, 2011). This means that they need to apply market intelligence, specifically customer needs intelligence, in their new product designs as well. Below, the different ways, as known in literature, of how R&D gathers this customer needs intelligence from the market or through the customer-facing functions – therefore, by their dissemination of customer needs intelligence towards the R&D function- are listed. Inherently, it also describes the interface between R&D and the customer-facing functions.
A. DIRECTLY FROM THE MARKET

In the first place, R&D can incorporate a technology orientation, which is more focused on technical intelligence gathering through Internet research, scientific conventions, tradeshows or similar fairs about the latest possible technologies. A strong focus on technology orientation creates product differentiation and products that exceed those of competitors (also known as competitive advantage). Moreover, a technology-orientation can be used to unveil latent needs (Mu & Di Benedetto, 2011) and stimulates the novelty of new product ideas (Spanjol et al., 2011). Besides, Baker et al. (1985) found that successful new process ideas are more likely to originate from engineering or production.

However, Mu and Di Benedetto (2011) state that despite a stronger focus on technology, R&D should still have a customer-focus by means of a market orientation. R&D can generate customer needs intelligence by direct customer connections, without interaction with any other department and translate this knowledge into product features. If and how this direct generation with customer is done, is not well described by literature yet.

B. THROUGH THE MARKETING FUNCTION

The R&D and marketing cooperation is, compared to the interfaces that will be discussed next, highly researched in NPD literature and recognized as one of the most important elements of in NPD success (Atuahene-Gima & Evangelista, 2000; Griffin & Hauser, 1986) and organizational performance (Stock & Reiferscheid, 2014). Apart from their individual tasks, they have shared responsibilities that require cooperation throughout the entire process, such as setting new product goals, identifying opportunities for next generation products or product improvements, understanding customer needs, and finding solutions for the always reoccurring engineering design and customer needs tradeoffs (Griffin & Hauser, 1996). It is important that the marketing and R&D cooperation is manifest throughout the entire NPD project - the discovery, development, and commercialization phases - since their responsibilities might evolve as new technologies solutions become available, customer needs change, competitors come up with new products, or legislation constraints alter (Griffin & Hauser, 1996; Ernst et al., 2010). Gupta et al. (1985) summed up the top five most important areas where R&D- marketing integration is needed:

1. Marketing providing R&D with customer requirements
2. Marketing providing R&D with regular feedback from customers regarding the product performance
3. Marketing providing R&D with information on competitors’ moves and strategies
4. Marketing’s involvement in setting new product goals and priorities with R&D
5. R&D’s involvement in developing new products according to market needs

However, the risk of marketing providing R&D with customer needs intelligence is that it is too focused on the strategic information, since no operational knowledge from the operational functions is processed (Ernst et al., 2010; Homburg & Jensen, 2007). Moorman and Rust (1999) argue that marketing’s value is based on the degree to which it develops the knowledge and skills required to connect the customer to the product, thus contributing to financial accountability. Moreover, marketing’s influence as a input for R&D is bigger when market volatility is high and unpredictable (Homburg et al., 1999), and less in
competitive industries with moderate price-rivalry and highly formalized decision-making process (Goetz et al., 2013) and when market changes are unpredictable (Homburg et al., 1999).

Besides, not all innovation projects require the same degree of integration between R&D and marketing (Song & Thieme, 2006). Some researchers say that the more innovative the project, the greater the need for R&D - marketing integration (Olson et al., 1995). Lamore et al. (2013) implied that a responsive market orientation (which addresses expressed needs of customers) compared to proactive market orientation (which addresses the latent needs of customers) (Naver et al., 2004) would be more market driven and, therefore, the marketing function more dominant. And, in contrast, that a proactive market orientation would be more research driven and, therefore, the R&D function more dominant. As so, they believed that the marketing- R&D integration would be higher in responsive market orientation than in proactive orientation. They found that, indeed, both market orientation strategies were positively related to R&D - marketing integration, but that responsive market orientations show a higher level of cooperation between R&D and marketing, meaning that the marketing department identifies new product opportunities and works with the R&D department to develop creative solutions to these expressed needs.

R&D’s role here is to create tangible solutions to the customer needs that were identified during the market researches. However, both market orientation strategies show that a higher level of marketing-R&D collaboration results into higher market performance, meaning that collaboration between departments result into more successful new product development programs, regardless of the focus on types of customer needs (latent or expressed).

C. THROUGH THE SALES FUNCTION

The interface between sales and R&D has received little attention in literature up till now (De Jong et al., 2014). Ernst et al. (2010) found that the R&D - sales cooperation has a positive and significant effect on new product success in both the concept and product development phase, but no impact in the commercialization phase. However, they call this last finding into question, since for some industries, cooperation and information sharing between sales and R&D in this phase might be beneficial as well.

In most companies, the sales function is not involved in the NPD process until the later stages (Judson et al., 2006). The sales force plays an important role in testing customer reaction to and use of new products prior to launch and in influencing targeted customers to purchase new products after launch, but commonly the bulk of development efforts have been concluded by then.

An explanation as to why cooperation between sales and R&D positively influences new product success is that this cooperation channels critical information regarding customer requirements (Ernst et al., 2010). Sales people have knowledge, skills and relationships that are specific to the market segment they cover (Goetz et al., 2013). Thereby, the input from sales will increase the number of potentially successful new product ideas entering the NPD process (Judson et al, 2006). Furthermore, sales enables R&D to obtain immediate and valuable customer feedback on these ideas. This information and insights sharing between R&D and sales reduces the risk of a new product going into the next, more expensive, development stage of the NPD process that is not in line with customer needs. In the next stage of the product development, what matters most is getting feedback from customers on the technical product design and testing the prototype with customers. Sales can support R&D in this process by selecting the most promising customers for testing the prototype (Ernst et al., 2010). In the commercialization phase, sales is mainly
concerned with the launch of the product and monitoring competitor reactions. R&D is mainly concerned with direct customer contact to provide product training, repairing first malfunctions, and other types of support.

However, for the majority of companies, the sales functions is not equipped with the requisite job skills and training needed to effectively participate in the process of obtaining customer information related to NPD efforts, and provide R&D with the right information (Judson et al., 2006). Therefore, attention must be focused on hiring the individuals who possess the necessary skills and training new and current salespeople to perform such tasks is crucial (Autuaheme-Gima, 1997). Moreover, incorporating the right incentives, that are related to submitting new product ideas (Kleinschmidt & Cooper, 2004) for the salesforce is needed to make them more proactive is this behaviour (Gordon et al., 1997; Judson et al., 2006). Furthermore, although not much is known about in which NPD situation the sales force is a more effective input than in others, de Jong et al. (2014) state that in markets in which organizations are shifting from basic to customized products, organizations might benefit from a bigger role of the sales function(de Jong et al., 2014).

D. Through the Service Function

The interface between the R&D and service departments in goods manufacturers is a blind spot in research, i.e. no literature could be found on how R&D gathers customer needs intelligence from the service function.

E. Through Multiple Functions

Finally, R&D can gather its required customer needs intelligence through several functions simultaneously. In literature on market orientation, it is stated that the generation (next to the dissemination and the responsiveness) is the responsibility of the whole organization (Kohl & Jaworski, 1990; 1993). In other words, being a market oriented organization should be a cross-functional responsibility. However, it is not specifically described which functions should have which role in the generation of customer needs intelligence.

Much of the cross-functional cooperation that has been studied within the NPD literature has been derived from the resource dependence theory (Salancik & Pfeffer, 1978; Hillman et al., 2009). The resource dependence theory states that the degree of interdependence and the nature of interactions among various functional specialists in an organization are affected by the accomplishment of the collective task (Song & Swink, 2002). This means that the relative importance of each function, in this case, in providing R&D with customer needs intelligence, in NPD strongly depends on the nature of the tasks and activities performed at that moment (Ernst et al., 2010). Therefore, an R&D function could gather its customer needs intelligence from different channels or functions, depending on the task or activity they have to perform at that moment in time. However, the literature on this matter is limited.
2.3.3. R&D’s Dissemination of Intelligence in NPD

From the current perspective, R&D’s dissemination refers to R&D sharing their knowledge with the market, directly or through the customer facing functions. Customer needs intelligence needs to be combined with technological knowledge from R&D, for example on their technological competence or opportunities, to achieve new product success (Rubera et al., 2012). R&D’s knowledge involves, amongst others, information on their technological capabilities, competences, opportunities, and preliminary product features. In a research into the key success factors of transferring R&D knowledge, Cummings and Tjeng (2003) found that the extent to which different functions share similar knowledge bases increases the knowledge transfer success. Moreover, Song et al. (2010) found that the co-location of functional units improves R&D knowledge sharing as well. Information on new product ideas is usually shared through oral communication, written communication or through Information Technology (IT) tools (Judson et al., 2006).

2.3.4. R&D’s Responsiveness to Customer Needs Intelligence in NPD

NPD projects can use several design engineering tools to improve their responsiveness to customer needs intelligence. They are used to translate customer needs into new product designs. Some examples of tools by top innovating firms are Six Sigma, Concurrent Engineering, Quality Function Deployment and Value Analysis, and rapid prototyping (Barczak et al., 2009). They can also all be used for faster product development times.

2.4. Conclusion

To summarize, R&D needs input in the form of market information to design and develop new products that are commercially successful (Gupta et al., 1985). Although IT tools and systems are important sources of information in market orientation (Jayachandran, 2005), this study will focus on the different functional departments as input of customer needs intelligence for R&D and their interface with R&D in NPD, since their interactions with customers are the primary sources for customer information, but does take the use of IT tools in market orientation processes in NPD into account.

In most NPD literature, marketing is seen the usual and most common input of this information for R&D. Nevertheless, other inputs may provide valuable insights in this matter as well. Reviewing the previous sections, one can conclude that the more operational CFFs can have additional roles executing the market orientation concept in NPD, next to the roles of R&D and marketing, to increase new product success. Although the role of sales or (technical) services in new product development (not selling or servicing) and their interface with R&D, engineering or manufacturing is unknown. Despite the fact that is has been found that the R&D – sales, R&D - services and the marketing – sales integration is very important, the exact role of how sales or (technical) services can contribute in the generation, dissemination and responsiveness to R&D in NPD, what their responsibilities are and how they should interact with R&D in this matter still remains unclear in literature (Ernst et al., 2010; de Jong et al., 2014). As Ernst et al., (2010, p. 89) state: “Further research is needed to examine the specific processes by which these types of information are input into the NPD process. For example, some ways of collecting and reporting customer information from sales may be more effective than others.”
Secondly, apparently, R&D case use different functions through which they gather customer needs intelligence. In this study, we will focus on this aspect of generation in NPD: how customer needs intelligence is gathered by the R&D function. These different ways of how R&D gathers customer needs intelligence directly or through other functions can be described as gathering approaches. They are shown in Figure 3. As can be seen in Figure 3 this research will complement the approaches found in literature with the possibility of (an)other customer-facing function(s) providing R&D with valuable market intelligence, that has not been described by literature yet. As explained before, we will focus on the customer needs aspect of market intelligence: customer needs intelligence.

Accordingly, we propose the following set of approaches that R&D can apply to receive customer needs intelligence needed for new product development:

1. Direct R&D approach: one specific customer or a small group of selected customers are providing R&D with direct information on customer needs and wants to apply in the design of the new product. However, this approach is not well described by literature yet. This research has to find out if and how R&D functions would adopt this approach.

2. Dominant customer-facing function approach
   2.1. Through marketing: marketing is the dominant input that is providing R&D with general market information on customer needs and wants.
   2.2. Through operational customer-facing functions:
      a. Sales: sales is the main input of market and customer information for R&D.
      b. Services: services is the main input of market and customer information for R&D.
   2.3. Through (an)other customer-facing function(s): Do organizations use other functions that are in direct contact with customers on an ongoing basis, that can present R&D with valuable market and customer insights that is not yet described in NPD literature?

3. Multiple customer-facing functions approach: a certain combination of different abovementioned customer-facing functions are used to provide R&D with market information throughout the NPD process and project, with each their own role or specialization.

A summary of all current findings in literature of these three overall approaches can be found in table 6. Next to a general description of the approach, the findings om how an approach contributes to or undermines new product success, and the internal and external factors that influence that relation, as described in the literature search, are shown. However, when, in what situations and how to use which approach to get the right customer needs intelligence to R&D for them to be able to apply in new product designs? In existing literature, there is no overall conceptualization of the factors influence the approach that is most beneficial for R&D to adopt in a certain NPD situation. These factors or conditions have to be concluded from the conducted research. These can be called contingencies, which means that the choice of an approach is dependent on the fulfillment of a certain condition. Moreover, the organizational structure of working in silos, i.e. functions operating in isolation from others, can hinder the dissemination and responsive practices, this study will investigate the dissemination (information sharing) between R&D and the CFFs, and their responsiveness to CNI during the entire NPD process, i.e. during all three stages of discovery, development and commercialization (Durmusoglu & Barczak, 2001).
RESEARCH GAPS

Based the conducted literature review, this research will address several research gaps. First of all, current literature lacks an integrative and overarching conceptualization of R&D’s approaches to gather customer needs intelligence in NPD projects. Second, an overview of factors that R&D, marketing, sales and services, or other market-oriented functions may incorporate to best generate, disseminate and respond to customer needs intelligence in these approaches; especially the roles of sales and services in these processes is unclear as well as the role of their corresponding cooperation with R&D are under-researched. Third, an overview of the internal (e.g. project type, innovation typology, or other) and external (market dynamics, magnitude of client base, or other) contingencies that determine which of these approaches to apply in which situation to enhance the probability of new product success.

FIGURE 3: CONCEPTUAL MODEL OF R&D APPROACHES TO GENERATE, DISSEMINATE AND RESPOND TO CUSTOMER NEEDS INTELLIGENCE
<table>
<thead>
<tr>
<th>Research fields</th>
<th>Direct &amp; R&amp;D approach</th>
<th>Marketing</th>
<th>Dominant customer-facing function &amp; R&amp;D approaches</th>
<th>Services</th>
<th>Multiple customer-facing function &amp; R&amp;D approach</th>
<th>Gaps in current research &amp; contributions of this thesis project</th>
</tr>
</thead>
<tbody>
<tr>
<td>General description of R&amp;D’s approach to use customer need knowledge in NPD</td>
<td>R&amp;D generates MI and CNI directly from customers, without interaction with any other department and uses knowledge on technologies to translate this into product features (Griffin and Hauser, 1996).</td>
<td>Most common approach in literature, the R&amp;D-marketing interface; marketing is responsible for generating MI and CNI (Wong &amp; Tong, 2012; Stock &amp; Reiferscheid, 2014; Malshke &amp; Biemans, 2014; Cuipers et al., 2021)</td>
<td>Several researches have indicated numerous reasons why sales can be of additional value as input in NPD (Hein et al., 2014; Ernst et al., 2010; Malshke &amp; Biemans, 2014; Judson et al., 2006), because Sales has a much broader and more operational link to individual customers, in contrast to marketing. However, the exact role they can play in NPD is unknown (De Jong et al., 2014).</td>
<td>One suggestion made by van der Heijden et al. (2013), to use services as direct customer contact for turning complaints into suggestions for improved new products.</td>
<td>Being a market-oriented organization, that is, including several departments in generating, disseminating and responding to MI and CNI (Kohl &amp; Jaworski, 1990). But how exactly, is not described.</td>
<td>Research Gap 1: Integrative and overarching conceptualization of R&amp;D’s approaches to capture market intelligence on customer needs in NPD projects</td>
</tr>
<tr>
<td>Extent of current research</td>
<td>Well-researched</td>
<td>Scarcely-researched</td>
<td>Under-researched</td>
<td>Under-researched</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Typical performed activities</td>
<td>Technology orientations: Technical intelligence gathering (Internet research, R&amp;D’s personal contact with customer, scientific conventions, trade shows)</td>
<td>Traditional market research: conjoint analysis, customer surveys, focus groups</td>
<td>Sales report analysis, face-to-face contact with (leading) customer, Customer Relationship Management (CRM)</td>
<td>Primary recovery service role, and sourcing customer knowledge and developing ideas for performance improvement</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Research findings on contribution of approach on new product success</td>
<td>A strong focus on technology orientation creates product differentiation and products that exceed those of competitors (i.e., competitive advantage); technology-orientation is used to unveil latent needs (Mu &amp; Di Benedetto, 2011).</td>
<td>Marketing plays crucial role in implementing and successfully managing pronounced market orientation in organizations (Goetz et al., 2011).</td>
<td>Sales force is uniquely equipped to understand customers’ needs and wants; direct and unique contact with customers (De Jong et al., 2014) and understands what features should be best added to current products (Judson et al., 2006).</td>
<td>-</td>
<td>Articles on effect market orientation on new product success (Mooman &amp; Rust, 1999; Narver &amp; Slater, 1990, etc.) and articles on effect of cross-functional collaboration in NPD on new product success, say that a cross-functional approach is most successful. However, they do now describe how in detail.</td>
<td>Research Gap 2: An overview of factors that an organization, that is R&amp;D, Marketing, Sales and (Technical) services or another market-oriented function, may incorporate to best generate market intelligence, disseminate market intelligence and respond to customer needs intelligence in these approaches; especially the roles of Sales and Technical services in these processes is unclear as well as the role of their corresponding cooperation with R&amp;D are under-researched.</td>
</tr>
<tr>
<td>Research findings on reasons the approach hinders new product success</td>
<td>Not sufficient; possibility of creating new products that have no link to the market (Griffin &amp; Hauser, 1996). Successful new process ideas are more likely to originate from engineering or production (Baker et al., 1985). Technology orientation improves the novelty of new product ideas (Spanjol et al., 2011)</td>
<td>Not solely sufficient; possibility of being a too “strategic” approach, no operational knowledge from more operational departments is processed (Kohl &amp; Jaworski, 1990).</td>
<td>Sales is presumed to have no technical knowledge for understanding customer needs (and therefore lacks credibility) towards R&amp;D (Judson et al., 2006).</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Research findings on internal factors that influence the success or failure of the approach</td>
<td>Despite a stronger focus on technology, R&amp;D should still have a customer-focus by means of a market orientation (Mu &amp; Di Benedetto, 2011).</td>
<td>Marketing’s influence as a input for R&amp;D is bigger when market volatility is high and unpredictable (Homburg et al., 1999).</td>
<td>Sales needs a more active role: it should be integrated into the strategic decision-making process of being market-oriented in NPD, to improve salespeople’s knowledge sharing (Ahearne et al., 2012). Incorporate performance metrics in compensation and control systems for sales departments. (Kraft et al., 2012). Moreover, when the salesforce only receives incentives on sales numbers on existing products, there is little motivation for new product idea generation activities (Gordon et al., 1997; Judson et al., 2006). Little is known on this matter; however, markets in which organizations are shifting from basic to customized products might benefit from a bigger role of the sales function in this context of NPD (De Jong et al., 2014).</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Research findings on external factors that influence the success or failure of the approach</td>
<td>Goa et al. (2007) say that technology orientation has a negative effect on NPD performance at low levels of technological turbulence. Marketing is hardly helpful in less competitive industries with moderate price-rivalry and highly formalized decision-making process (Goetz et al., 2013), and when market changes are unpredictable (Homburg et al., 1999).</td>
<td>Marketing plays crucial role in implementing and successfully managing pronounced market orientation in organizations (Goetz et al., 2011).</td>
<td>Sales force is uniquely equipped to understand customers’ needs and wants; direct and unique contact with customers (De Jong et al., 2014) and understands what features should be best added to current products (Judson et al., 2006).</td>
<td>-</td>
<td>Articles on effect market orientation on new product success (Mooman &amp; Rust, 1999; Narver &amp; Slater, 1990, etc.) and articles on effect of cross-functional collaboration in NPD on new product success, say that a cross-functional approach is most successful. However, they do now describe how in detail.</td>
<td>Research Gap 3: An overview of the internal (project type, innovation typology, or other) and external (market dynamics, magnitude of client base, or other) contingencies (moderators) that determine which of these approaches to apply in which situation to enhance the probability of new product success.</td>
</tr>
</tbody>
</table>

**TABLE 6: OVERVIEW OF LITERATURE RESEARCH ON R&D APPROACHES**
3. METHODOLOGY

The following section elaborates on the research methodology. From the literature review, a more specific research question can be initiated. Several sub research question are needed to help answer that question. They will be described below. Afterwards, the research methodology and design that is used to answer those questions is outlined.

