FLOORTJE BLINDENBACH-DRIESSEN

Innovation Management in Project-Based Firms

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Innovatiemanagement in projectmatig werkende bedrijven

Proefschrift

ter verkrijging van de graad van doctor
aan de Erasmus Universiteit Rotterdam
op gezag van de rector magnificus
Prof.dr.S.W.J. Lamberts
en volgens besluit van het College voor Promoties.

De openbare verdediging zal plaatsvinden op
donderdag 22 juni 2006 om 13.30 uur

door
Floriena Petronella Blindenbach-Driessen
geboren te Middelstum

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Erasmus Research Institute of Management (ERIM)
RSM Erasmus University / Erasmus School of Economics
Erasmus University Rotterdam

Internet: http://www.erim.eur.nl

ERIM Electronic Series Portal: http://hdl.handle.net/1765/1

ERIM Ph.D. Series Research in Management, 82

ISBN-10: 90 – 5892 – 110 –7
ISBN-13: 978-90-5892-110-9

Design: B&T Ontwerp en advies www.b-en-t.nl / Print: Haveka www.haveka.nl

voor Wim
Maaike, Jaap en Pieter

Preface

As a chemical engineer at Fluor Daniel, I experienced how difficult it is for a project-based firm to innovate. Later, as a performance consultant I became even more aware of the difficulties project-based firms have to innovate. During many alignment meetings, where at the start of a project the visions and project goals of the various parties involved are aligned, bright and innovative ideas were proposed that potentially could be very rewarding. However, when I asked the project manager two months after the alignment meeting which of the ideas were incorporated in the projects, they would typically react: "well, they were good ideas, but let's implement them on the next project". These project managers did not have the time to develop these innovative ideas, because of the stringent deadlines and tight budgets they had to cope with. Nor were they willing to take the risk and experiment with new products or processes in their project. This experience was the drive to start, and finish, my dissertation on innovation in project-based firms.

It took me five years to transform my experiences at Fluor Daniel into the research that is presented in this dissertation. At the start, I thought writing a dissertation would be rather easy, that was a big underestimation. I don't think I ever worked so hard. At the same time I enjoyed many rewarding moments; receiving the runner up best paper award at the International Product Development Conference in 2005 and the acceptance of my first article with Jan van den Ende in Research Policy.

Without the support of ERIM I would never have had the required knowledge to understand and apply both the qualitative and quantitative methodologies used in this dissertation, nor would I have been able to familiarize myself with the management literature. I would like to express my thanks to Jan van den Ende, who taught me the finesses of innovation management theory and made me accept that writing is a process that consists of many iterations. I would also like to thank Steef van de Velde, who provided both the tangible and intangible support for this dissertation. Such support is not only essential for development projects as this dissertation shows, but also for an AIO-project. I could not have written this dissertation without Jan van Dalen's help with the SAS program. In the last phase, the detailed comments of Donald Gerwin and Ale Smidts truly helped to improve each chapter.

Data collection was made possible due to the support of the four case companies: IG&H Management Consultants, Slavenburg, Tauw and Tebodin Consultants & Engineers. The collection of the survey data was clearly helped by this research being brought to the attention of the members of Stichting NAP, ONRI, VIANED and ICT~Office (former Nederland~ICT). I am also grateful to all the R&D managers and project leaders who spent time filling out the questionnaire. The enthusiastic cooperation of Vivian Wiersum, Marjoleine Jonker, and Evert Jan Lemmens truly helped to increase the response rate of the survey!

Working at the Management of Technology and Innovation department at the RSM Erasmus University has been a very pleasant experience with colleagues as Janneke Hermans, Ferdinand Jaspers, Bob Kijkuit, Koen Dittrich, Raf Jans, Julien

Mostard, Hans Quak, Elfi Krauth, Marcel van Assen and Wilfred Dolfsma and all the other members of the department. I would like to separately thank Carmen Meesters and Rutger de Wal, who enabled me to be a teleworker during the past year.

I also would like my to thank my parents who enabled me to broaden my horizon. The support of my family, in particular of Robert Bosch and Dries Driessen, my friends, our neighbors at the Sleedoorn in Poortugaal and Gerda Leeuwenhage has also been essential to bring this project to an end.