3.1. RESEARCH QUESTION

To address the gaps as described in the literature overview conclusion, the main research question is:

Which approaches can R&D use to gather customer needs intelligence during new product development (NPD) projects, and what are associated contingencies that enhance dissemination and responsiveness of the whole NPD project team, that will lead to commercial success of new products?

To be able to answer this main research question, several sub research questions are used:

1. Which approaches does R&D use to gather customer needs intelligence?
2. Which factors enhance dissemination between R&D and customer-facing functions in NPD projects?
3. Which factors enhance responsiveness of R&D and customer-facing functions in NPD projects?
4. Which are internal factors (or contingencies), within NPD project teams, determine which approach the R&D will incorporate to gather, disseminate and respond to customer needs intelligence in NPD projects?
5. Which external factors (or contingencies), outside of NPD project teams, determine which approach R&D will incorporate to gather, disseminate and respond to customer needs intelligence in NPD projects?

3.2. RESEARCH METHODOLOGY

A combination of the literature analysis (see chapter 2) and a field study is used to develop a model that will describe R&D’s approaches to using customer needs intelligence in B2B organizations. Figure 5 provides an overview of the research process, the process from the definition of the initial problem towards the closure of the study. Step 1, 2 and 3 in Figure 5 are conducted in previous sections. The next sections will describe the qualitative field study: the research design, and the data collection and process of the analysis of the field study (step 4, 5, and 6 in Figure 5). Chapter 4 and 5 will describe the conceptualization of results of the study, the discussion, and the conclusion.

3.2.1. RESEARCH DESIGN

An exploratory, qualitative multiple case study research method is adopted. This study is of exploratory and qualitative nature, because the research area, sketched in the literature review, is rather unexplored and under-researched. The goal of an exploratory and qualitative research is to give an indication as to the why, how, and when issues considering this research topic (Blumberg et al., 2008). This study uses the method of a multiple case study research, because several cases are used to arrive at specific or general conclusions about certain phenomena, while recognizing the multitude of variables, complex
interrelations, and ambiguities of business life (Gummesson, 2005). Therefore, it can be concluded that the characteristics of a case study research are beneficial for investigating the problem at hand. Eisenhardt (1989) described the general process of building a theory from case study research, as shown in Figure 4. It starts with selecting cases, followed by crafting instruments and protocols for data collection. For example, choosing if the data collection will be quantitative or qualitative. Then, a researcher must enter the field for data collection. The analysis of the data is done by within-case and cross-case analyses. By means of iterative process of formulating constructs and relationships, and searching for the why behind the relationships, hypotheses can be shaped. These have to be compared by conflicting as well as similar research to be able to come to the final theory.

![Figure 4: Building Theory from Case Study Research (Eisenhardt, 1989)](https://via.placeholder.com/150)

How these subsequent steps will be executed is explained in the following sections and chapters.

**Case Study Selection**

Arthur D. Little (i.e., Amsterdam office) has a large network of technology and innovation driven companies. Organizations from their client base and from university relations were invited to participate in this research. In developing the sample, it was attempted to maximize the diversity among participants by selecting organizations from different industries and of different sizes, but simultaneously, to be able to generalize the results, to increase the external validity (Gibbert et al., 2008). External validity is the believe that theories must not only account for phenomena in the settings of which they are researched, but also in other settings. This study places itself in the wider context of technology and innovation driven business-to-business (B2B) companies. Market intelligence gathering is especially important for B2B companies since they are confronted with more complex customer demands, and operate in value networks comprised of a highly diverse set of stakeholders. Moreover, customer-facing employees from sales and service often are more important for B2B organizations since the client base is usually smaller and the contact is closer. These customer-facing functions spend a significant amount of time with customers and are in a unique position to serve as a primary source of information regarding marketplace problems and customer requirements (Chonko et al., 1991).

In total, 32 cases were selected for study from 15 companies. Each case study represents a recently completed NPD project in which *product innovations*, which are a new technology or combination of technologies introduced commercially to meet a user or a market need were developed. The selection of cases focused on innovations that range between completely incremental and completely radical product innovations which include the following set of product innovations types as proposed by Ringen et al. (2012) (see Table 5): repositionings, new to the customer products, product improvements, additions to existing product lines and new product lines. The reason for this selection is that for very incremental innovations, such as cost reductions, or very radical (or breakthrough) innovations, such as new-to-the-world products, market intelligence gathering plays a less decisive role (Song & Thieme, 2009).
<table>
<thead>
<tr>
<th>Research Phases</th>
<th>Tasks and illustrating figures</th>
<th>Deliverables</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Definition of problem</td>
<td>The observation of a concrete business problem:</td>
<td></td>
</tr>
<tr>
<td></td>
<td><img src="image1.png" alt="Diagram" /></td>
<td>Literature study and relevant research gaps</td>
</tr>
<tr>
<td>2. Initial literature review for developing conceptual framework</td>
<td>Literature research on relevant theories</td>
<td>Three initial main and seven sub approaches for R&amp;D to use market intelligence on customer needs in NPD</td>
</tr>
<tr>
<td></td>
<td>- New product development</td>
<td>Corresponding activities, belonging to each approach, for as far as current literature and knowledge is sufficient</td>
</tr>
<tr>
<td></td>
<td>- Market orientation: generate, disseminate and respond to customer need intelligence</td>
<td>Several links to commercial performance of new products</td>
</tr>
<tr>
<td></td>
<td>- Roles departmental functions in NPD and their respective interfaces</td>
<td>The expectation of several contingencies which influence the choice of approaches</td>
</tr>
<tr>
<td></td>
<td>- Transactive Memory System</td>
<td></td>
</tr>
<tr>
<td>3. Research model: conceptual framework</td>
<td>Conceptual model of R&amp;D approaches to generate, disseminate and respond to customer needs intelligence:</td>
<td></td>
</tr>
<tr>
<td></td>
<td><img src="image2.png" alt="Diagram" /></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Three initial main and seven sub approaches for R&amp;D to use market intelligence on customer needs in NPD</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Corresponding activities, belonging to each approach, for as far as current literature and knowledge is sufficient</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Several links to commercial performance of new products</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- The expectation of several contingencies which influence the choice of approaches</td>
<td></td>
</tr>
<tr>
<td>4. Determine research methodology to test conceptual framework</td>
<td>Develop research design</td>
<td>Research Proposal and Interview Guide</td>
</tr>
<tr>
<td>5. Perform exploratory and qualitative field study</td>
<td>Conduct approximately 30 semi-structured interviews within various B2B companies</td>
<td>Transcriptions of interviews</td>
</tr>
<tr>
<td>6. Analysis of field study</td>
<td>Follow Grounded Theory approach: open, axial and selective coding (Strauss &amp; Corbin, 1998)</td>
<td>Contributions to conceptual framework, concerning activities that belong to the different approaches, the link of the different approaches to commercial performance and the identification of contingencies (internal and external)</td>
</tr>
<tr>
<td>7. Discussion and Conclusions: Finalization of framework</td>
<td>Use results from coding process, and connect that to a future literature search, to develop new theory</td>
<td>Final Model</td>
</tr>
<tr>
<td>8. Theoretical arguments and limitations</td>
<td>Final framework of R&amp;D approaches to generate, disseminate and respond to customer needs intelligence, with associated contingencies (internal and external moderators)</td>
<td>Theoretical implications, Managerial implications, Limitations of this study, Indications for future research directions</td>
</tr>
</tbody>
</table>

**FIGURE 5: RESEARCH PROCESS**
3.2.2. DATA COLLECTION

QUALITATIVE INTERVIEWS
Data for the field study was collected by *semi-structured interviews*. Semi-structured interviews are one of the most commonly used qualitative research methods (Clifford et al., 2010). In appendix A, a detailed description of the interview protocol for these interviews can be found, including an introductory questionnaire that was sent to and filled in by the interviewees prior to the face-to-face interview, and the questionnaire that was discussed during the actual interview. In general, the two questionnaires were structured around the following questions:

1. “How would you describe the core business of the project (product), market and technology environment (customers and competitors, and dynamics), project (life span) and new product development activities (stage-gate approach etc.)?”

2. “What activities did your NPD team employ to generate, disseminate and respond to customer needs intelligence?”

3. “How did these activities affect (stimulate or undermine) your new product development activities in the project and the commercial success of the new product?”

Organizations were approached to participate through different channels: emails, phone calls, and teleconferences. To be able to *tease* organizations to participate, a *teaser* document was made that stated the gaps this research would address, which practical or managerial issues it would address, the value the results would have for their organizations and what the subsequent steps of participation would be. Thereafter, an intensive process of staying in contact with these organizations and convincing them to participate took place. During the conversations with organizations, we asked them to provide us with preferably two recently completed NPD projects with the right product innovation type (see section 3.2.1.), one that resulted in commercial success, one that resulted in commercial failure.

In the end, in total, 32 interviews were conducted. 28 of those were about specific NPD projects: 13 resulted in commercial success, 15 in commercial disappointment (Table 7). The interviews used the critical incidents technique. This is a method in which the respondent is asked to answer the questions with respect to exactly one specific case or situation (Flanagan, 1954); in this case, the NPD project. This technique was used to be able to extract the good practices (of the successful projects) from the bad practices (in the unsuccessful cases), since interviewees were asked what the gathering approach of R&D was, and what factors positively influenced or undermined the success of their project. Moreover, the critical incident technique has proven to be able to identify rare events that would have been missed by methods that focus on common events or general experience (Flanagan, 1954). Furthermore, four interviews were about the different approaches the specific organization uses in their typical NPD projects.

The interviews lasted 60 minutes on average and were primarily face-to-face except in one case, which was conducted by phone. 25 of those interviews were in Dutch, seven in English. They were all recorded and transcribed in the same language afterwards. In Table 7 below, an overview of the sample characteristics is given on a new product project level. As shown, the 28 interviews on projects and 4 on general processes, were done with organizations from 8 different industries. From the 28 projects on
specific product innovations, the configuration of the experience with the technology used or the target market is also shown.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Number of cases</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Interviews</td>
<td>Projects</td>
<td></td>
</tr>
<tr>
<td><strong>Industry of organization</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automotive</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chemical industry</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machines and equipment</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturing</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical equipment</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil &amp; Gas</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pharmaceutical</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water treatment</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Product Innovation type (to the organization)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Known technology, known market</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Known technology, new market</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>New technology, known market</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>New technology, new market</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>New product performance (i.e. meet the business case)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial success</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial disappointment</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Generally optimal</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TABLE 7: SAMPLE CHARACTERISTICS OF 32 INTERVIEWS AND 27 SPECIFIC DISCUSSED PROJECTS**

**INTERVIEWEES**

In selecting the interviewees for every case study, the choice was based on three criteria. For every case study, the team member of the NPD team that (1) was part of the project decision-making process from start to end, (2) had a complete overview of all the technical aspects of the project, and (3) had complete insight in how all the functions and stakeholders were involved throughout the project, was selected as interviewee. Typically, the project leader would fit this profile, but the interviewees employed other (hierarchical) roles as well (e.g. vice president, innovation manager, project or product manager). Moreover, the interviewees came from various functions (e.g. marketing, R&D, sales or business development).

**3.2.3. DATA ANALYSIS AND INTERPRETATION**

The unit of analysis of this multiple case study research is the NPD project. The outcome variable is new product success, i.e. when the unit of analysis – the NPD project – met the commercial expectations that were set in the initial business case at the beginning of the project.

As Eisenhardt (1989) described, analyzing the data from a multiple case study research is done by within-case studies and a cross-case pattern search. A within-case analysis gains familiarity with the data and
stimulates a preliminary theory generation. This analysis existed of an iterative process of analyzing every single conducted interview. The cross-case analysis analyzes across cases, and forces investigators to look beyond initial techniques, relationships, impressions and see the evidence through different lenses. The two analyses were done by the Grounded Theory approach (Strauss & Corbin, 1998): open, axial and selective coding.

Firstly, in chunks of five transcriptions at a time, the writer of this report and her supervisor independently engaged in open coding. In this step, concepts that are present in the data are identified and given a label - a code. For the coding process, a codebook with a list of codes was used. The content of the final codebook can be found in Appendix B, and shows the names of the codes and sub codes that were used together with their description. Afterwards, results and related differences from both parties were compared and discussed. In an iterative process, the coding plan was changed by means of these discussions, until no more changes had to be made. In deciding which codes to include in the next steps of analysis, the frequency of the mentioned concepts among all participants was taken into account. Moving to axial coding, relationships between the different categories of data that have emerged from the open coding process were attempted to recognize. “The essence of this approach is to explore and explain a phenomenon (the subject of your research project, or one of them) by identifying what is happening and why, the environmental factors that affect this (such as economic, technological, political, legal, social and cultural ones), how it is being managed within the context being examined, and what the outcomes are of the action that has been taken” (Saunders et al., 2009, p. 511). Specifically, the various R&D approaches were related to new product success or failure, and the associated contingencies. Finally, selective coding was conducted, which is used as a integration and refinement process, to come to the overall framework with its moderators, which is the objective of this research. For the within-case analyses, for every transcript, the following aspects were extracted:

- The overall process from product ideation to launch
- All communication processes that occurred between R&D and customer
- Factors that determined the selected customer needs intelligence gathering approach of the R&D function
- Factors that positively influenced or undermined the approach

Examples of these case study analyses can be found in Appendix D. For every approach, two illustrative examples will be given: one that resulted in commercial success, and one that resulted in commercial failure. The cross-case analysis can be found in the excel sheet in Appendix E. This analysis was done by filling in all constructs, which represented all mentioned phenomena by interviewees, for every project, and analyzing that against the commercial result of the project and the approach used. In further examining this data, the variables with distinct relations to or patterns with the adopted approach and commercial success were extracted, the others were left out.

The results of these analyses are described in the next chapter.
4. CONCEPTUALIZATION OF OVERALL FRAMEWORK

From the multiple case studies, several approaches of how customer needs intelligence is gathered by R&D people in NPD teams were extracted. We will discuss how each approach is related to the new product performance in terms its commercial success, with its own variety of measures (Wong & Tong, 2012). The case studies also showed that some organizations start off with a technology push approach, which means that no market intelligence on customer needs was gathered initially (Mu & Di Benedetto, 2011). Though, for the approach to result in a commercially successful product, at some point in the project, organizations need to link the technology to the market or the customer. How that is done, will be described by the conceptualization of the different approaches in the following section. Moreover, there will be discussed how each approach is related to new product success in terms of the unit of analysis: the NPD project’s success. From a B2B organization point of view, it is important to know how the costs of incorporating the approach can be earned back by the additional value it will yield. Furthermore, it appeared that which approach to adopt depends on certain contingencies, i.e. moderators, that form two connected sets: structural and process moderators. The overall conceptual framework is depicted in Figure 6 and will be conceptualized and explained in the next sections. Appendix F provides tables that shows how often these concepts were mentioned by interviewees.

4.1. CONCEPTUALIZATION OF R&D APPROACHES OF GATHERING CUSTOMER NEEDS INTELLIGENCE

We propose four overall approaches that an R&D function can adopt to gather customer needs intelligence in NPD processes: (1) the direct R&D approach, (2) the indirect dominant CFF – which can be the marketing, sales, services, or a sales engineering function – approach, (3) the indirect multiple CFF approach and (4) the combined approach. Below, the conceptualization of every approach is discussed. As many of them are not yet described in literature, illustrative quotes that make up the conceptualization of the approach can be found in Appendix C.

DIRECT R&D APPROACH

The direct R&D CNI approach refers to the R&D function’s independent customer needs intelligence gathering activities, without help or support from typical market-oriented functions such as marketing and sales. An R&D function engaging this in this approach has a more leading role in actively identifying customer needs and translating them into product requirement based on customer needs by means of personal conversations with employees from (potential) customer organizations. This approach often involves a project concerning the development of complex, high-tech products where product designs and parameters continuously need to be verified throughout the project at, for instance, the customer’s site. In the words of an R&D manager of a chemical organization,

[Respondent 9]: For us, it becomes extremely technical in an early stage. We are doing lab tests for our customers and also pilot plants at our customer’s site. All the technological or engineering departments were involved in this. [...] We had direct customer contact on the operational issues and the results of those tests.
Customer needs intelligence gathering approaches

1. Direct R&D Approach
   - Reliance on direct customer contact
   - CFF = marketing, sales, technical service and/or sales engineering function

2. Indirect Dominant CFF Approach
   - Reliance on customer-facing function

3. Indirect Multiple CFF Approach

4. Combined Approach

Structural Moderators

- Customer – technology needs structure
  - Tacitness of customer needs – technology needs
- Organizational resource structure
  - Dispersion of requirements engineering skills
- Market structure
  - Product roll out strategy

Process Moderators

- Dissemination Levers
  - Formal & informal dissemination between R&D and CFFs
  - Continuous inbound and outbound information sharing
- Responsiveness Levers
  - Objectivity of CNI (fact-based vs. opinion-based)
  - Continuous verification and validation loops

New Product Commercial Performance

- Measures
  - Sales volume
  - Technical requirements (specs) or quality
  - Customer satisfaction
  - Cost target (price, margin, yield)
  - Time to market

FIGURE 6: OVERALL CONCEPTUAL FRAMEWORK
Using the direct R&D approach, a NPD project has a higher chance to be commercially successful (i.e., meet the business case) by translating first-hand customer information (e.g., ‘voice of the customer’) into the design of the new product (Lockamy and Khurana 1995). The direct approach prevents the misinterpretation of technical information as technicians of the selling firm talk directly to technicians of (potentially) buying firms. Moreover, as employees from both the seller and buyer firm speak the same technical jargon they are not only more able but also more willing to share information. As an R&D manager of a high-tech organization explains,

[Respondent 10]: Technicians at the customer’s side are usually a bit more loose-lipped towards us as R&D, we often get more information out of them than out of people on strategic positions such as procurement. Relationship management is extremely crucial for a customer in these situations. For this project, that was our [R&D] responsibility. So technology to technology. I have also sat at the table with sales people, but I do not like that. They have more than one hat, that is very bothersome.

However, the downside of this approach is that if R&D people cannot translate customer needs into design attributes (e.g., aesthetics) projects still may fail. As an R&D manager of a manufacturing company explained,

[Respondent 14]: In hindsight, it was really important for sales to be present, even just on the side, to understand the customer, not only the needs and wishes, but also the worries. [...] For example, we had an issue on noise, which we needed to manage. The customer complaint was that “I don’t like this type of noise”, and not the noise level. The noise level, you can manage on a technical level. But the type of noise, you cannot discuss at a technical level.

The approach also may lead to the isolation of the technical development process from the commercial process where important non-technical customer needs are discussed and determined (e.g., timing of delivery, price, services, legal issues). As the R&D manager points out,

[Respondent 11]: There was a commercial process we did not know about. [...] Eventually, the project failed for commercial reasons. But did we foresee that? I think we can question that. [...] But as you see in many projects, these are the critical moments. I think, in discussions with customers, the technical part of the project went well. But beyond that part, we had no idea what was going on in the market and where it was going. We did not, and commerce did not. Although it was more the role or responsibility of our commercial departments to foresee this.

Thus even if the R&D function develop products that are technically well designed and highly valuable for customer, it could be that the project failed for other non-technical reasons. To deal with these problems, some R&D functions within a NPD project acknowledged their shortcomings in the commercial process and actively involved a customer-facing function within their organization to gather customer need intelligence to help determine design attributes for the new product.

**INDIRECT DOMINANT CFF APPROACH**

The indirect dominant CFF approach refers to the one function being mainly responsible for providing R&D with customer need intelligence. Commonly, these functions are marketing, sales or (technical) services. In this approach, the dominant function acts as a gatekeeper in NPD (Reid & de Brentani,
they “champion” ideas for new product innovations, which means that they decide whether or not to share information from the environment (customers in this case) with others. The indirect dominant marketing approach is mostly used by organizations. Marketing is generally responsible for a wide variety of activities that provide relevant information for the entire NPD process, such as market trend analysis, opportunity assessment, market research, market segmentation, product positioning, and communication (Ernst et al., 2010). Also, they are often responsible for building the business case (Malshe & Biemans, 2014). These activities are all rather strategic. Many of the case studies in this research revealed this particular role for the marketing function as well. However, marketing also talks directly to customers and builds stable relationships, a task usually associated with sales’ responsibility (De Jong et al., 2014). As a project leader of a manufacturing company said,

[Respondent 5]: I am the product marketing manager, I was the primary point of contact for customer interfaces. Certainly I did talked a lot to customers in the market collection phase. [...] So we used a lot of that type of “market research” if you want to call it that, in that phase. And then in general, there were some industry trend reports like third party suppliers for market research saying the volume of samples is growing, things like that.

In a variety of projects that adopted the indirect dominant marketing approach, marketing operated as a filter between the input from sales and service employees and R&D, to make sure only the most relevant information comes in, and also to make sure that the right information goes out. As an R&D project manager adopting the indirect dominant marketing approach points out,

[Respondent 15]: Well, sales does deliver some input, but that always goes through the marketing function. I think it is very beneficial to have one central point of communication who collects all the information, organizes it, and disseminates it. Otherwise, too many discussions will arise in the project team.

Although marketing is commonly described as being the main or dominant input for market intelligence on customer requirements, sales can also be an important input for NPD. Especially in a B2B setting since they have a much stronger and more operational link to individual customers, in contrast to marketing (Ernst et al. 2010). In some situations, next to their typical role, the sales force can also (partly) take over the marketing function’s responsibilities (Homburg et al. 2008). Sales can adopt operate as account managers by facilitating R&D with really specific customer requests for existing products, but they can also cover more strategic topics regarding future general customer needs. As the project leader of a chemical company explains,

[Respondent 2]: The market data was gathered by our sales force through different customers. Not only the specific questions, but covering certain topics. So by talking to different customers, and asking “Is there a general need here and what would they use it for? What would the benefit be”? So sales gathered the market data on customer needs. There was a believe that this was a need, and then we used the sales force to connect to the customers to confirm that need and then to target one big customer to focus on the specifics, to see what would make it successful.

Companies commonly include their sales force, among other functions, in providing R&D with customer needs data. However, the dominant sales approach mainly arose from the personal relationship the sales employee had with the specific target customer. This sometimes resulted in an
undesirable situation, in which the sales employee had too much power. Which, in turn, caused the R&D function to develop a product that was not optimally linked to the overall needs in market, and did not sell as expected. The project manager describes,

[Respondent 2]: The sales person’s interpretation was kind of locked in quickly. Which caused problems. The expectations with the customer were set to quickly, instead of standing back and say: “Well, that is the customer’s view, but what is the actual value of what we are doing? It might have other benefits [...].” So with different expectations, if R&D was engaged in that sort of discussions instead of R&D just developing [...] the product at a certain cost price, sales kind of locked in something we haven’t even proven you can make yet. There should have been a different dialogue at the start: one to manage expectations at the customer, and one to extract more value from the product for [...] our organization.

Although previous research is lacking on the role of the service department in providing input on customer needs our data shows that the service function can be successfully used as main input for R&D in developing their new product. For instance, service employees can serve as input for optimizing new products reliability based on failure history of existing products. The R&D manager explained as to how they use that approach,

[Respondent 7]: From my point of view as R&D in the running business, I do not have direct contact with customers. It is the service organization, and through them, our field service employees. We have in this [...] program where we go over to the field service employees, and we explain them what we are doing with the complaints they have received. That is very important, because the field service employees are talking to customers. They are bringing in an issue, and the customers wants to know when this issue is solved. So communication from [our organization] through the field service employees is a very important key element.

The R&D manager also illustrates why this approach has worked very well in this project,

[Respondent 7]: I think our cooperation and relationship with our service department, as one of the main inputs, is very close. I have daily contact with my colleague, our service manager. We talk about issues in the morning, we talk about issues in the evening, actually all day. We are working very closely together. Both of us have the same KPIs. We have organized a situation that we both are responsible of getting the reliability of [...] our product on a higher platform. Having the same targets, the same KPIs, really works.

Using the indirect dominant CFF approach, an NPD project has a higher chance to be commercially successful, since this specialized function might, for example, have the most extensive product knowledge, know a large part of the potential customer pool, or simply more time to visit the most customers. R&D people then can focus their scarce time on what they do best, designing and developing new products.

On the other hand, being dependent on one function might be detrimental, for instance, because the information is coloured by the specific functional background of the CFF. In that sense, relying on one function only, might not always be the most beneficial way to commercial success of the new product, as the project manager of a chemical organization illustrated,
[Respondent 2]: I was project director, I came in a year after it initiated. My view would be that we lost some of the value in the project, because sales was the only person talking to the customer and feeding back their interpretation of what they believed the customer was looking for. In my view, this got to technical to quick. They were immediately locking us into a corner, so we could not get out of that specifications. If I was able to do it over again, I would involve myself and R&D earlier to try and make that as flexible as possible.

Another project manager used an indirect dominant marketing approach analyses,

[Respondent 8]: Maybe, we relied on marketing a bit too much. You do sense that our marketing function is a bit strange. They are having difficulties with putting in enough effort at the beginning of the project, to be able to clearly define the full set of requirements. We started with a list that needed to be satisfied. The set of requirements was made by marketing, but during the projects a lot of things had to be changed or modified [...]. In this case, we have been able keep that under control, but there are lot of projects in the past where this completely span out of control.

To be able to tackle this downside of one-sided information, some organizations use a hybrid sales engineering function, which can operate as an effective bridge between commercial and technical customer needs (Niu & Wang, 2011). Remarkably, they are the most used indirect dominant function approach in this study. This is a surprising finding, since not much is known on the sales engineering function in current marketing or new product development literature or on its respective role. Often, they are referred to as application engineers or specialists, technical sales, architects, system engineers or integration managers. As the data shows, when the configuration of products becomes more complex, organizations start deploying such a hybrid sales engineering function, since the specialist roles of R&D, marketing, sales, or services are not sufficient in these cases. A sales engineer can adequately mediate in this matter; they are not pure engineers, however, they are not merely commercial as well. They are something in between as they do not only sell but also provide technical advice and support. Accordingly, they combine two abilities: Technological knowledge and interpersonal skills (Niu & Wang, 2011). Organizations often employ a sales engineering function when they are concerned with modular products, which are products that consist of several components with the ability to couple, develop, change, and refine individual pieces independently (Ulrich, 1995). A project leader of an organization that develops modular products clarifies the role of the sales engineering functions in their company,

[Respondent 17]: Systems engineering are our experts on a systems level. They are a kind of internal consultants who have a lot of knowledge on how to translate the logistical question of the customer into the best system concept. You can imagine that we have different building blocks from which we can build up a system. And we have to make a match between what the customer asks and what kind of concept or layout would fit the best. So [applications] are involved in the initial discovery phase, to support the sales force in presenting the best concept to the customer. And they also play a very important role towards R&D, because they have some kind of double role: on the one hand, they talk a lot to customers and receive many questions and requests from them. On the other hand, do they also look at what is generally possible in our market. They search for trends, and what that would mean for our systems in the coming years. And then, how we
could realize these trends or systems in requirements for R&D, so for new building blocks within our entire systems.

As can be remarked, due to their hybrid commercial and technical role, sales engineers are more able to speak the “language” of R&D, have the same goals or targets and timeline in mind. A program manager of a manufacturing company explains his interpretation of this phenomenon:

[Respondent 23]: Marketing looks across the market through different market reports and tries to form a general view on things. It is less based on hard facts. The system engineers often really speaks to customers […]. Sales is usually occupied with the very next project. If you ask a sales guy: “What do you need from us?” he describes the things he needs to win the case he is in right now. Systems is somewhere is the middle: on one hand, they are engaged with the projects at hand, but they also look a bit further than that. So for us [as R&D], they are more valuable. If you solely follow sales, who is running after its next big case, you will lose the main focus.

On the downside, the hybrid characteristic of this function might cause a lack of in-depth knowledge, which R&D and sales do have, or misses the general and broader knowledge that a marketing function possesses. R&D has specific technical knowledge, while sales has higher levels of specific market knowledge (i.e., about customers and competitors) than marketing, which has broader knowledge on entire product businesses (Ernst et al., 2010). Therefore, some organizations used several functions concurrently to provide R&D with customer needs intelligence.

**INDIRECT MULTIPLE CFF APPROACH**

The indirect multiple CFF approach refers to R&D having several (more than one) channels through which they gather market intelligence on customer needs. In this approach, the NPD project becomes a multifunctional program, where all functions work together in a cross-functional team, with the customers (Crawford & Di Benedetto, 2008). Commonly, each function has a specific role in gathering the customer need intelligence. Which functional role belongs to which department differs between the various NPD teams that adopted this approach. The R&D lead of a manufacturing company illustrates that he uses different channels for information about different aspects of the product,

[Respondent 6]: I had discussions with the marketers about the specific components [of our product]. I talked to the systems engineer about the more generic parts […]. Often, the systems engineer and the marketer went to the customer together to gather information [on their needs] for us.

Or as an R&D manager of another organization explains,

[Respondent 15]: Marketing made a Mood Book for us, that showed how the mood of a customer would be for a certain application. And from that Mood Book, there were certain aspects that needed more information for us to be able to work with it. Then sales started to gather the detailed information by visiting customer directly.

Yet, another R&D manager describes,

[Respondent 23]: What worked well for us in this project, is that we split up [the
role for gathering customer information]: [...] we used marketing to see if there was a general need for [our product]. Then, we used system engineers to set up the specific requirements of what exactly to deliver for it to be successful, by talking to a few very dedicated customers.

Using the indirect multiple CFF approach, an NPD project has a higher probability to become a commercial success, since, for their organizations, R&D is typically not the most ideal function to talk to customers, and this can better be left up to the CFFs, who are typically more specialized in this kind of role. This because R&D often speaks a different “language” than the customer or, in situations concerning confidential information, they spill too much information that was not supposed to be spread outside the selling organization. As an R&D employee explains,

[Respondent 3]: At some point in the project, you know the specs and the expected performance. Then it is time to present this to the customer. This is always done through marketing or customer support. We as R&D practically never talk directly to customer. [...] So all information is broadly shared within the project team. We [as R&D] tell them exactly what we are doing. It is up to marketing and customer support to decide what they will tell or show the customer. [...] I am always a proponent of bringing people in direct contact with each other. However, when I am faced with a customer: I am a technician, I start to speak my mind about all that is technically possible or doable. A customer would be frightened to death. That is why it is favorable that someone is in the middle of that, filtering that. I think it is a good thing to present information through other channels that decide what information can be spread... and what not.

However, on the downside, excluding R&D from the customer interface and customer needs intelligence gathering might also bring along some complications. In the words of a project manager of a chemical organization, who has experienced these kinds of problems in his projects,

[Respondent 12]: R&D does not directly gather market data on customer needs. Mostly, the market intelligence generation is done via our group, so the application and technical group with sales. We are the ones who have the direct contact with the customers, the market, with the institutes. We are more or less the eyes and ears. And we bring this information with marketing together, we make a profile together to make the actual product. [...] However, that has changed now. And what we have seen is that if we get R&D involved as well in that process, then they have a more or less a better understanding and the ability to translate what we say into the product itself. So they can actually work faster with it. We have noticed that that leads to a more successful product or project.

As explained in the direct dominant R&D approach, involving R&D in gathering customer needs intelligence assures that they perceive the intelligence first-hand without the interference of another function’s or person’s interpretation. In some situations or for some aspects of customer needs, this might be valuable, since, for example, the technology is so complex or so new. On top of that, it increases the probability of R&D genuinely understanding the customers’ problems or opportunities before developing a solution and the ability to have real-time interactive discussions without any time delays. Some organizations had already adopted that approach in their NPD projects, to able to get information from all sides of the spectrum concerning customer needs intelligence.
COMBINED APPROACH
The combined approach refers to both R&D and one or more CFFs being responsible for gathering customer need intelligence. This approach resembles the Quality Function Deployment (QFD) methodology. QFD is a development process based on inter-functional teams, including marketing, manufacturing, engineering, and R&D (Griffin & Hauser, 1993), and “links the needs of the customer with design, development, engineering, manufacturing, and service functions by finding both spoken and unspoken needs, translating these into actions and designs, and focusing various business functions toward achieving this common goal” (Yung et al., 2006, p. 257). A convincing majority of projects that incorporated this approach resulted in a commercial successful product (5 out of 7) and it was described as the most optimal approach by another 11 interviewees when they were asked what their future points of improvement would be. Several project managers – or managers from other functional areas – depicted why and how they adopted this approach. One project manager explains,

[Respondent 24]: I see added value in the fact that sales collects other information than R&D. If sales talks to purchasing from the customers’ side, other information emerges than when our R&D team talks to the R&D from the customers’ side. R&D is commonly more loose-lipped in sharing information, while a purchaser covers up a lot. So we as R&D share the information that we possess and the information we still need with sales and the application specialists. An application specialist will in turn gather even other information, since he has another background, other needs and also other discussions with customers.

And as another interviewee illustrated,

[Respondent 26]: We, as a company, want to be more specialty than commodity. What is really important in that, is the difference in capability of the people that are at the table with the customers to perform our discovery phase in the right way. To find new information and insights. It is a big part of how we train our employees, and it definitely does not stop at sales, it also involved our colleagues of R&D, technical service and applications. We want them to be able to have the same discussions as sales up to a certain level. Why do we do that? We think that is very valuable. New product development is all about value creation and capturing.

Using the combined approach, as illustrated by the quotes above, a NPD project has a higher probability to be a commercial success, because of the possibility of doing joint customer visits. Every function has its own typical specialty, background, and information needs. With the combined approach, every function is able to perceive their needed information first-hand, and is able to have interactive discussions with customers on its own relevant subjects.

Despite the high success rate of this approach there are also noticeable drawbacks. Not every NPD project seems to need this kind of labour intensive approach to be commercially successful. Since so many functions are involved in gathering, disseminating, and responding to customer needs intelligence, it has to be clearly defined which function is responsible for what aspect, how and when all relevant information is shared within the project team, but also how it is communicated externally towards the target market. One respondent remarked,
[Respondent 27]: Although marketing was involved in gathering the CNI and we had an interface with them, I had no clue what they were doing. We have a clear process with milestones, and marketing had that as well, but I was not present at those meetings. I had no idea what actually happened in that function. They have to report to me, but I had to proactively chase them for information. Information is always ad hoc presented to us, while it would be better if trends or other information would be proactively displayed to us. Moreover, sales, applications and marketing were all located in different locations in Europe. I really would like to see that differently.

Looking back on the four overall approaches, one can claim that they vary between R&D’s reliance on direct customer information to R&D’s reliance on a customer-facing function providing customer information. Their respective order would then be (1) the direct R&D approach, (2) the combined approach, (3) the indirect multiple CFF approach, and (4) the indirect dominant CFF approach. This categorization can also be seen in Figure 6.

To summarize, although all described customer needs intelligence (CNI) gathering approaches have the potential to lead to a commercially successful product innovation, each also come with possible downsides that might undermine the positive financial outcomes. Hence, in the following sections, moderating factors will be examined, which represent conditions under which the approaches lead to NPD project commercial success.

4.2. The Moderating Role of Structural Characteristics

From all interview data, we focus on structural moderators of the relationship between R&D’s CNI gathering approach and new product success of the project. Similar to the framework of Palmatier et al. (2006) and Mullins et al. (2014) with three variables types (seller-focused, customer-focused and dyadic), we propose three types of moderators: organizational resource structure (seller-focused), market structure (customer-focused) and customer-needs technology structure (dyadic). All three constructs were repeatedly emphasized in the interviews. In the next section, the constructs will be conceptualized and propositions of when to apply each specific R&D CNI gathering approach to enhance new product success will be given. In appendix C, an overview of explanatory quotes from the interviews is given.

Organizational Resource Structure:

Dispersion of Requirements Engineering Skills

Conceptualization: Requirements engineering skills refer to someone’s skills in the process of defining, documenting, and maintaining requirements, to be able to satisfy customer or user needs (Nuseibeh & Easterbrook, 2000). The term originates from the systems and software engineering literature, but is applicable to many other fields (Jiao & Chen, 2006). It requires requirements identification, analysis and negotiation, specification, systems modelling, requirements validation, and management. Requirements engineering skills are very important for designing and engineering a product that is linked to customer needs. It translates customer needs into product specifications, and is therefore extremely valuable information for R&D. In existing literature, a marketing function typically takes upon this role (Griffin & Hauser, 1996).

In this study, we distinguish high versus low requirements engineering skills. Moreover, it appears to be depending on the organization whether the most skilled function is the marketing, sales,
applications, or even the service function. Or in some cases, the project team has no CFF that possesses this skill to a good enough extent, and R&D is forced to take upon the requirements engineering aspect of product development itself. As a project manager explains,

[Respondent 24]: A good sales manager can even sell his own wife. That does not mean that he is able to comprehend the R&D side of things. You need to pick the right CFF or R&D for this, depending on the type of market you are operating in at that moment.

Research propositions: We argue that the degree of requirements engineering skills that a particular function possesses within an NPD project may be differently dispersed between CFFs and R&D. This creates four situations of the extent to which R&D or the CFFs possess requirements engineering skills: (1) high for R&D, high for CFFs, (2) high for R&D, low for CFFs, (3) low for R&D, high for CFFs, and (4) low for R&D, low for CFFs. Specifically, they may be dispersed among the different four CFFs identified in our sample: marketing, sales, applications, and service. In the field study, a project leader explained,

[Respondent 19]: Our applications group has much more specific customer information, much more application information that the average sales manager. The applications group is especially set up for [these specific market] customers or their applications, which is their specialty. Our sales manager does not have this kind of specialisation. They have to sell all our products to all our customers. [...] That means that they are, by definition, behind on the marketing and applications group.

We have observed that the dispersion of requirements engineering skills determines the effectiveness of involving a specific functional role in adopting an approach. When both R&D and (a selection of) CFFs have requirements engineering skills, teams are able to involve all those functions in CNI gathering and, therefore, may especially benefit from the combined approach.

[Respondent 14]: We were allowed to take initiative to get information the best possible way. [...] The sales team was the main point of contact. When we needed information [on the customer’s complaints or worries], the sales guy was normally involved in collecting information, and they supported this collection in all possible ways. But business related information was more driven by the [marketing] function and the technical information was more driven by the [R&D function]. So for the development part, sales trusted the direct contact of R&D with the customer, but he did not step out. [...] Since the early beginning of the technical specifications, this was done directly with the customer. With support of the sales, but without filtering. So not indirectly, so that R&D was also at the table with the customer, together with sales.