A special thanks go to Jaap and Aalke Blindenbach. When I had children ill, conferences to attend, or was teaching in the Netherlands while leaving my family in the US, they were literally always there when needed. There are no means to express my gratitude to them.

Also my beloved children, Maaike, Jaap and Pieter deserve special thanks. They rarely complained about their working mother always being in a hurry. And most important, they always made me immediately forget about my dissertation, at the moments I did not need to think of it. Last, but not least, my dear Wim, without his support I definitely would have given up before reaching the finish! He told me to "Keep smiling"!

Floortje Blindenbach-Driessen
Reston, USA, April 2006

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Chapter 1

Introduction to the Study

INTRODUCTION

Project-based firms become increasingly important in Western economies (Gann and Salter 2000; Knight Wendling Consulting 2000; Whitley 2006). Project-based firms are organized around projects (Gann and Salter 2000), produce complex systems by order of their clients (Hobday 2000), and usually operate in a business-to-business environment (Prencipe, Davies and Hobday 2003). Examples are Engineering Companies, Construction Companies, Consultancies and System Integrators in the Information Technology (IT) industry. Project-based firms execute large projects for their clients, such as designing and building a refinery for an oil company, building a new IT system for a bank, or the construction of a new railway station for the government. Since project-based firms enable the execution of complex projects, and since demands of customers and society become increasingly complex, we may expect that project-based firms become even more central to our economies and societies in the future.

In spite of that, only recently project-based firms are receiving more attention in the management literature. Publications on project-based firms address issues such as their specific characteristics (Greenwood, Li, Prakash and Deephouse 2005; Hobday 2000), the transformation of functional organizations to project-based organizations (Bernasco, De Weerd-Nederhof, Tillema and Boer 1999; Lindkvist 2004), and knowledge exchange within these organizations (Prencipe and Tell 2001; Robertson, Scarbrough and Swan 2003; Salter and Gann 2003; Werr and Stjernberg 2003).

In this dissertation we address another, yet crucial, process in project-based firms, the new product and new service development process. Some authors claim that the characteristics of project-based firms make these firms more flexible, and as such more innovative compared to other types of firms (Hobday 2000; Volberda 1998). Others have found that these firms have difficulty to innovate their product or service portfolio (Ayas 1997; Christensen and Baird 1997; Gann and Salter 2000; Nambisan 2001). We investigate how the specific characteristics of project-based firms influence their innovative activities.

Project-based firms are distinctly different from firms that manufacture mass products. The main difference between a project-based and a manufacturing firm is the organizational structure. Project-based firms have an organizational structure that is similar to a matrix organization, however in a project-based firm the projects outweigh the functional departments. There even exist project-based firms in which functional departments are completely absent (Hobday 2000). Making projects pivotal to the firm enables project-based firms to create unique complex solutions for their customers (Hobday 2000). These solutions are typically combinations of custom-designed products and related services, executed to customer order (Prencipe et al. 2003). To create these solutions, collaboration with outside parties is essential. The capabilities of project-based firms lie in the integration of the various parts of the solution they offer.

Project-based firms do not necessarily possess the knowledge and technology that is needed within each of the parts (Prencipe et al. 2003).

The project-based structure of project-based firms enables local optimization for the execution of each project (Hobday 2000). At the same time, coordination between the individual projects is often absent. As a consequence, both learning from a project (Ayas 1997; Gann and Salter 2000; Hobday 2000), and the creation of new services and products that supersede the needs of individual projects (Christensen and Baird 1997; Gann and Salter 2000) becomes difficult. The problem of renewing is not due to a lack of innovative ideas (Christensen and Baird 1997; Keegan and Turner 2002). As the case 'cultivating capabilities to innovate: Booz Allen & Hamilton' (Christensen and Baird 1997) shows, the difficulty lies in the process of transforming ideas into powerful new service offerings suitable for many of the project-based firms' clients.