Thus, we propose that,

RP_{1a}: Under the conditions of high requirements engineering skills of R&D, and high requirements engineering of the CFFs, the combined approach increases new product commercial success.

The requirements engineering skills can also be more concentrated within the R&D function. For example, this can arise from a very broad range of product that the CFFs are responsible for, so that
they have not been able to specialize themselves in a particular the product technology. In these cases, a direct R&D approach enhances new product success the most. As an R&D manager explains,

[Respondent 27]: We already had product A and B. The customer wanted a product with quality of A and functionality of B. So applications wanted to make some sort of combination of both products. However, I [as R&D] did not think that was the right assessment: the solution for the customer needed a whole new product. From that moment on, R&D became the lead for product requirements, which thus had to do with the knowledge of the application engineer.

Therefore,

\[\text{RP}_{1b}: \text{ Under the conditions of high requirements engineering skills of R&D, and low requirements engineering skills of the CFFs, the direct R&D approach increases new product commercial success.}\]

Although R&D engineers are often highly skilled on the technical side, they are not always the right function to involve during the process that has to take place before the product requirements can be specified, which is determining the customer requirements, since they are often highly technology-oriented. Technology orientation refers to the focus on using superior and sophisticated technologies in developing new technologies and creating new product ideas. This results in a strong emphasis on technology, stepping away from a market orientation (Mu & De Benedetto, 2011). In the words of a project manager,

[Respondent 21]: It is extremely noticeable in our organization: much is driven from our technology roadmap, so from what happens within R&D. So, the downside is that R&D eventually decides what we will do or develop. [...] It is eventually always technology that wins, but they had no clue what the customer wants. R&D often does not know why they are making something, they just do it. And then, it could easily be the case that there is a mismatch between our product and our customers. So why did we make this product, why did we invest so much time, effort and money? If R&D would have seen, just for once, how our customers use our product, they would have never developed it this way. It would be better if our customer-facing functions would get a stronger voice.

In these situations, we argue that those CFFs that possess requirements engineering skills should be involved in the CNI gathering process. It depends on the organization which function(s) possess(es) these skills. Specifically, in conditions where the configuration of products becomes highly complex, adopting an indirect dominant sales engineering approach is beneficial. Hence,

\[\text{RP}_{1c}: \text{ Under the conditions of low requirements engineering skills of R&D, and high requirements engineering skills of the CFFs, the indirect dominant or indirect multiple CFF approach increases new product commercial success.}\]

Finally, we have observed situations in which both R&D and the CFFs lack sufficient requirements engineering skills often result in commercial disappointment. It is proposed that, in these situations, it is best that R&D collects multiple and various aspects of customer needs to be able to define the most optimal product requirements to increase new product success. Therefore, they have to adopt the indirect multiple CFF approach,
RP18: Under the conditions of low requirements engineering skills of R&D, and low requirements engineering skills of the CFFs, the indirect multiple CFF approach increases new product commercial success.

To summarize, the four different configurations of dispersion of requirements engineering skills between R&D and the CFFs and their respective most effective approach is given in Table 8 below.

<table>
<thead>
<tr>
<th>Requirements engineering skills</th>
<th>CNI gathering approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;D High</td>
<td>CFFs Commonly low</td>
</tr>
<tr>
<td>High</td>
<td>1. Direct R&amp;D Approach</td>
</tr>
<tr>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>(for a particular selection)</td>
<td>2. Combined Approach</td>
</tr>
<tr>
<td>Low</td>
<td>Commonly low</td>
</tr>
<tr>
<td>Low</td>
<td>3. Indirect Multiple CFF Approach</td>
</tr>
<tr>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>(for particularly one)</td>
<td>4. Indirect Dominant CFF Approach</td>
</tr>
</tbody>
</table>

**TABLE 8: RELATION BETWEEN DISPERSION OF SKILLS AND CNI GATHERING APPROACH**

**MARKET STRUCTURE:**

**PRODUCT ROLL OUT STRATEGY**

*Conceptualization:* A product roll-out strategy refers to the way a new product is introduced in the market (Bronnenberg & Mela, 2004). A product roll-out strategy involves choosing a target market. A target market selection refers to the select group of customers whose needs the organization is trying to solve (Crawford & Di Benedetto, 2008).

In this study, we have identified four main types of target market selections, under which every project could be subdivided: (1) one specific (lead) customer, (2) a small selection of customer with a specific need, (3) a larger market with an overall need, and (4) an expanding target market after the product was designed for a specific customer or small select group of customers. Hence, four product diffusion strategies arise for the NPD projects respectively: an engineering-to-order, a niche market, a mass market, and phased roll out strategy (Bronnenberg & Mela, 2004).

Several NPD projects in this research sample involved the *engineering-to-order (ETO)*. With this approach, the designing and engineering of the product can be highly customer-oriented or customized, which contributes to customer value (Silventoinen et al., 2014). The production is based on receiving a customer order and the developing a technical specification accordingly. Each product is a result of a project, which means customer orders are often organized as a whole project (Yang, 2013). Niche products are more individualized products tailored to the needs of a very specific target group rather than to the mass market (Schaefer, 2014). Phased roll out is the sequential introduction of a product. Often, this phased roll out is done as a method of market testing with a small or even broad target market for a broader end target market (Crawford & Di Benedetti, 2008), as a project manager also explains,

*Respondent 2*: We used the key customers to start developing because we were pretty confident we could produce with them. But we had a customer in another market: the food production market, who could use this product as...
well. But we didn’t have the same discussion with them, we were more or less using one key customer, develop it with the expectation that if we got to stage 4, the other customer would take the product on as well.

We have developed this with [our customer who came in with the request]. They have been the pilot, and that can we use as a reference for further sales all over the world.

Research propositions: We argue that the product diffusion strategy determines the effectiveness of adopting an approach. For each of the four abovementioned product diffusion strategies, a particular R&D CNI gathering approach is most effective for new product success.

From the sample, it can be extracted that, when a NPD project was originated by and solely developed for a specific customer (an engineering-to-order project), the direct R&D approach is most successful. Apparently, since these project involve very specific customer requests, it is most effective for R&D to hear the highly detailed specifications first-hand or directly from the more technologically skilled CFF sales engineering, and to intensively and iteratively find ways to be able to customize the requirement technology towards the explicit customer’s needs. Moreover, because no other customer needs have to be taken into account, no other point of view from CFFs need to be taken into account.

[Respondent 10]: This one customer came in with a request and we took it. The communication became between us [as R&D] and the customer’s R&D very fast. So technology talked to technology, so to speak. They also had 6 to 7 engineers at the table each time. The contact was very intensive, way more intensive than we ever did before. [...] We talked about how things could be better, cheaper, different. As soon as subjects as these come along, with specific customers, discussions between the two technical groups [of supplier and customers] become very essential. You also remove a lot of costs with this approach for both parties.

Therefore, it is proposed that,

RP2a: Under the conditions of an engineering-to-order product roll-out strategy, the direct R&D approach or indirect dominant sales engineering approach increases new product commercial success.

When the product is targeted at a select niche market, functions with specialist knowledge of a select group of customer or customers that use a specific applications of the B2B supplier’s product is needed. Typically, these functions will be sales, services, or applications/sales engineering. The broad and generic view of a marketing function is not sufficient here. As a R&D manager explains,

[Respondent 4]: It’s for the kind of business we are in, a niche market; the information I receive from my operational customer-facing functions sales and services is nearly the only way to get any guidance on what you need to develop. For many markets, you can buy studies of market data, such as market shares. But for this market, we do not know. We really depended on our eyes in the market.

43
Thus,

$RP_{2b}$: Under the conditions of a niche market product roll-out strategy, the indirect dominant CFF or indirect multiple CFF approach [including sales, service, and/or sales engineering] increases new product commercial success.

However, when the product innovation is targeted at a mass market, it is important to take the more general aspects of broader market needs into perspective. This knowledge is possessed by the marketing function. One project leader explains that their project failed in targeting a mass market without incorporating a marketing view.

[Respondent 23]: This was a product that was relatively widely applicable. You can attach it as an add-on to all of our [products]. So first, systems engineering started talking to only 20 dedicated customers who could be interested. [...] They stated a clear need for this product. So we expected a lot of market potential. And in this case, we neglected to look at it from a more general marketing view. We should have asked ourselves: Did we accidently find 20 specific customers who were interested or is it representative for all the hundreds of [customers] in total? And it is only now, which is way too late, there we are starting to do research with marketing on how big this market actually is. But that is a big risk in our organization. We accidently talked to 20 customers who asked us if we could provide a solution for them, and we drew the conclusion that it would be a major demand. Which it was not at the moment.

Thus,

$RP_{2c}$: Under the conditions of a mass market product roll-out strategy, the indirect dominant or indirect multiple CFF approach [including marketing] increases new product commercial success.

Additionally, some organizations adopt a phased roll out strategy, in which the product is designed and developed with one or a small select group of customers, but is rolled-out to a bigger target market afterwards (Bronnenberg & Mela, 2004). Therefore, the NPD teams benefit from a combined approach. As a R&D project manager illustrates,

[Respondent 27]: The application engineering looks at what the specific customer wants. [...] He speaks to this one customer, and does the first translation from the customer wishes into what [our organization] should deliver. Afterwards, we [R&D] started talking directly to the customer as well about what they truly need. To really understand what the customer wants. Marketing rather helps us with road mapping, for replication possibilities. And that is something we, as R&D, like to take into account as well. Because then, you will be able to sell it to more customers after it is designed and developed. So, it does depend from which input we derive the customer requirements or internal requirements.

Therefore,

$RP_{2d}$: Under the conditions of a product phased roll-out strategy, the combined approach [including marketing] increases new product commercial success.
To summarize, the four different product roll out strategies and their respective most effective approach is given in Table 9 below.

<table>
<thead>
<tr>
<th>Product roll out strategy</th>
<th>CNI gathering approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customized, engineer-to-order</td>
<td>1. Direct R&amp;D Approach</td>
</tr>
<tr>
<td>Phased roll out (from lead user(s) to broader market)</td>
<td>2. Combined Approach</td>
</tr>
<tr>
<td>• Niche market (involve sales, service, and/or sales engineering)</td>
<td>3. Indirect Multiple CFF Approach</td>
</tr>
<tr>
<td>• Mass market (involve marketing)</td>
<td>4. Indirect Dominant CFF Approach</td>
</tr>
<tr>
<td>• Niche market (specifically sales, service, and sales engineering)</td>
<td></td>
</tr>
<tr>
<td>• Mass market (specifically marketing)</td>
<td></td>
</tr>
</tbody>
</table>

TABLE 9: RELATION BETWEEN DIFFERENT PRODUCT ROLL OUT STRATEGIES AND CNI GATHERING APPROACH

CUSTOMER NEEDS – TECHNOLOGY NEEDS KNOWLEDGE STRUCTURE:

TACITNESS OF CUSTOMER – TECHNOLOGY NEEDS KNOWLEDGE CONFIGURATION

Conceptualization: Organizations face intensive competition and changing needs, and thus are trying to create knowledge by a spiral process between explicit and tacit knowledge to enhance their competitive advantage and, thus, their new product’s success (Su et al., 2007). Explicit or codified knowledge refers to knowledge that is communicable in formal and systematic language. On the other hand, tacit knowledge has some personal quality, which makes it hard to formalize and communicate (Nonaka, 1994). As we observed in this field study and as is recognized in Su et al. (2007) as well, product innovation must link technological competence such as engineering knowledge and process know-how with customer competence such as knowledge of customer needs. Therefore, both product knowledge and customer knowledge must be congruently managed. Tacitness inherently creates high uncertainty. Uncertainty in this concept can be defined as the difference between the information possessed and the information required to perform particular tasks (Berends et al., 2012).

In this study, we identified high and low tacitness of product knowledge as well as of customer knowledge. Hence, a configuration of four possible scenarios arise. Customer knowledge can be quite tacit or hard to define because of three reasons (Tuli et al., 2007): (1) customers are frequently not fully aware of their business needs and cannot easily articulate them to a suppliers, (2) requirements definition is not just about asking customers for functional specifications, but also about understand their broader business needs, and (3) customer needs can change or evolve over time, so future needs also need to be defined. Next to uncertain customer knowledge, technological knowledge can also be uncertain. “Perceived technological uncertainty refers to the inability to completely understand or accurately predict some aspect of the technological environment as it relates to NPD project decisions” (Song & Montoya-Weiss, 2001, p. 64). For example, an NPD project manager may perceive a product technology to be well understood, highly developed and, therefore, straightforward in its application. Alternatively, the product technology may be perceived as undeveloped and unknown. Technology or product knowledge requires a deep understanding of the technology used and related technological possibilities. And evidently, the overall product knowledge possession becomes harder when the technology used becomes more complex and the market more rapidly
changing (Song & Montoya-Weiss, 2001). Consequently, the CFFs need thorough R&D training to be able to comprehend the required product knowledge.

Research propositions: We argue that configuration of the tacitness of customer needs and technology needs determines the effectiveness of an approach for new product success. These high and low values are in this case not dichotomous but rather more continuous in nature. But for the sake of clarity we present them as four combinations.

First, when both customer needs and technology needs are not codified, it is important that discussions on all aspects are taking place to enhance the process of turning tacit knowledge into explicit knowledge. As a project leader clarifies,

[Respondent 22]: We were far behind on competition, we missed a functionality. We got a lot of feedback from customers on this. Eventually, we went to customers with an R&D team to research, bottom-up, why our product was failing. It is very complex. [...] We did not understand why our customers found that [our product] was failing them, and the customer did not know either. So our systems are so extensive, that an applications team went to talk to our customers first, since they speak the language of our customers. But the needs were so hard to translate into software, that my project team, applications and R&D went to all customers together.

Therefore,

RP\textsubscript{3a}: Under the conditions of high technology needs tacitness, and high customer needs tacitness, the combined approach increases new product commercial success.

Second, if it is not yet clear what the technological needs are, but the customer needs are rather clear, mediating CFF dialogues are not necessary. R&D needs to gather the technological possibilities on their own or preferably together with the technicians of the customer(s). As a project leader of a water treatment organization explains,

[Respondent 1]: The need of the customer is in fact: 'The water needs to be clean against acceptable costs.' The rest is a black box for him, as long as it does what it is supposed to do. That is really manageable. What we [as R&D] had to try to figure out, was the technical execution. So how could we make it smarter, more stable, more robust. We wanted to make a disruptive, completely new technology for that. We did that by going to congresses, visiting universities, and talking to the customer's technical people, also to test our technology.

Thus,

RP\textsubscript{3b}: Under the conditions of high technology needs tacitness, and low customer needs tacitness, the direct R&D approach increases new product commercial success.

In this study, some organizations had very well defined, codified technology performance indicators. Their remaining challenge was to customize the product towards the (specific) customer requests. In these cases, there is no urgency for R&D to talk to customers, since they know which technology specs they have to deliver. However, the still tacit customer needs need to be translated into specs by multiple CFFs, to be able to capture the full picture of customer value, as an R&D person illustrates,
[Respondent 6]: If you look at our customers, three defined and critical technology dimensions are always important for them [...]. We translate those into parameters. This way, you come to what your customer wants from a technological standpoint. In [our market] that is fairly simple: we have a certain law that we have to live up to [...]. The whole market in which we operate is following that law, our competitors as well as our customers. This way, innovating becomes a self-fulfilling prophecy, which is almost predictable. And as long as we keep delivering the technology, this prophecy stays correct. [...] And then, marketing and systems engineering have intensive discussions with our customer and deliver me the specs for the products for specific customers, such as the layout, the size, the weight, infrastructure, and the particular modules the customer wants and what he is willing to pay for it.

Thus,

\[ \text{RP}_{3c}: \text{ Under the conditions of low technology needs tacitness, and high customer needs tacitness, the indirect multiple CFF approach increases new product commercial success.} \]

Lastly, in the least complex situation of low technological needs tacitness and low customer needs tacitness, the input of mainly one CFF will suffice. This is usually the case in markets with slow dynamics. As a project manager in this conditions explains,

[Respondent 19]: What our customers want is actually pretty stable, we know them really well. We have been able to map the last 15 years very well. What they want is very clear. How our products need to behave is also fairly clear. Actually, just the technical details matter. [...] So the only data gathering we did was on how to make and price the product so that it would be more attractable for a somewhat lower segment than before [...]. Marketing was responsible for that.

Thus,

\[ \text{RP}_{3d}: \text{ Under the conditions of low technology needs tacitness, and low customer needs tacitness, the indirect dominant CFF approach increases new product commercial success.} \]

To summarize, the four different configurations of the tacitness technology and customer needs and their respective most effective approach is given in Table 10 below.

<table>
<thead>
<tr>
<th>Tacitness of customer and technology needs</th>
<th>CNI gathering approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer</td>
<td>Technology</td>
</tr>
<tr>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

TABLE 10: RELATION BETWEEN CONFIGURATION OF TACITNESS OF NEEDS AND CNI GATHERING APPROACH
In summary, we propose that the new product success of the four overall approaches of how R&D gathers customer needs intelligence depends on the dispersion of requirements engineering skills between R&D and the CFFs, the product diffusion strategy of the new product, and the configuration of the customer and technology needs tacitness. The next section outlines which dissemination and responsiveness practices NPD teams have to incorporate to what extend to influence the commercially successful outcome of the approaches.

4.3. THE MODERATING ROLE OF PROCESS CHARACTERISTICS

Below, several factors that will moderate the effectiveness of all four R&D CNI gathering approach on new product success will be discussed. They represent two coherent sets of moderators that are associated to the two additional indicators of market orientation, next to market intelligence gathering: dissemination and responsiveness. All three indicators are crucial for being market-oriented as an organization, and therefore, deliver commercially successful product innovations (e.g. Wren et al., 2000; Baker & Sinkula, 1999). From this field study, several factors that influenced effective dissemination and responsiveness could be extracted. We propose that all process moderators strengthen the impact of the R&D CNI gathering approach on new product success, regardless whether it is the direct R&D, indirect dominant CFF, indirect multiple CFF, or combined approach.

DISSEMINATION LEVERS:

FORMAL AND INFORMAL DISSEMINATION BETWEEN PROCESS BETWEEN R&D AND CFFS

*Conceptualization:* Dissemination can happen formally or informally. The importance of balanced formal and informal dissemination had already been recognized in current management literature: (Maltz & Kohli, 1996; Kohli & Jaworski, 1990; Carbonell & Escudero, 2010). Formal dissemination between the different functions, through e.g. frequent, prescheduled team meetings, product or market requirement or specification documents, presentations, emails, shared drives, or project folders, ensures quality of the shared information, makes sure that the information is documented, and assures that the information reaches all other (relevant) team members as well.

In this study, we recognized that teams differ in the extent to which they engage in formal and informal dissemination processes. Therefore, we distinguish high versus low, formal versus informal dissemination. Commonly, organizations used their Stage-Gate approach (Cooper, 2014) for the formal dissemination, as one project manager explains here,

*Respondent 3:* We have a product generation process with 14 key decision meetings. That is a formal protocol which states which function has to deliver what and when. That assures that everyone knows where and when to get what kind of information. And on top of that, we have formal program and project meetings, to share even more detailed information.

However, it can also take up much time due to all formal procedures the information has to go through, and the redundant time functions have to wait for the next scheduled meeting to be able to share the information. Therefore, ad-hoc, informal dissemination, by team members just walking into each other’s offices or talking at the coffee machine, is essential for speeding up the dissemination process, and eventually, the time-to-market of the product. As two project managers separately explain,
(1) [Respondent 2]: People definitely talk together informally as well. I think that that works pretty well, I would be very annoyed if it would take 6 weeks to the next meeting before someone tells me something. A lot of informal hall talk happened, certainly in the R&D function on what the challenges were. The sales guy would be both informal and formal as well.

(2) [Respondent 5]: I think only formal ways of doing it will not work. I think informal ways is the way to be, most time efficient.

Research proposition: The important of both processes between the two relevant parties within this study – R&D on the one side, and the involved CFFs in the NPD team on the other side - was also acknowledged by the participants in this study. The more functions are involved in gathering CNI the more coordination is needed. A study by Conduit & Mavondo (2001) states that formalization of dissemination processes ensures and stimulates the coordination between functions, and that informal dissemination has positive effect on innovation speed (Carbonell & Escudero, 2010). Therefore,

RP4: Highl y formal and highly informal information sharing processes between R&D and CFFs increases the positive relationship between all R&D CNI gathering approaches and its new product commercial success.

CONTINUITY OF INBOUND AND OUTBOUND DISSEMINATION

Conceptualization: Traditionally, organization’s Stage-Gate NPD processes required that a product was completely defined before it moved into the development stage (Cooper, 2014). However, the world moves too fast today to allow R&D to develop in isolation after receiving a product definition at the end of the discovery phase. Customers might not even be clear on what they want or need in the first place, and secondly, sometimes their requirements simply change during development, due to a new customer need, a new competitive product, the emergence of a new technological possibility. Therefore, members of a NPD project benefit from continuous intelligence dissemination to ensure that all assumptions made in the discovery phase are still valid. As a project manager of a successfully completed project illustrates,

[Respondent 26]: We have experienced that it is really important to come together as a whole team at least once a month. Those meetings do not always have to be physical, they can be virtual as well. It makes sure that information is exchanged, but also that the right information from all points of view is being passed on, through co-reports. We discuss (a) what is the status?, (b) what went well, what not? Are there any corrective measures?, and (c) what are the next steps?

In this study, we found that members of NPD project differ in the level of continuity of their dissemination process. Moreover, in previous sections, we primarily discussed the inbound intelligence flow from the market. However, successful organizations claim that outbound intelligence flows from R&D (through CFFs) to the market and its customers is rewarding as well. This flow is commonly used for new product preannouncement, which is a communication process that companies use to send messages to target groups before launching the new product, to let them know something new is coming (Su & Rao, 2010). However, it can also be used for product development or positioning, since it can help firms to test the product or concept on target markets and customers (Su & Rao, 2010). As the interviewees also mentioned, the purpose of this outbound
intelligence flow is commonly to communicate development changes, since technologies and materials are evidently subject to change during the development stage too, and to verify if customers are still satisfied with the product specifications and willing to pay for it. In other words, they are checking the customer’s buy-in. A marketing manager explains why they incorporate this intelligence flow in their NPD projects,

[Respondent 23]: We regularly communicate our progress to our customers. And that often goes through our systems engineering function again. We ask them if they can check how valuable our customers still consider certain functions. Or to consider changes. And sometimes, the customer comes back with feedback we have to deal with.

Or, it can be used to identify opportunities for R&D, as another project leader explains,

[Respondent 24]: When we think we have signaled a trend, we involve sales directly and consult with them to verify if they can check if that trends really exist in the market. We will come up with a questionnaire for them to check: are customers involved in this, is it an issue, is it not an issue.

Research Proposition: We propose that the continuity of inbound or outbound dissemination flows, so during all three NPD discovery, development, and commercialization phases, within NPD teams positively influences the new product success of all four approaches. This continuity inherently implies that there should be no gaps, and that R&D should not operate in isolation in the development phase. Therefore,

RP5: High continuity of inbound & outbound dissemination processes between R&D and the CFFs enhances the positive relationship between all four R&D CNI gathering approaches and new product commercial success.

RESPONSIVENESS LEVERS:

OBJECTIVITY OF CNI: FACT-BASED VERSUS OPINION-BASED

Conceptualization: The competitive advantage of organizations often lies in a firm’s ability to use market intelligence, and not in its access to market intelligence (Maltz & Kohli, 1996). According to several R&D people participating in this research, the extent to which R&D actually uses or is able to use the CNI that is gathered and disseminated, depends on the objectivity of the intelligence. In others words, it depends on whether the information on customer needs is translated back to them in the form of facts or opinions. “Customer attributes, commonly called the voice of customers (VoC), tend to be linguistic and usually non-technical in nature. It is deemed to be difficult for engineers to translate the VoC into concrete product and engineering specifications” (Jiao & Chen, 2006, p173). Opinion-based information that reaches R&D through CFFs, such as “the customer does not like this problem” or “the customer would very much appreciate a feature like this” is not very translatable into verifiable product requirements for R&D. Several projects in this sample failed because the development was based on unsubstantiated assumptions. R&D needs data-driven, fact-based information to be able to optimally align the product features to customer needs. This implies that R&D needs to clearly specify facts they are looking for, and the CFFs need to be able to keep questioning the customer until the latent, underlying, rooted need is discovered. In the words of two project managers dealing with opposite situations,
(1) [Respondent 27b]: The nice thing is that the product development had done his part of the job very well, so that there was no ambiguity, no mix up was possible anymore with what sales was saying. What sales was saying with words, in wine and dine language, the product development had written down in hard engineering numbers. And that was indirectly the inspiration of what R&D had to achieve as a minimum. If you can achieve more, all the better, but that is the minimum.

(2) [Respondent 23]: Our CFFs do not specifically specialize themselves in gaining the right input from the market. May be purely on experience, but not explicitly. What generally absolutely lacks in this organizations, is that this process [of generating and using customer need intelligence] is not fact-based enough. We have enough channels to collect feedback from customers, but the feedback is just not factual enough. And when feedback is not factual, and contains too much feelings or emotions, our trust [as R&D] in the CFFs decreases.

Research proposition: We argue that creating fact-based customer needs intelligence improves the new success of all four approaches, since R&D is in general better capable to fast and responsiveness to it. Hence, we propose that,

RP₆: High objectivity [fact-based rather than opinion-based] CNI strengthens the positive relationship between all four R&D CNI gathering approaches and new product commercial success.

CONTINUITY OF RESPONSIVENESS: ITERATIVE VERIFICATION & VALIDATION LOOPS

Conceptualization: Similar to the relevance of continuous dissemination (Cooper, 2014), is relevance of the continuous responsiveness to CNI for new product success. More continuous responsiveness make a firm better able to adapt to new information in today’s fast changing market needs by adopting a more spiral or iterative development, that allows for experimentation with customers. This type of approach makes the NPD process more lean and agile, and encourages project teams to fail often, fail fast, and fail cheaply. It creates “a focus on quick response to change, and continuous customer or stakeholder involvement in the development of the product”(Cooper, 2014, p. 23). This experimental and iterative way of developing is especially relevant in uncertain technology environments (Song & Montoya-Weis, 2001). It is also in line with the effectuation theory, which adopts a more iterative problem-solving process during the entire NPD process than the prediction-based causation theory, that depends on predictions made on the basis of upfront market research before development (Berends et al., 2014). The effectuation theory is best adopted under high innovativeness of NPD projects (Brettel et al., 2012).

In this study, it is observed that NPD projects differ in their level of continuity responsiveness by incorporating early prototype testing. Since the early prototyping enables customers to actually experience the product in development, the organization is able to verify and validate if (1) the initial product requirements are still valid, and (2) verify if the product satisfies the product requirements. If (1) and/or (2) are negative, changes can be made to the design before the actual launch.

The success of such an iterative approach very clearly appears from the data of this study as well: 12 out of 13 interviewees who stated that they used continuous validation and verification loops were
successful. On the contrary, 13 out of 17 who did not, were a commercial disappointment after launch. A project manager of a medical devices explains the key point that made the difference between his successful and unsuccessful project,

[Respondent 22]: In our organization, we usually ask feedback of customers two to maximally three times before we commercialize it. In this successful project, however, we really developed the product iteratively: make a preliminary version, go to the customers, ask feedback, go back, modify a new version, go back to the customer. In the end, we only introduced after software version 10. Normally we would introduce it like a Big Bang. But the customers were very satisfied.

It sounds like common sense, but as another product manager explains in general,

[Respondent 20]: We should step away from the fact that there would be some kind of magical gap in the middle where developers make all kinds of things that aren’t even validated, It has to be a continuous process. With continuous validation in the market; there must be interaction with the customer and R&D continuously. Without this process, everybody is just hoping it will be what they expected it to be. However, this a very risky process that happens within a lot of organisations.

Research proposition: We claim that continuous verification and validation loops through all types of concept and prototype testing improves the commercial success of all four R&D CNI gathering approaches. Again, there should be no gaps in development where R&D keeps developing the initial idea in isolation. Although the testing of actual, tangible prototypes is not possible in every situations, organizations can use various simulations to generate feedback. An project leader demonstrates how they incorporate this lean and agile development approach,

[Respondent 23]: We try to continuously test and check whether our development still fits with what every stakeholder needs to be successful. That means that our development cycles are very short, and that you deliver something very concrete and tangible after these short periods that you can test internally or outside in the market. It does not have to be ready or complete, but we are not waiting until we are completely ready developing before receiving feedback anymore. [...] It is not always possible to develop something concrete so short cycled, since our systems are so large, but then you will try to deliver a mock-up or a simulation of the product. We want to prevent something that you have invested in for a long time, and while you introduce it as a Big Bang, your customers say: “Well, that was not entirely what I needed”.

Thus,

RP7: High continuity of responsiveness by iterative verification and validation loops enlarges the positive relationship between all four R&D CNI gathering approaches and new product commercial success.
This study results into several and diverse concluding findings and discussions. This section will outline these conclusions and discussion. Firstly, the main research question, proposed in the beginning of this report, will be answered. Second, the overall conclusions of the study are depicted. Finally, the theoretical and managerial implications will be depicted, as well as the limitations of this study that together with the overall findings provide directions for future research.

5.1. **CONCLUSION: ANSWERING THE RESEARCH QUESTION**

This research started with the evident problem that *too many product innovations result into commercial failure after launch*. However, some organizations are better at innovating than others. A common cause for a product innovation’s commercial failure is a lack of alignment with the market, i.e. the customer’s needs (Judson et al., 2006). Many researches have shown that a market orientation can improve the new product performance of organizations (Carbonell & Escudero, 2010; Wren et al., 2000; Baker & Sinkula, 1999; Pelham & Wilson, 1996; Slater & Narver, 1994a; Atuahene-Gima, 1995). A market orientation has three indicators – market intelligence generation, dissemination, and responsiveness – and three elements – customer orientation, competitor focus, and cross-functional coordination or cooperation (Kohli & Jaworski, 1990; Narver & Slater, 1994b). This study focused on the two elements customer orientation and cross-functional coordination, which are also the two that exert the greatest influence on new product success (Wong & Tong, 2012). We concentrated on the generation of, dissemination of, and responsiveness to *customer needs intelligence* (CNI).

R&D’s role in new product development mainly considers the generation of technological knowledge and applies this knowledge to design new products (Ernst et al., 2010). However, this technological knowledge has to be aligned with CNI to be able to develop new products that meet market requirements and generates sufficient financial returns for organizations. The generation of CNI is primarily the responsibility of customer-facing functions (CFFs). Nonetheless, in extant literature it is especially the role that marketing function plays in providing R&D with CNI that has been investigated. Surprisingly, the role of other customer-facing functions is nearly neglected. Little is known on the different ways of how R&D functions gather their required CNI and which approaches work best under which conditions. Therefore, the research question of this study was,

*Which approaches can R&D use to gather customer needs intelligence during new product development (NPD) projects, and what are associated contingencies for dissemination and responsiveness of the whole NPD project team, that will lead to commercial success of new products?*

Since market intelligence gathering is even harder for B2B organizations as they do not only have customers, but also end-users (the customer’s customers) (Kohli & Jaworski, 1990; Homburg et al., 2014), and their client base is usually smaller, so they can serve as a primary source of information (Chonko et al., 1991), B2B new product development projects were the focus of this study.

In answering the research question, the results of this study show that R&D can have four distinct overall approaches, that vary in the extent to which they rely on the direct needs intelligence from customers or from customer-facing functions. Respectively, these are: (1) the direct R&D approach,
in which R&D functions solely rely on their own direct (CNI) gathering with customers, (2) the combined approach, in which they rely on both their own direct contact as well as the indirect input they receive from one or multiple CFFs, (3) the indirect multiple CFF approach, in which they rely on multiple CFFs as input for CNI, and (4) the indirect dominant CFF approach, in which one CFF dominantly provides R&D with CNI.

Additionally, the results showed that the effectiveness of these approaches depend on certain contingencies, or moderators. These represent three structural characteristics, that are market-focused, organization-focused, and dyadic: the product roll out strategy, the dispersion of requirements engineering skills between R&D and the CFFs, and the configuration of customer and technological (or product) needs tacitness within a market and the organization. Moreover, it reveals that other functions next to marketing might be successfully incorporated in this process as well. However, which particular customer-facing function(s) should be involved in these approaches is also crucial.

Lastly, we expected contingencies for the dissemination and responsiveness to customer needs intelligence. Involving more functions as input for customer needs knowledge requires more communication and coordination. Therefore, all following moderators improve dissemination and responsiveness under a high condition: (1) formal, next to informal dissemination processes between R&D and all relevant CFFs or customers, (2) continuous inbound and outbound intelligence sharing, (3) objective CNI rather than subjective CNI, and (4) continuous iterative verification and validation loops, by using early protocept, simulations, mock up or prototype testing.

Below, the concluding findings on all contingencies per approach, next to their revealed advantages, disadvantages and key success factors are given. Moreover, the impact of the contingencies is discussed.

5.1.1. THE DIRECT R&D APPROACH

Apparently, there are situations where the R&D function can serve as a valuable customer-facing function as well, to customer needs and value. Especially in technologically complex (tacit, uncertain) situations, and typically, in customized, engineering-to-order projects. It allows for first-hand feedback from customer which prevents misinterpretation of their real needs. Moreover, technicians to technicians might be willing to share more information mutually that would happen between commercial departments. From the interviews, it can be remarked that the direct R&D approach has the risk of becoming too focused on solely the technological needs, without taking into account the non-technical needs, such as the willingness-to-pay or the due date of the project. Organizations should keep in mind that this approach is best to use when R&D has great interpersonal and people skills to possess enough requirements engineering skills and when the (more subjective) customer needs are very well known and made explicit.

5.1.2. THE INDIRECT DOMINANT CFF APPROACH

Second, the indirect dominant CFF approach should be used when technology and customer needs are rather explicit, since there is only one main input of customer needs intelligence. Noticeably, from all indirect dominant CFF alternatives, the indirect dominant strategic marketing approach was used very little compared to the expectations in practice and in theory. Respondents claimed that this is due to the fact that the strategic marketing function typically lacks specific customer information that is needed in most B2B projects, which confirms the importance of the more operational customer-facing functions, such as sales, technical service, and the sales engineering function. Nonetheless, as was also the case in several successful projects, they are a valuable input when targeting a broader target market, to look beyond the expressed needs of close customers to more environmental factors that
could influence a customer’s needs without being aware of it, and for road mapping, i.e. spotting future general market trends, that R&D has to prepare for and adopt to as well. Notably, since this approach has the downside of providing intelligence that is too biased or colored by one specialized CFF, the approach necessitates very high requirements engineering skills of the dominant CFF. Also, the dominant approach should not originate from an inherent concentration of power within dominant function, but from its skills, or market or product expertise. The target market selection niche or mass market influences which CFF is should be dominant. When the requirements engineering skills are right, this approach provides structured, overseeable input and decreases probability of irrelevant information (‘noise’) reaching R&D by filtering incoming information.

Sales was found to serve as effective mediator, knowledge broker, relationship initiator or builder between customer and R&D or marketing. Unfortunately, data revealed that their requirements engineering skills are often quite low, due to their natural focus and expertise on the commercial aspect of new product development. This commercial focus also causes opportunistic behaviour of the sales force, which means that they are more focused on the immediate sale, in spite of this being against the firm’s wishes or long-term interests (Siguaw et al., 1994). Moreover, they are more focused on achieving their sales targets than on providing R&D with valuable customer information. This behaviour was confirmed by a great majority of interviewees. As one project leader illustrated,

> What often happens now, is that sales comes to engineering and asks: What do you have that I can sell? But no, that is not enough. It should be the other way around. I should be hearing from sales what I should develop.

For these two reasons, an organization benefits highly from defining a hybrid sales engineering function. They can serve as an effective bridge between R&D on one side and the customer, sales and service on the other side. Due to their dual role and possession of both technological knowledge and interpersonal skills, they are a very credible function for R&D, as many organizations in this research indicated.

Although not broadly researched in academic literature, the data showed that using the technical service function as CNI input for R&D is particularly valuable when the product’s serviceability and downtime is highly important. The serviceability of changed or new features for customers can immediately be taken into account, instead of being accounted for after launch by spending a lot of time and costs on solving the problems. A manufacturing company of this sample showed a great example of this: when designing modules for new products, R&D had to review a database with all stored malfunctions of this particular module to make sure these malfunctions would not come up in the next generation of products.

5.1.3. THE INDIRECT MULTIPLE CFF APPROACH

The indirect multiple CFF approach is most effective when the customer needs are quite tacit or very changeable or uncertain (compared to slower moving markets), but the customer is too technologically ignorant for R&D to be able to have direct discussions with them or when R&D has insufficient interpersonal or people skills to have sufficient requirements engineering skills. Further, this approach allows organizations to incorporate a wide range of customer needs into their product design, which makes this approach highly adequate in situations where the functions within an organizations are highly specialized in their traditional roles such as described in earlier literature (see section 2.3.), and therefore, distinctively have low overall requirements engineering skills. However, good and formalized communication and coordination is required to align all inputs of information (Conduit & Mavondo, 2001) and to reduce rework.
5.1.4. THE COMBINED APPROACH

Lastly, the combined approach resulted in the highest number of successful projects in this research sample. Presumably, since it incorporates several points of view, similar to the indirect multiple CFF approach, but also incorporates guided direct R&D to R&D contact. However, it requires high requirements engineering skills of both R&D and (a selection of) CFFs. Because this approach allows for joint customer visits, this can stimulate more information sharing between functions in the development process (Narver & Slater, 1995). Therefore, in NPD projects with high uncertainty (or tacitness) from both the technology and the customer side, which is definitely not an unlikely situation in NPD, the combined approach is highly recommended. Specifically, it should be used in phased roll out strategies. However, more than all other approaches, it needs extensive coordination between all incoming information channels and R&D to decrease the chance of miscommunication of responsibilities.

5.1.5. THE MODERATORS

Because of the structural moderating effects that were found in this study, one can say that high specialization of functions within a NPD project is not beneficial for overall commercial success of new products. In other words, if the organizational structure allows functions to work in silos, i.e. in isolation from each other, this is detrimental for new product success. Practically, because this can hinder the dissemination and responsiveness to intelligence, since in many cases, the CFF must speak R&D language in order to transform the mostly cryptic and non-technical voice of the customer (Jiao & Chen, 2011) into information that is usable for R&D. Therefore, the CFF that is in direct contact with R&D needs high technology or product knowledge, which commonly requires a smaller product range that they are responsible for. Also, it requires goal alignment between the usually short-term goals of the CFFs and the long-term perspective of R&D, which is not always easy to achieve, as many project leaders stated. When both are in place, they have a higher credibility towards the R&D function, which is a common issue in practice (Gupta et al., 1985; Judson et al., 2006; Malshe & Biemans, 2014), and increases the probability of R&D actually using their information (Lewis, 2003).

As a project leader concludes,

Sales delivers us all elements that we should offer. However, they do not deliver us the specific technical elements to get our value proposition optimal. This happens within applications engineering. In our organization, the best engineers are former sales people, and also some former sales guys are now in engineering. That means, that you need cross-functional rotation to make both departments effective and develop the right way.

For continuous inbound and outbound dissemination, next to credibility, trust is required between the development and the commercial side (the more operational CFFs). Besides opportunistic behavior, there are other risks involved in early new product preannouncement through the sales function that the project leaders in this research frequently mentioned: the sales force starts promising or making customer enthusiastic about a new upcoming product, which (1) stops customers from buying the current product – which is detrimental for the organizations overall performance, or (2) R&D is eventually not able to live up to. Therefore, many companies put in place a more strategic function, such as a marketing or application function, to filter the incoming and outgoing information. However, this behavior is not present in every sales force (Siguaw et al., 1994), and therefore the filter is not needed in every situation. Moreover, as a result of adopting a continuous responsiveness method of developing with frequent iterations loops, the feedback becomes more fact-based and becomes better to use for R&D to make their final design as good as possible for the customer.
Mapping the three structural moderators

The three structural moderators were found to have a distinct moderating effect on the relationship between the four overall gathering approaches. However, one could also combine them, to see if the different conditions of the moderators can be mapped, and therefore, as a combination have a moderating on the relationship between the four overall CNI gathering approaches and new product success. Figure 6 shows how such mapping could be illustrated.

Future qualitative comparative analysis (QCA) research could identify if the conditions of the three structural moderators can be mapped. QCA is a method to identify the different combinations of causally relevant conditions linked to an outcome (Ragin & Strand, 2008). It is used in researches where there is a focus on a qualitative outcome, and seeks to identify the different conditions that generate it, and therefore, would very much fit for this purpose of investigating whether the combination of conditions of the three structural moderators - as shown as the horizontal lines in Figure 6 - together are linked to an CNI gathering approach. QCA could find out if these are optimal combination of conditions for an approach. This would imply that for NPD projects under certain types of market and project condition combinations, i.e. the way organizations roll out their new products (A in Figure 6), and the uncertainty of the market and technology that the organization operates in (B in Figure 6), B2B companies should adapt the skills of their people and departmental functions (C in Figure 6) to be able to adopt the most optimal approach. This would have implications for the way and whom organizations should train in certain skills.

5.2. IMPLICATIONS

5.2.1. THEORETICAL IMPLICATIONS

This research results into three fundamental contributions to theory. Firstly, it provides a comprehensive conceptualization of four R&D functions’ approaches to gathering customer needs intelligence that resulted in commercial success. Current market orientation literature and literature that studies market orientation in NPD solely focuses on the organization-wide generation of, dissemination of, and responsiveness to market intelligence (e.g., Kohli & Jaworski, 1990; 1993; Slater & Narver, 1994a; 199b, Langerak et al., 2004; Wren et al., 2000). Hereby, it also enriches previous research findings by moving away from predominant focus on the approach where marketing provides R&D with market intelligence towards a more overall strategic consideration of R&D
functions’ approaches to gather CNI for developing their products. These approaches involve more functions than expected: sales, tech services, and a hybrid sales engineering function. It provides new product development research with a more comprehensive framework for referring to B2B organizations developing commercially successful product innovations. Secondly, it agrees with and enriches NPD literature that claims that the role of the more operational customer-facings functions such as sales or service is greater than merely taking over the selling aspect of the new product in the commercialization phase (Helm et al., 2014; Ernst et al., 2010; Malshe & Biemans, 2014; van der Heijden et al., 2013), by showing that they can also be used as input for R&D’s new product development practices.

Moreover, it provides contextual moderators that indicate that certain market and organization characteristics influence the effectiveness of an approach. Until today, there is scarce literature on this subject. Research primarily describes factors that positively influences the, in our research called indirect dominant marketing approach or a technology push (technology-oriented) approach (Mu & DiBenedetto, 2011; Wong & Tong, 2012; Cuijpers et al., 2011). Additionally, these moderators show that the extent of involving the R&D or marketing function themselves in generating CNI depends on situations within the organization, in the market, and the way the product will be diffused in its market. Lastly, the results of this research agreed with already existing market orientation literature on formal and informal dissemination (e.g., Maltz & Kohli, 1996; Kohl & Jaworski, 1990), and with NPD literature that states that continuous dissemination by adopting a more agile or spiral, effectual and data-driven approach positively influences new product success (e.g. Cooper, 2014; Berends et al., 2014). It augments existing literature by categorizing these NPD literature concepts in the dissemination and responsiveness concepts of market orientation literature.

5.2.2. MANAGERIAL IMPLICATIONS: RECOMMENDATIONS FOR PRACTICE

Furthermore, the results of this study provide several practical or managerial implications as well. For R&D and technology driven B2B organizations, it provides a roadmap for aligning product features to customer needs in a most effective way, depending on the conditions of the project at hand. The managerial recommendations to practitioners are:

(1) Adopt the right, customized approach per NPD project.

- Depending on (1) the distribution of the requirements engineering skills among the R&D function and the customer-facing functions, (2) the level of tacitness or uncertainty of technology and/or the customer needs, and (3) the product roll out strategy.

(2) Include the right customer-facing functions as input, considering their expertise, but assuring their requirement engineering skills for the particular project.

- Every CFF has its own expertise in certain aspects of CNI. In general, marketing can be included for the more strategic overall market needs and roadmapping, sales is a valuable input on key buying factors and can serve as an effective mediator or relationship builder between R&D or marketing and the customers, and services is valuable input of key customer problems with current products and the new products serviceability. However, approaches should be adopted according to all their requirements engineering skills.

- Developing a hybrid sales engineering function can be very beneficial, since they are in an ideal position to cooperatively innovate with customers and translate this information back to R&D. Second, they are highly credible for R&D due to their technological and product knowledge.
- R&D is also a well-suited sparring partner for the customer in the process of making the technology needs more explicit. Especially, when R&D also has interpersonal skills and a close relationship with its customers.

3) Increase the overall probability of new product success by improving overall dissemination and responsiveness

- Improve dissemination between R&D and customer-facing functions by stimulating formal and informal information sharing, continuously during the entire NPD project to prevent gaps in the dissemination process.
- Improve responsiveness of the NPD team by adopting a continuous method of iterative development stimulating actual experience and usage of the customers with the (conceptual) new product. In adopting this kind of strategy in towards new product development, customer-facing functions can play a very important role for organizations.

5.3. LIMITATIONS & DIRECTIONS FOR FUTURE RESEARCH

This study has some limitations that offer opportunities for future research. First, since this is a master thesis project with a particular deadline, at the start of this research a decision had to be made between two alternatives: interview more people from different functions within one NPD project team but compare less projects in total; or incorporate more NPD projects in total in the sample to be able to analyze and compare, but therefore interviewing only one team member per NPD project. The latter approach was chosen because the goal of this study was the exploration of the subject. Therefore, it was better to explore more NPD projects (more units of analysis) than go into more depth in fewer NPD projects. This option brings along the risk of involving merely one point of view. However, we tried to mitigate this risk by asking the organizations for project leaders to be interviewed with an overall view on all operations and decision-making processes, to be able to capture as many aspects of one single case study as possible. Moreover, doing case studies at more organizations increases the external validity, and therefore makes it more generalizable (Saunders et al., 2009). Moreover, probably also less approaches, moderators and levers would have arisen from the smaller amount of analyzed projects and by talking to fewer interviewees. However, more points of view from the processes of one project would have increased the internal validity of the extracted factors from one single case study, that is, the plausibility of the research propositions of this study (Gibbert et al., 2008). Future, more in-depth, studies could investigate the internal validity of the research propositions. Additionally, the research propositions (described in chapter 4) were not tested due to the explorative and qualitative nature of this study. However, these propositions offer research opportunities for further quantitative studies, survey researches for example.

Secondly, the functional background of the interviewees was quite concentrated in the R&D function. To be precise, 18 out of 32 interviewees came from the R&D function. More or better defined moderators or levers could have been derived in from more other perspectives than R&D. Incorporating a higher variety of functional background of the interviewees in future research might bring out other perspectives moderators and levers as well. Future research should investigate if the other functions perceive the extracted moderators and levers the same way, or if additional moderators and levers can be found.

Thirdly, from the resource dependency theory (Hillman et al., 2009) and the findings of Ernst et al. (2010), it could be expected that different CFF functions might be best to be used (dominantly) as
input for R&D in the three different NPD phases – discovery, development, and commercialization phase – because of their functional expertise. In other, this would mean that NPD team do adopt a stable approach throughout the entire NPD project, but switch between approaches based on the situation at hand. Although some remarks were made on this matter by the participating organizations, the data fell short in being able to come to overall conclusions or moderating effects. Future studies are required, and could deep-dive into this phenomenon.

Furthermore, the measurement of commercial success was rather subjective. Interviewees were asked to rate their own success by stating if the initial expectations in the business case were met. Since so many organizations from, for example, different industries, size, income, and profit, there was not one good overall measures to define as commercial success. A suggestion for future research would be to use the ROI (return on investment) for more financially comparable organizations.

Besides, projects that concerned extremely radical or disruptive innovations were left out of the research, since they have their own specific dynamics. However, the approaches, moderators, and levers might be different for these situations, since higher levels of innovativeness call for other types of problem-solving approach due to the inherent high levels of uncertainty (Brettel et al., 2012). Further research should look into if the approaches and moderators also count for more highly innovative projects. Also, the study was conducted in the physical goods area, i.e. product innovations. However, the characteristics of service or process innovations could alter the market orientation, since service firms are uniquely different from manufacturing firms and therefore face unique challenges in innovation (Atuhene-Gima, 1999). For example, because of the intangibility of services, a greater understanding of customer needs in required. Thus, further research could investigate whether the conceptual framework also counts for service innovations.
6. REFERENCES


APPENDIX A: THE INTERVIEW GUIDE

1. INTERVIEW METHODOLOGY

This research on how to use market intelligence on customer needs in New Product Development – i.e. the interface of R&D and customer-facing functions in New Product Development, will use multiple (that is, 32) case studies to provide more insights and best practices on the matter. Data for the case studies will be gathered by the qualitative research method of interviewing. The research will be conducted at the consultancy company Arthur D. Little, for which the companies in their client network can be considered the pool of potential interviewees. Prior to developing the interview plan, an extensive literature review on the relevant topic was conducted. The literature review was used to find existing knowledge and emerging themes on the research subject that might be relevant to investigate during the interviews (Hill et al., 1997). Based on the research topic, the literature review, and thorough discussions together with Arthur D. Little’s management, a selection of suitable companies among Arthur D. Little’s clients was made. These companies were all invited to join the research, of which 15 decided to participate. A more detailed description of this process and the content of the interviews will be given in the interview guide in section 2.2. However, first the goal of the interviews, the structure of the interviews, and some information on the interviewees are given.

1.1. INTERVIEW RESEARCH OBJECTIVE

During the interviews, the objective is to gather information on organization’s approaches of utilizing different departmental functions in new product development and how they collectively gather, share and use market intelligence on customer needs throughout new product development processes. Specifically, focus will be placed on investigating the impact of the cooperation between R&D and the customer-facing functions, i.e., sales and technical services, on new product success in NPD projects. The interview is ordered in accordance with the three steps of being a market-oriented organization, which entails generating, disseminating and responding to market intelligence (Kohl & Jaworski, 1990). The second component - disseminating market intelligence - concerns knowledge sharing between functions (Narver and Slater, 1995). Therefore, other methodologies on relational information processes will be used as input for the interview questions and probing as well (Jayachandran et al., 2005). The research will be from a R&D perspective, which means that R&D will be the unit of analysis.

1.2. INTERVIEW DESIGN: SEMI-STRUCTURED INTERVIEWS

Because the research area is rather unexplored and under-researched, and the research project is of exploratory and qualitative character, the interviews will be semi-structured. Semi-structured interviews are one of the most commonly used qualitative research methods (Clifford et al., 2010). A fixed set of sequential questions is used as an interview guide but additional questions can be introduced to facilitate further exploration of issues brought up by the interviewees, thus almost taking the form of a managed conversation (Cachia and Millward, 2011). Open-ended questions are asked which should lead to open responses (Clifford et al., 2010). Thus, a semi-structured interview uses as list of specific questions, but leaves sufficient room to deviate from these specific questions for
additional information. A common mistake in semi-structured interviews is that researchers ask too many scripted questions, so that leeway is not encouraged (Hill et al., 2005). Therefore, Hill et al. (2005) recommend to include 8 to 10 scripted open-ended questions per hour. Because the interviews for this research are also targeted to take about an hour, this guideline is tried to be respected in this interview as well.

1.3. INTERVIEWEES
15 organizations provided 32 case studies, and among those, 27 specific NPD projects: 13 projects that met their initial market expectations set in its business case, and 14 that did not. Of every project, one representative or project leader will be asked to be interviewed. It is required that every interviewee was closely involved in the project in the following way:

- Was part of the project decision-making process from start to end;
- Had an complete overview of all technical aspects of the project;
- Had complete insight in how all the functions and stakeholders were involved throughout the project.

In total, 32 New Product Development project leaders or representatives will be interviewed.

1.4. CONDUCTING THE INTERVIEWS
The interviews will be audiotaped in order to analyze the data afterwards and to deduct overall best and worst practices from this data. This enables comparing an organization’s performance against these best practices, and allows providing feedback to the participants as. The interviews will be conducted face-to-face, but when needed, semi-structured interviews can also be very well conducted by telephone (Cachia and Millward, 2011).

While conducting the interviews, the interviewer has a dual role: a content-oriented and management role (van Aken et al., 2007). The goal is getting clear and unbiased answers, while also managing the time spent on the variety of issues. Next, it ensures an open and pleasant atmosphere by showing and letting the interviewees know that they are an important contribution to the solution of the research problem.

2. THE INTERVIEW PROCESS

2.1. PLANNING AND SETTING UP THE INTERVIEWS
The process of planning and setting up the interviews will be as follows:

- Inviting innovation or R&D-driven companies that operate in business-to-business markets
- Determining selection of participating companies to provide 30 cases to study in total
- Decide two or three projects and a staff members per project that fit interview profile together with company contact person
- Schedule interviews with selected interviewees
- Send introduction and the questionnaire to interviewees prior to conducting the interviews

2.2. THE INTERVIEW GUIDE
The interviews will contain open-ended questions to apply the semi-structured interviewing method. After each question, the remarks of the interviewee can be reflected or probed on (Britten, 1995). According to Britten (1995), there are six types of questions that can be asked in a qualitative
interview: behavior or experience, opinion or belief, feelings, knowledge, sensory and background or demographics. A mix of those will be asked in these interviews.

It is strived to be able to answer the following main questions after the interview is completed and thereby be able to fill in table 8 afterwards:

(1) “How would you describe the core business of the project (product), market and technology environment (customers and competitors, and dynamics), project (life span) and new product development activities (stage-gate approach etc.)?”,

(2) “What activities did your team employ to generate, disseminate and respond to customer needs intelligence?”, and

(3) “How did these activities affect your new product development activities in the project and the commercial success of the new product?”

<table>
<thead>
<tr>
<th>Table 8: Interview Format</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interviewee background</strong></td>
</tr>
<tr>
<td>Personal background</td>
</tr>
<tr>
<td>Function within company or project</td>
</tr>
<tr>
<td><strong>Involvement in particular NPD Project</strong></td>
</tr>
<tr>
<td>Degree and way of involvement</td>
</tr>
<tr>
<td><strong>General NPD Questions</strong></td>
</tr>
<tr>
<td>Core business (products)</td>
</tr>
<tr>
<td>NPD activities?</td>
</tr>
<tr>
<td>KPI’s in business case: Achieved: yes/no</td>
</tr>
<tr>
<td><strong>Involved functions:</strong></td>
</tr>
<tr>
<td><strong>Activities/tools/methods? Outcome?</strong> Discovery stage</td>
</tr>
<tr>
<td>Role of R&amp;D</td>
</tr>
<tr>
<td>1. Gathering MI/CNK</td>
</tr>
<tr>
<td>2. Disseminating MI/CNK</td>
</tr>
<tr>
<td>3. Responsiveness to MI/CNK</td>
</tr>
<tr>
<td>Role of marketing</td>
</tr>
<tr>
<td>Role of sales</td>
</tr>
<tr>
<td>4. Gathering MI/CNK</td>
</tr>
<tr>
<td>5. Disseminating MI/CNK</td>
</tr>
<tr>
<td>6. Responsiveness to MI/CNK</td>
</tr>
<tr>
<td>Role of technical services</td>
</tr>
<tr>
<td>7. Gathering MI/CNK</td>
</tr>
<tr>
<td>8. Disseminating MI/CNK</td>
</tr>
<tr>
<td>9. Responsiveness to MI/CNK</td>
</tr>
<tr>
<td>Further Remarks?</td>
</tr>
</tbody>
</table>

TABLE 8: INTERVIEW FORMAT
2.2.1. INTRODUCTORY INFORMATION

A couple of days before the scheduled interviews, an introduction to the survey will be send to all participants. First, a short background of the research project will be given, what the objectives of the interview are, and why this particular interview is relevant to the project (van Aken et al., 2007). Also, some concepts which will be discussed during the interviews are defined, as are shown in the next section. Besides, it will be explained that the results of the interviews will be given in the form of a company specific report per organizations that compares their innovation practices on the particular subject to the extracted best practices from this entire research. It will be made clear that these will become available in the second quarter of 2015. In this document, the participants are asked to fill in the first 6 questions of the questionnaire in section 2.2.2. The rest of the questionnaire is also added in the document, so that the participants could prepare for the interview beforehand.

When starting the actual interviews, it has to be made clear to the interviewees that the interview will be audiotaped, but that anonymity and confidentiality will be secured. After the data is collected and analysed, the tapes will be destroyed. An introduction to the survey will again be explained, and the general questions filled out in the introduction document will be briefly checked on validity with the interviewee.

Definitions

During the interviews, interviewee will be asked about certain terms or concepts. Following definitions will be explained to the participants before starting the interview, to increase the validity of the answers given by each interviewee.

*Discovery phase*: this is also called the fuzzy front-end phase, in which you start identifying market opportunities, collecting and analyzing customer requirements, generating product ideas that align the opportunities with customer needs. Moreover, typically product concepts are tested with customers, so that a clear description of the selected product requirements can be developed. Budget and schedules will be set up as well.

*Product development stage*: in this phase the product requirements and specifications that were defined are translated into a final design, which is then converted into a concrete product ready to launch. This phase also involves testing the product, both internally and with customers.

*Commercialization stage*: here, the formulation, execution, and synchronization of the launch are performed. During commercialization, production ramp up, training of the sales forces, purchasing of media time and space, and the development of media messages are also carried out.

*Market Intelligence*

Market intelligence refers to a firm’s knowledge about its customers and competitors.

*Market intelligence generation*: obtaining, analyzing, and interpreting the forces that influence customers’ needs and preferences.

*Market intelligence dissemination*: the process of information exchange and communicating market intelligence within the organization.

*Market intelligence responsiveness*: the response action by the whole organization to the market intelligence generated and disseminated.
2.2.2. The Intake Questionnaire (Send, filled in, and returned by email)

The following questions will be send to all participants prior to the scheduled interviews in an introduction document, which also contains the actual questionnaire for during the interviews, so they will be able to prepare for those meetings. They are asked to return the filled-in survey by email before the date of the interview.

A. Participants Background
   1. Could you briefly explain your role and function within your organization?

B. Innovation Project and involvement
   2. What was your role and how were you involved in the project we will be discussing during the interview?

   3. Could you elaborate on the following the characteristics of this project?
      a. Product characteristics: newness to the firm, newness to the market? Existing or new technology? Existing or new technology?
      b. Project characteristics: life span?
      c. Customer characteristics?
      d. Competition characteristics?
      e. Market and technology dynamics?
      f. Project team: size, stability?

   4. Was there a formal NPD process (such as a stage-gate approach)? If yes, could you describe it? If not, how was your NPD organized?

   5. Which functions were planned to be formally involved, as decided in the initial planning of this project?

C. New Product Success: criteria and outcomes

   6. Which key performance indicators or success measures did you use in the initial business case for this innovation project to determine the success of the new product?

   7. In hindsight, do you believe these initial criteria were met or not? And do you consider the launched [Product Innovation] to be a success? If not, why?
2.2.3. **INTERVIEW OPEN-ENDED QUESTIONS (FACE-TO-FACE INTERVIEWS)**

**D. Market intelligence/customer needs knowledge generation:**

*Intelligence generation: obtaining, analyzing, and interpreting the forces that influence customers’ needs and preferences*

In general, does R&D use market data for developing new products? Was there any specific market data additionally used for this project? If yes, did this market data include knowledge on customer needs? And if so, was it generated throughout the entire NPD process? What activities, tools, or methods did you employ to generate customer needs data? Which function(s) contributed in this process and how?

**E. Market intelligence/customer needs knowledge and “R&D capabilities” dissemination/sharing**

*Intelligence dissemination: the process of information exchange within the organization*

Was the market information from various functions integrated and shared in this project? And if yes, how?

a. Did R&D share information with customer-facing functions, for example on their practices, capabilities, development progress or product features and benefits? What activities, tools or methods were used to realize this? And how and where was that information stored?

b. Did the customer-facing functions share their knowledge on with R&D? What activities, tools or methods were used to realize this? And how and where was that information stored?

Prompts: Formal or informal? Via IT tools or also face-to-face?

**F. Market intelligence responsiveness**

*Responsiveness: the response action by the whole organization to the market intelligence generated and disseminated.*

How did the project team (the involved functions) respond to or use the shared market intelligence in the NPD process as a whole and how did this affect the new product success according to you?

**G. Reflecting on/evaluating the project**

In previous questions, you stated your team’s plans and goals realized practices with regard to the discussed topics. Was this in line with what you planned at the beginning of the project? If not, what was not accomplished and what was the impact of that gap on the success or failure of your new product according to you?

Lastly, why did or did you not utilize your customer-facing functions in this NPD project? Do you foresee a bigger role of customer-facing functions in future NPD projects?

**H. Closing the Interview: additional remarks**

Towards the end of the interview, room is left for additional information that the interviewee likes to add (van Aken et al., 2007). The interviewee will be thanked for his or her time, and the manner in which feedback on the interview will be given, is explained again.
# Appendix B: Final Codebook

<table>
<thead>
<tr>
<th>Main code</th>
<th>Sub code (level 1)</th>
<th>Sub code (level 2)</th>
<th>Code description</th>
</tr>
</thead>
<tbody>
<tr>
<td>New product success</td>
<td>Performance measures</td>
<td>KPI's</td>
<td>The measures that were used in the initial business case to determine the ultimate success of the NPD project</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sales volume</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cost target</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Market share</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Technical requirements</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Time to market</td>
<td></td>
</tr>
<tr>
<td>CNI generation</td>
<td>Approaches</td>
<td>Technology push</td>
<td>The ways R&amp;D gathers CNI in NPD projects, and which (CFF) function are involved in that gathering process, either as a filter function or through a direct contact with R&amp;D.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Direct R&amp;D</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Indirect - Marketing</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Indirect - Sales</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Indirect - Service</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Indirect - Sales engineering</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Indirect multiple CFF</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Combined</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Involved function gathering CNI</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Filter function</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Interface R&amp;D - CFF</td>
<td></td>
</tr>
<tr>
<td>Functional roles generation</td>
<td>Role R&amp;D</td>
<td></td>
<td>The roles of the different NPD teams function in generating CNI, i.e. which aspects of CNI do they cover</td>
</tr>
<tr>
<td></td>
<td>Role marketing</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Role sales</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Role services</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Role sales engineering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>External Moderators</td>
<td>Target market selection</td>
<td></td>
<td>External characteristics (outside project team) that influence the effectiveness of an approach on NPD success</td>
</tr>
<tr>
<td></td>
<td>Product roll out strategy</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Technical knowledge customers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transparency technology needs</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transparency market needs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal moderators</td>
<td>CFF's requirements engineering skills</td>
<td></td>
<td>Internal characteristics of the project team that influence the effectiveness of an approach on NPD success</td>
</tr>
<tr>
<td></td>
<td>R&amp;D's requirement engineering skills</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Relative power of function</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Product range CFF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CNI dissemination</td>
<td>Dissemination levers</td>
<td>Technical knowledge CFF</td>
<td>Factors related to dissemination between R&amp;D and the (relevant) CFFs. In particular, that enhance dissemination, and thereby the effectiveness of an approach on NPD success</td>
</tr>
<tr>
<td></td>
<td>Trust</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Formal dissemination</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Informal dissemination</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Continuity dissemination</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inbound dissemination</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CNI responsiveness</td>
<td>Responsiveness levers</td>
<td>Factors related to responsiveness of R&amp;D to CNI. In particular, that enhance responsiveness, and thereby the effectiveness of an approach on NPD success</td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Objectivity CNI</td>
<td>Factors related to responsiveness of R&amp;D to CNI. In particular, that enhance responsiveness, and thereby the effectiveness of an approach on NPD success</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Continuity responsiveness</td>
<td>Factors related to responsiveness of R&amp;D to CNI. In particular, that enhance responsiveness, and thereby the effectiveness of an approach on NPD success</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Credibility CFF</td>
<td>Factors related to responsiveness of R&amp;D to CNI. In particular, that enhance responsiveness, and thereby the effectiveness of an approach on NPD success</td>
<td></td>
</tr>
</tbody>
</table>
### Table 10: Illustrative quotes for the conceptualization of the CNI gathering approaches

<table>
<thead>
<tr>
<th>Conceptual approaches</th>
<th>Definitions</th>
<th>Explanatory quotes from interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct R&amp;D approach</strong></td>
<td>R&amp;D gathers customer needs intelligence independently, first-hand from customer</td>
<td><strong>Quote 1:</strong> For us, it becomes extremely technical in an early stage. We are doing lab tests for our customers and also pilot plants at our customer’s site. All the technological or engineering departments were involved in this. [...] We had direct customer contact on the operational issues and the results of those tests.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Quote 2:</strong> Technicians at the customer’s side are usually a bit more loose-lipped towards us as R&amp;D, we often get more information out of them than out of people on strategic positions such as procurement. Relationship management is extremely crucial for a customer in these situations. For this project, that was our [R&amp;D] responsibility. So technology to technology.</td>
</tr>
<tr>
<td><strong>Indirect Dominant CFF approach</strong></td>
<td>R&amp;D gathers customer needs intelligence by relying on the input one dominant customer-facing function</td>
<td><strong>Quote 1:</strong> I am the product marketing manager. I was the primary point of contact for customer interfaces. Certainly I did talked a lot to customers in the market collection phase. [...] So we used a lot of that type of “market research” if you want to call it that, in that phase. And then in general, there were some industry trend reports like third party suppliers for market research saving the volume of samples is growing, things like that.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Quote 2:</strong> Well, sales does deliver some input, but that always goes through the marketing function. I think it is very beneficial to have one central point of communication who collects all the information, organizes it, and disseminates it. Otherwise, too many discussions will arise in the project team.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Quote 3:</strong> The market data was gathered by our sales force through different customers. Not only the specific questions, but covering certain topics. So by talking to different customers, and asking “Is there a general need here and what would they use it for? What would the benefit be”? So sales gathered the market data on customer needs.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Quote 4:</strong> From my point of view as R&amp;D in the running business, I do not have direct contact with customers. It is the service organization, and through them, our field service employees. We have in this [...] program where we go over to the field service employees, and we explain what we are doing with the complaints they have received. That is very important, because the field service employees are talking to customers. They are bringing in an issue, and the customers wants to know when this issue is solved.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Quote 5:</strong> Systems engineers play a very important role towards R&amp;D, because they have some kind of double role: on the one hand, they talk to customers and receive many questions and requests from them. On the other hand, do they also look at what is generally possible in our market. And then, how we could realize these trends or systems in requirements for R&amp;D, so for new building blocks within our entire systems.</td>
</tr>
<tr>
<td><strong>Indirect Multi CFF approach</strong></td>
<td>R&amp;D gathers customer needs intelligence by relying on the input of multiple customer-facing function</td>
<td><strong>Quote 1:</strong> I had discussions with the marketers about the specific components of our product. I talked to the systems engineer about the more generic parts [...] Often, the systems engineer and the marketer went to the customer together to gather information on their needs for us.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Quote 2:</strong> Marketing made a Mood Book for us, that showed how the mood of a customer would be for a certain application. And from that Mood Book, there were certain aspects that needed more information for us to be able to work with it. Then sales started to gather the detailed information by visiting customer directly.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Quote 3:</strong> What worked well for us in this project, is that we split up [the role for gathering customer information]: [...] we used marketing to see if there was a general need for our product. Then, we used system engineers to set up the specific requirements of exactly to deliver for it to be successful, by talking to a few very dedicated customers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Quote 4:</strong> At some point in the project, you know the specs and the expected performance. Then it is time to present this to the customer. This is always done through marketing or customer support. We as R&amp;D practically never talk directly to customer. [...] So all information is broadly shared within the project team. We [as R&amp;D] tell them exactly what we are doing. It is up to marketing and customer support to decide what they will tell or show.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Quote 5:</strong> R&amp;D does not directly gather market data on customer needs. Mostly, the market intelligence generation is done via our group, so the application and technical group with sales. We are the ones who have the direct contact with the customers, the market, with the institutes. We are more or less the eyes and ears. And we bring this information with marketing together, we make a profile together to make the actual product. [...]</td>
</tr>
<tr>
<td><strong>Combined approach</strong></td>
<td>R&amp;D gathers customer needs approach both directly through customers and also indirectly through customer-facing functions</td>
<td><strong>Quote 1:</strong> So we as R&amp;D share the information that we possess and the information we still need with sales and the application specialists. An application specialist will in turn gather even other information, since he has another background, other needs and also other discussions with customer.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Quote 2:</strong> We, as a company, want to be more specialty than commodity. What is really important in that, is the difference in capability of the people that are at the table with the customers to perform our discovery phase in the right way. To find new information and insights. It is a big part of how we train our employees, and it definitely does not stop at sales, it also involved our colleagues of R&amp;D, technical service and applications. We want them to be able to have the same discussions as sales up to a certain level.</td>
</tr>
<tr>
<td>Structural moderators</td>
<td>Definitions</td>
<td>Explanatory quotes</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Dispersion of requirements engineering skills</td>
<td>The extent to which the requirements engineering skills (translating needs into requirements) are dispersed between R&amp;D and/or the customer-facing functions</td>
<td>Quote 1: A good sales manager can even sell his own wife. That does not mean that he is able to comprehend the R&amp;D side of things. You need to pick the right CFF or R&amp;D for this, depending on the type of market you are operating in at that moment.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Quote 2: Our applications group has much more specific customer information, much more application information that the average sales manager. The applications group is especially set up for [these specific market] customers or their applications, which is their specialty. Our sales manager does not have this kind of specialization. They have to sell all our products to all our customers. [...] That means that they are, by definition, behind on the marketing and applications group.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Quote 3: We already had product A and B. The customer wanted a product with quality of A and functionality of B. So applications wanted to make some sort of combination of both products. However, I [as R&amp;D] did not think that was the right assessment: the solution for the customer needed a whole new product. From that moment on, R&amp;D became the lead for product requirements, which thus had to do with the knowledge of the application engineer.</td>
</tr>
<tr>
<td>Product roll out strategy</td>
<td>The strategy for the process by which the product innovation is rolled out to particular markets over time</td>
<td>Quote 1: We used the key customers to start developing because we were pretty confident we could produce with them. But we had a customer in another market: the food production market, who could use this product as well. But we didn’t have the same discussion with them, we were more or less using one key customer, develop it with the expectation that if we got to stage 4, the other customer would take the product on as well.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Quote 2: This one customer came in with a requests and we took it. The communication became between us [as R&amp;D] and the customer’s R&amp;D started very fast.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Quote 3: It’s for the kind of business we are in, a niche market; the information I receive from my operational customer-facing functions sales and services is nearly the only way to get any guidance on what you need to develop. For many markets, you can buy studies of market data, such as market shares. But for this market, we do not know. We really depended on our eyes in the market.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Quote 4: This was a product that was relatively widely applicable. You can attach it as an add-on to all of our [products]. So first, systems engineering started talking to only 20 dedicated customers who could be interested. [...] They stated a clear need for this product. So we expected a lot of market potential. And in this case, we neglected to look at it from a more general marketing view.</td>
</tr>
<tr>
<td>Configuration of customer needs - technology needs tacitness</td>
<td>The extent to which the customer needs and/or the technology needs are tacit, compared to being explicit</td>
<td>Quote 1: We were far behind on competition, we missed a functionality. We got a lot of feedback from customers on this. Eventually, we went to customers with an R&amp;D team to research, bottom-up, why our product was failing. It is very complex. [...] We did not understand why our customers found that [our product] was failing them, and the customer did not know either. So our systems are so extensive, that an applications team went to talk to our customers first, since they speak the language of our customers. But the needs were so hard to translate into software, that my project team, applications and R&amp;D went to all customers together.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Quote 2: The need of the customer is in fact: ‘The water needs to be clean against acceptable costs.’ The rest is a black box for him, as long as it does what it is supposed to do. That is really manageable. What we [as R&amp;D] the had to try to figure out, was the technical execution. So how could we make it smarter, more stable, more robust. We wanted to make a disruptive, completely new technology for that. We did that by going to congresses, visiting universities, and talking to the customer’s technical people, also to test our technology.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Quote 3: If you look at our customers, three defined and critical technology dimensions are always important for them [...]. We translate those into parameters. This way, you come to what your customer wants from a technological standpoint. In [our market] that is fairly simple: we have a certain law that we have to live up to [...]. The whole market in which we operate is following that law, our competitors as well as our customers. This way, innovating becomes a self-fulfilling prophecy, which is almost predictable. And as long as we keep delivering the technology, this prophecy stays correct. [...]</td>
</tr>
</tbody>
</table>

Table 11: Illustrative quotes for the conceptualization of the structural moderators
<table>
<thead>
<tr>
<th>Process moderators</th>
<th>Definitions</th>
<th>Explanatory quotes</th>
</tr>
</thead>
</table>
| **Formal and informal dissemination processes** | The formal and informal (gathered) CNI sharing between R&D and all relevant customer-facing functions in the project team                                                                                                                                                                                                                           | **Quote 1:** We have a product generation process with 14 key decision meetings. That is a formal protocol which states which function has to deliver what and when. That assures that everyone knows where and when to get what kind of information. And on top of that, we have formal program and project meetings, to share even more detailed information.  
**Quote 2:** We have a product generation process with 14 key decision meetings. That is a formal protocol which states which function has to deliver what and when. That assures that everyone knows where and when to get what kind of information. And on top of that, we have formal program and project meetings, to share even more detailed information.  
**Quote 3:** I think only formal ways of doing it will not work. I think informal ways is the way to be, most time efficient.                                                                                                                                                                                                                       |
| **Continuity of dissemination**        | The extent to which the dissemination process within an NPD team is continuous                                                                                                                                                                                                                                                                                                                       | **Quote 1:** We have experienced that it is really important to come together as a whole team at least once a month. Those meetings do not always have to be physical, they can be virtual as well. It makes sure that information is exchanged, but also that the right information from all points of view is being passed on, through co-reports. We discuss (a) what is the status?, (b) what went well, what not? Are there any corrective measures?, and (c) what are the next steps?  
**Quote 2:** We regularly communicate our progress to our customers. And that often goes through our systems engineering function again. We ask them if they can check how valuable our customers still consider certain functions. Or to consider changes. And sometimes, the customer comes back with feedback we have to deal with.  
**Quote 3:** When we think we have signalized a trend, we involve sales directly and consult with them to verify if they can check if that trends really exist in the market. We will come up with a questionnaire for them to check: are customers involved in this, is it an issue, is it not an issue. |
| **Objectivity of customer needs intelligence** | The extent to which the gathered and disseminated is fact-based, compared to opinion-based                                                                                                                                                                                                                                                                                                              | **Quote 1:** The nice thing is that the product development had done its part of the job very well, so that there was no ambiguity, no mix up was possible anymore with what sales was saying. What sales was saying with words, in wine and dine language, the product development had written down in hard engineering numbers. And that was indirectly the inspiration of what R&D had to achieve as a minimum. If you can achieve more, all the better, but that is the minimum.  
**Quote 2:** Our CFFs do not specifically specialize themselves in gaining the right input from the market. May be purely on experience, but not explicitly. What generally absolutely lacks in this organizations, is that this process [of generating and using customer need intelligence] is not fact-based enough. We have enough channels to collect feedback from customers, but the feedback is just not factual enough. And when feedback is not factual, and contains too much feelings or emotions, our trust [as R&D] in the CFFs decreases.  
**Quote 3:** Our CFFs do not specifically specialize themselves in gaining the right input from the market. May be purely on experience, but not explicitly. What generally absolutely lacks in this organizations, is that this process [of generating and using customer need intelligence] is not fact-based enough. We have enough channels to collect feedback from customers, but the feedback is just not factual enough. And when feedback is not factual, and contains too much feelings or emotions, our trust [as R&D] in the CFFs decreases. |
| **Continuity of responsiveness**       | The extent to which the responsiveness project within an NPD team is continuous, i.e. iterative validation and verification loops are used                                                                                                                                                                                                                                                        | **Quote 1:** In our organization, we usually ask feedback of customers two to maximally three times before we commercialize it. In this successful project, however, we really developed the product iteratively: make a preliminary version, go to the customers, ask feedback, go back, modify a new version, go back to the customer. In the end, we only introduced after version 10. Normally we would introduce it like a Big Bang. But the customers were very satisfied.  
**Quote 2:** We should step away from the fact that there would be some kind of magical gap in the middle where developers make all kinds of things that aren’t even validated, it has to be a continuous process. With continuous validation in the market; there must be interaction with the customer and R&D continuously. Without this process, everybody is just hoping it will be what they expected it to be. However, this a very risky process that happens within a lot of organizations.  
**Quote 3:** We try to continuously test and check whether our development still fits with what every stakeholder needs to be successful. That means that our development cycles are very short, and that you deliver something very concrete and tangible after these short periods that you can test internally or outside in the market. It does not have to be ready or complete, but we are not waiting until we are completely ready developing before receiving feedback anymore. […] It is not always possible to develop something concrete so short cycled, since our systems are so large, but then you will try to deliver a mock-up or a simulation of the product. We want to prevent something that you have invested in for a long time, and while you introduce it as a Big Bang, your customers say: “Well, that was not entirely what I needed”.

Table 12: Illustrative quotes for the conceptualization of the process moderators
APPENDIX D: EXAMPLES OF WITHIN-CASE ANALYSES

EXAMPLE 1: UNSUCCESSFUL DIRECT R&D APPROACH

Communication process:
- Highly technical face to face R&D discussions
- Separate, distinct commercial process led by sales function
- Marketing function does not exist within organization

Causes of commercial disappointment
- Sales function technically too inadequate
  - Due to large overall product range
- R&D is much better at probing questions, and retrieving the right customer value
- No alignment, interaction between R&D and sales
- No interaction with customer during development phase (customer already chose other supplier)
EXAMPLE 2: PARTLY SUCCESSFUL DIRECT R&D APPROACH

**Communication process**
- Technical face to face R&D discussions
- Business development came in with idea, R&D took feature specifications over
- High technically knowledgeable customer, equal sparring partner for R&D
- Do not involve sales, service too early, value proposition needs to be completely clear first

**Causes of commercial success, later disappointment**
- Clear market need knowledge: clear goal
- Project successfully developed for one customer, not successful in targeting entire market
EXAMPLE 3: UNSUCCESSFUL INDIRECT DOMINANT MARKETING APPROACH

Indirect Dominant CFF Approach

Communication process

- Marketing always filter function between customer, sales and R&D
- Marketing is R&D’s main and only direct product requirements input
- Sales sporadically checks specific aspects that need clarification at specific customers

Causes for commercial disappointment

- Marketing is not good at setting correct & clearly defined specifications, ready for R&D to work with, in discovery phase
  - Too technologically ignorant according to project leader
  - Too many changes in product requirements after Requirements Specifications Document during development phase
    - Major delays
    - Way too expensive, twice as promised
- Product innovation forced by government legislation, but insufficient added product advantage compared to earlier model
EXAMPLE 4: SUCCESSFUL INDIRECT DOMINANT APPLICATION APPROACH

Indirect Dominant CFF Approach

FIGURE 10: EXAMPLE INDIRECT DOMINANT CFF APPROACH

Communication process

- Customer came in with request
- Sales/area managers set up general early discussions with customer, then applications took over
- The CFFs and R&D had a lot of frictions, since both had different goals and targets in mind
- Applications was central point of contact, mediated between customer sales/service and customer
- Input from applications is very valuable, since every project is so unique

Causes of commercial success

- Customer needs were very clear, predictable, stable market for long
- Applications has high technological knowledge, perfect bridge between sales and service, the customer and R&D
- Frequent formal and informal communication between functions within project team
- Frequent communication with the customer in development phase was not needed, since end goal was so clear for both parties
**EXAMPLE 5: UNSUCCESSFUL INDIRECT MULTIPLE – MARKETING, SALES ENGINEERING, SERVICES - APPROACH**

**Indirect Multi CFF Approach**

**FIGURE 11: EXAMPLE INDIRECT MULTIPLE CFF APPROACH**

**Communication process**

- Marketing and applications (systems) often go to customers together
- Marketing brings in the more generic customer requests
- Applications comes brings in the more specific customer requests
- First, marketing interprets the questions from the customer, then applications together with the engineers translate those into technical specifications.
  - Technical specification are always pretty straightforward (not the execution, but the specifications), so no direct R&D contact is needed
- Marketing and applications are involved in all key decision meetings

**Causes of commercial disappointment**

- Friction between R&D and service, since functionality (R&D) has priority over maintenance (Service)
- There was no time to include all specifications
  - Specs prioritization was done by R&D, but they had no verification loops with marketing or customers
- Customer information is highly confidential and therefore only parts are shared with R&D
EXAMPLE 6: SUCCESSFUL INDIRECT MULTI – MARKETING, SALES ENGINEERING, SERVICES AND SALES- APPROACH

Indirect Multi CFF Approach

Marketing

R&D

Applications

Customer

Customer Support (local & corporate)

Account Managers

Communication process:

- No direct contact between R&D possible, customer is not very technologically knowledgeable
- Different aspects of customer needs is channeled to R&D through different functions

Causes of commercial success

- CFFs are highly technologically knowledgeable
  - Consistent project team trinity (product manager, systems engineer, product development manager)
- Formalized frequent cross-functional meetings (14 Key Decision Points) → causes high coordination
- KPIs are very clear & stable for every product: follows a scientific law, consistency of 3 overall technically measurable KPIs
EXAMPLE 7: UNSUCCESSFUL COMBINED – R&D, APPLICATIONS, MARKETING, SALES - APPROACH

FIGURE 13: EXAMPLE COMBINED APPROACH

Communication process

- Sales/account managers initiate a project, and then R&D, marketing and applications take over
- Marketing is there for the expansion after ETO project (replicability)

Causes of commercial disappointment

- All CFFs have low requirements engineering skills in this project due to complex technology
- Marketing was too slack in providing information to R&D, R&D had to ask for it but oftentimes did not receive anything
- There was no frequent communication: R&D was not part of marketing’s milestone meetings, had no idea about the marketing process
- Sales leads are stored in a database, but never shown to R&D
- No informal communication possible due to the fact that all functions were located in different countries
- Customer request was passed on too “vague” towards R&D, which caused major problems in the end
- Customer needs were translated into functional requirements immediately, instead of first defining customer requirements specifications
- No early responsiveness (verification), first field test only in phase 3
EXAMPLE 8: SUCCESSFUL COMBINED – R&D, MARKETING, SALES – APPROACH

Communication process

- First, sales was main point of contact for customer
- Then, it shifted: Discussion partner for customer was adjusted to the type of needs to be discussed (commercial, technical, business)

Causes for commercial success

- Sales and marketing both had high technological knowledge → ability to probe questions for R&D
- Sales’ main goal is also the customer’s long-term prospects → R&D-sales goal alignment
- Direct R&D to R&D contact was very valuable, however, sales was there for everything beyond the technical requirements
  - The subjective/emotional topics (for example: the type of noise)
- The involvement of sales and team information sharing was formalized throughout entire NPD project
<table>
<thead>
<tr>
<th>Project</th>
<th>Project outcome</th>
<th>Approach</th>
<th>Product roll out strategy</th>
<th>Requirements engineering skills CFF</th>
<th>Requirements engineering skills R&amp;D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Partly successful</td>
<td>Direct R&amp;D Approach</td>
<td>Sequential (expansion failed)</td>
<td>Low (Sa)</td>
<td>High</td>
</tr>
<tr>
<td>2</td>
<td>Unsuccessful</td>
<td>Indirect Dominant Sales</td>
<td>Sequential (expansion failed)</td>
<td>Low (Sa)</td>
<td>Low</td>
</tr>
<tr>
<td>3</td>
<td>Successful</td>
<td>Indirect Cross-functional</td>
<td>Sequential (expansion succeeded)</td>
<td>High (M&amp;Se&amp;FA)</td>
<td>Low</td>
</tr>
<tr>
<td>4</td>
<td>Successful</td>
<td>Multi-channel</td>
<td>Mass</td>
<td>High (Se), Low (Sa)</td>
<td>High</td>
</tr>
<tr>
<td>5</td>
<td>Successful</td>
<td>Indirect Dominant Marketing</td>
<td>Mass</td>
<td>High (M)</td>
<td>Low</td>
</tr>
<tr>
<td>6</td>
<td>Unsuccessful</td>
<td>Indirect Cross-functional</td>
<td>Mass</td>
<td>High (A &amp; M)</td>
<td>Low</td>
</tr>
<tr>
<td>7</td>
<td>Successful</td>
<td>Indirect Dominant Service</td>
<td>Mass</td>
<td>High (Se); Low (Sa), low (M)</td>
<td>High</td>
</tr>
<tr>
<td>8</td>
<td>Unsuccessful</td>
<td>Indirect Dominant Marketing</td>
<td>Mass</td>
<td>Low (Mi), Low (SA)</td>
<td>Low</td>
</tr>
<tr>
<td>9</td>
<td>Unsuccessful</td>
<td>Direct R&amp;D</td>
<td>ETO</td>
<td>Low (Sa)</td>
<td>Low</td>
</tr>
<tr>
<td>10</td>
<td>Successful</td>
<td>Direct R&amp;D</td>
<td>ETO</td>
<td>Low (Sa)</td>
<td>High</td>
</tr>
<tr>
<td>11</td>
<td>Unsuccessful</td>
<td>Direct R&amp;D</td>
<td>ETO</td>
<td>Low (Sa)</td>
<td>Low</td>
</tr>
<tr>
<td>12</td>
<td>Unsuccessful</td>
<td>Indirect Dominant Applications</td>
<td>Mass</td>
<td>High (A), Low (Sa), Low (M)</td>
<td>Low</td>
</tr>
<tr>
<td>13</td>
<td>Unsuccessful</td>
<td>Technology Push --&gt; Multi-channel</td>
<td>Niche</td>
<td>High (Se), Low (Sa)</td>
<td>High</td>
</tr>
<tr>
<td>14</td>
<td>Successful</td>
<td>Multi-channel</td>
<td>Stage-wise</td>
<td>Low (Sam Low (M)</td>
<td>High</td>
</tr>
<tr>
<td>15</td>
<td>Successful</td>
<td>Indirect Dominant Marketing</td>
<td>Mass</td>
<td>Low (Mi), Low (Sa)</td>
<td>Low</td>
</tr>
<tr>
<td>16</td>
<td>Unsuccessful</td>
<td>Technology Push --&gt; Direct R&amp;D</td>
<td>Niche</td>
<td>Low (Sa)</td>
<td>Low</td>
</tr>
<tr>
<td>17</td>
<td>Successful</td>
<td>Indirect Dominant Applications</td>
<td>Sequential (expansion TBD)</td>
<td>High (A), Low (Sa)</td>
<td>Low</td>
</tr>
<tr>
<td>18</td>
<td>Unsuccessful</td>
<td>Indirect Dominant Marketing</td>
<td>Mass</td>
<td>Low (Mi), Low (Sa)</td>
<td>High</td>
</tr>
<tr>
<td>19</td>
<td>Successful</td>
<td>Indirect Dominant Marketing</td>
<td>Mass</td>
<td>High (A), High (M), Low (Sa)</td>
<td>Low</td>
</tr>
<tr>
<td>20</td>
<td>Generally optimal</td>
<td>Indirect Dominant Product Manager</td>
<td>Mass</td>
<td>High (CFO); High (PM); High (M), low (Sa)</td>
<td>Low</td>
</tr>
<tr>
<td>21</td>
<td>Unsuccessful</td>
<td>Technology push</td>
<td>Mass</td>
<td>High (A), High (Se), Low (Sa)</td>
<td>Low</td>
</tr>
<tr>
<td>22</td>
<td>Successful</td>
<td>Multichannel</td>
<td>Mass</td>
<td>High (A), High (Se), Low (Sa)</td>
<td>Low</td>
</tr>
<tr>
<td>23</td>
<td>Unsuccessful</td>
<td>Indirect Dominant Applications</td>
<td>Mass</td>
<td>High (A), Low (Sa)</td>
<td>Low</td>
</tr>
<tr>
<td>24</td>
<td>Generally optimal</td>
<td>Multichannel approach</td>
<td>Mass</td>
<td>High (A), Medium (M) --&gt; Moving towards High (Tech Sa)</td>
<td>High</td>
</tr>
<tr>
<td>25</td>
<td>Successful</td>
<td>Indirect Dominant Product Manager</td>
<td>Mass</td>
<td>High (Product manager)</td>
<td>Low</td>
</tr>
<tr>
<td>26</td>
<td>Successful</td>
<td>Multichannel</td>
<td>Mass</td>
<td>High (A)</td>
<td>High</td>
</tr>
<tr>
<td>27 &amp; 28</td>
<td>Unsuccessful</td>
<td>Multichannel</td>
<td>Sequential (both failed)</td>
<td>Low (A), Low (Mi), Low (S)</td>
<td>Medium</td>
</tr>
<tr>
<td>29</td>
<td>Successful</td>
<td>Indirect Cross-functional</td>
<td>Mass</td>
<td>High (A); Low (Sa), Medium (Me), High (Se)</td>
<td>Low</td>
</tr>
<tr>
<td>30</td>
<td>Successful</td>
<td>Multichannel</td>
<td>ETO</td>
<td>Medium (Sa), High (A)</td>
<td>High</td>
</tr>
<tr>
<td>31</td>
<td>Unsuccessful</td>
<td>Multichannel</td>
<td>ETO</td>
<td>Low (Sa), High (A)</td>
<td>High</td>
</tr>
<tr>
<td>32</td>
<td>General</td>
<td>Indirect Multiple CFF approach</td>
<td>Mass</td>
<td>Low (Sa on modular products)</td>
<td>Low</td>
</tr>
<tr>
<td>Transparency of customer needs</td>
<td>Transparency of technology needs</td>
<td>Dissemination: Formalization: R&amp;D - CFF</td>
<td>Dissemination: Continuity</td>
<td>Responsiveness: Objectivity</td>
<td>Responsiveness: Continuity</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>---------------------------------</td>
<td>----------------------------------------</td>
<td>--------------------------</td>
<td>-----------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>High</td>
<td>Low</td>
<td>None (R&amp;D isolation)</td>
<td>No</td>
<td>Opinion</td>
<td>No</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
<td>Formal</td>
<td>No</td>
<td>Opinion</td>
<td>No</td>
</tr>
<tr>
<td>High</td>
<td>High</td>
<td>Formal &amp; Informal</td>
<td>Yes</td>
<td>Fact</td>
<td>Yes</td>
</tr>
<tr>
<td>Low</td>
<td>High</td>
<td>Formal &amp; Informal</td>
<td>No (not in phase 2)</td>
<td>No (not in phase 2)</td>
<td>No</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
<td>Formal</td>
<td>Yes</td>
<td>Fact</td>
<td>Yes</td>
</tr>
<tr>
<td>High</td>
<td>High</td>
<td>Formal &amp; Informal</td>
<td>No (not after phase 1)</td>
<td>Fact</td>
<td>No (not after phase 1)</td>
</tr>
<tr>
<td>High</td>
<td>High</td>
<td>Formal &amp; Informal</td>
<td>Yes (between R&amp;D and Se)</td>
<td>Fact</td>
<td>Yes</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
<td>Informal</td>
<td>Yes</td>
<td>Opinion</td>
<td>No (only at end of project)</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
<td>None (R&amp;D isolation)</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Low</td>
<td>High</td>
<td>Medium formal</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
<td>None (R&amp;D isolation)</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
<td>Formal &amp; informal (but still R&amp;D isolation)</td>
<td>Yes</td>
<td>Opinion</td>
<td>No</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
<td>Informal</td>
<td>No</td>
<td>Opinion</td>
<td>No</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
<td>Formal</td>
<td>Yes</td>
<td>Opinion</td>
<td>No</td>
</tr>
<tr>
<td>High</td>
<td>Low</td>
<td>Informal</td>
<td>Yes</td>
<td>Opinion</td>
<td>Yes (Sa &amp; Fact (R&amp;D))</td>
</tr>
<tr>
<td>High</td>
<td>Low</td>
<td>None (R&amp;D isolation)</td>
<td>No</td>
<td>Opinion</td>
<td>Yes</td>
</tr>
<tr>
<td>High</td>
<td>Low</td>
<td>None (R&amp;D isolation)</td>
<td>No</td>
<td>Opinion</td>
<td>No</td>
</tr>
<tr>
<td>High</td>
<td>Low</td>
<td>Formal &amp; Informal</td>
<td>Yes</td>
<td>Fact</td>
<td>No (not in 2nd phase)</td>
</tr>
<tr>
<td>Low</td>
<td>High</td>
<td>Formal &amp; Informal (with Marketing, not Sales)</td>
<td>No</td>
<td>Opinion</td>
<td>No (features not verified)</td>
</tr>
<tr>
<td>High</td>
<td>High</td>
<td>Formal &amp; Informal</td>
<td>Yes (with M, not Sa)</td>
<td>Fact</td>
<td>No</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
<td>Formal &amp; Informal</td>
<td>Yes</td>
<td>Fact</td>
<td>Yes (by early actual usage of product)</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
<td>No (R&amp;D isolation in 2nd phase)</td>
<td>Opinion (&quot;vague ideas&quot;)</td>
<td>No (introduction in market was like Big Bang)</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
<td>Yes</td>
<td>Fact</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>High</td>
<td>High</td>
<td>Formal &amp; Informal</td>
<td>Yes (but only since a few years)</td>
<td>Opinion (Sa), Medium (Ap, Se), Fact (Ma)</td>
<td>Yes (Role of applications)</td>
</tr>
<tr>
<td>Low</td>
<td>High</td>
<td>Yes (moving towards that)</td>
<td>Yes (inbound &amp; outbound)</td>
<td>Fact</td>
<td>Medium (moving towards this)</td>
</tr>
<tr>
<td>High</td>
<td>High</td>
<td>Formal &amp; Informal</td>
<td>Yes</td>
<td>Fact</td>
<td>No (not in phase 2, again in phase 3)</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
<td>Formal</td>
<td>Yes (inbound &amp; outbound)</td>
<td>Fact</td>
<td>Yes (theoretical)</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
<td>Formal (no meetings, just mail/phone)</td>
<td>No</td>
<td>Opinion</td>
<td>No (first field test only in 3rd phase)</td>
</tr>
<tr>
<td>High</td>
<td>High</td>
<td>Formal &amp; Informal</td>
<td>Yes</td>
<td>Fact</td>
<td>Yes (specific predetermined roadmaps)</td>
</tr>
<tr>
<td>Low</td>
<td>High</td>
<td>Formal</td>
<td>Yes</td>
<td>Fact</td>
<td>Yes</td>
</tr>
<tr>
<td>Medium</td>
<td>Very low</td>
<td>Formal</td>
<td>Yes</td>
<td>Opinion</td>
<td>Yes (too vague)</td>
</tr>
</tbody>
</table>

**TABLE 13: CROSS-CASE ANALYSIS TABLE**
APPENDIX F: FREQUENCY OF MENTIONED CONSTRUCTS

<table>
<thead>
<tr>
<th>Frequency mentioned process moderators for success</th>
<th>Successful project</th>
<th>Failed project</th>
</tr>
</thead>
<tbody>
<tr>
<td>32 (100%)</td>
<td>Formal</td>
<td>4 (13%)</td>
</tr>
<tr>
<td></td>
<td>Informal</td>
<td>1 (3%)</td>
</tr>
<tr>
<td></td>
<td>Formal &amp; Informal</td>
<td>12 (38%)</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>32 (100%)</td>
<td>Continuous of dissemination</td>
<td>17 (53%)</td>
</tr>
<tr>
<td></td>
<td>Discontinuous dissemination</td>
<td>1 (3%)</td>
</tr>
<tr>
<td>29 (91%)</td>
<td>Fact-based CNI</td>
<td>16 (55%)</td>
</tr>
<tr>
<td></td>
<td>Opinion-based CNI</td>
<td>2 (67%)</td>
</tr>
<tr>
<td>30 (94%)</td>
<td>Continuous responsiveness</td>
<td>13 (43%)</td>
</tr>
<tr>
<td></td>
<td>Discontinuous responsiveness</td>
<td>4 (13%)</td>
</tr>
</tbody>
</table>

**Table 14: Frequency mentioned process moderators**

<table>
<thead>
<tr>
<th>CNI gathering approaches</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct R&amp;D</td>
<td>6 (19%)</td>
</tr>
<tr>
<td>Indirect dominant CFF</td>
<td>12 (38%)</td>
</tr>
<tr>
<td>Indirect multi CFF</td>
<td>5 (16%)</td>
</tr>
<tr>
<td>Combined</td>
<td>9 (28%)</td>
</tr>
</tbody>
</table>

**Table 15: Frequency mentioned CNI approaches**

<table>
<thead>
<tr>
<th>Structural moderators</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements engineering skills CFFs</td>
<td>32 (100%)</td>
</tr>
<tr>
<td>Technology tacitness</td>
<td>27 (84%)</td>
</tr>
<tr>
<td>Customer tacitness</td>
<td>29 (90%)</td>
</tr>
<tr>
<td>Product roll-out strategy</td>
<td>32 (100%)</td>
</tr>
</tbody>
</table>

**Table 16: Frequency mentioned structural moderators**