We will refer to the projects that are executed to customer order as *business project*. The undoubtedly innovative solutions project-based firms deliver to their customers on business projects are in our view not innovations of a new product or service, but innovative solutions. We define an *innovation* as the development and commercialization of a new product or service. The innovative solutions of business projects are sold in advance. Consequently, during the development, the demands of only one specific customer need to be taken into account. The absence of market uncertainty clearly distinguishes these innovative solutions from new service and new product development as described in the innovation management literature. We will define *development projects* as the projects that are aimed at the development of ideas into new services or new products, including the commercialization of these products or services for a range of customers. Such development projects are distinctly different from development efforts on business projects, because development projects are driven by the project-based firm, instead of outside parties such as customers. Another difference is that the new services are developed as applications for a range of customers and are not specific solutions that suit the demands of one customer only.

The management of development projects within project-based firms is the focus of this dissertation. We chose this focus for several reasons. Firstly, as described above, the problems project-based firms have in their innovation efforts appear to be found in the process of transforming ideas into valuable service offerings for a range of customers (Christensen and Baird 1997). Secondly, the embeddedness of innovation efforts on business projects makes it difficult to compare these across projects, firms, or industries. We expect that development projects are comparable across different types of project-based firms and can be related to the innovation management literature. Thirdly, innovative activities on business projects are limited in scope and radicalness. Only minor changes, such as process innovations that clearly lead to performance improvement, seem reasonable to implement during business projects. For more risky or highly uncertain development efforts, the cost of failure is often too high. For instance in the process industry, the Liquefied Natural Gas (LNG) that will be produced in a to-be-built grass root LNG facility is typically already sold, before the engineering firm starts the construction. Failure to produce by the planned date implies millions of dollars lost per day.

Developing new services and products in dedicated development projects is therefore essential for project-based firms. How development projects are to be managed within project-based firms has not yet been investigated.

Project-based firms

Project-based firms are a result of the increasingly importance of projects and the increasing complexity of the management these projects (Galbraith 1971). Project management started around World War I, with the development of Gantt charts for navy ship construction, by Henry Gantt (1861-1919). However, its widespread use started only in the late 1950s, with the development of the Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT) (Klastorin 2004). The use of projects to achieve business goals has been growing ever since (Turner 1999). Project management is the core competence of project-based firms. Not every firm that executes projects is a project-based firm. Project-based firms are especially suitable for the execution of large, complex projects, requiring the integration of many technologies from many different firms (Galbraith 1971; Hobday 2000; Prencipe et al. 2003). Project-based firms can be most commonly found in the IT, Engineering and Construction industries.

We define *Project-based firms* therefore as: firms with a project-based organizational structure, which execute complex and integrated projects by order of a customer. The projects are complex due to the various parts that need to be integrated and due to the number of parties involved. We exclude project organizations that are set up for the delivery of one single project, as for example used in the film industry (Defillippi and Arthur 1998). Such firms exist only temporarily. Learning from projects and renewal of the service or product portfolio do not play a role in these temporary project-organizations (Whitley 2006). Project-based organizational structures are often applied in the research and development departments of firms (Bernasco et al. 1999; Lindkvist 2004), for instance in the defence and airspace industries. Also these project-based departments fall outside the scope of this dissertation. These departments are dedicated to the execution of innovation projects, as a consequence all capabilities and routines are designated for innovation projects, furthermore there is no competition for resources with business projects.

Project-based firms are a sub-sample of professional service firms. However professional service firms neither have all a project-based organizational structure, nor do they always deliver complex integrated solutions to their customers. Accountancies and lawyer firms are for example professional service firms, but not project-based firms.

Professional service firms benefit from a strong culture (Maister 1985) and a balanced mix between the organizational structure, its workforce and the work at hand (Maister 1982). Human resources are pivotal to professional service firms. How to create and maintain a high quality workforce has been described by Fosstenlokken, Lowendahl and Revang (2003) and Maister (2001). Knowledge management systems enable knowledge sharing within the workforce and thereby add to the quality of the provided services (Robertson et al. 2003; Werr and Stjernberg 2003). There is great overlap of the knowledge management systems for professional service firms and those for project-based firms (Prencipe and Tell 2001; Salter and Gann 2003). Such

knowledge management systems are however aimed at sharing knowledge between the professionals or employees of professional service firms, and not targeted at the development of new services or products. Maister (1996) states that the non-billable hours of professional service firms could be spend more effectively, as these hours could be directed to activities that generate future profits. How these hours can be effectively spend to the creation of new products or services, or how such activities compare with innovation management literature is not been addressed by Maister (1996).

Innovation management in project-based firms has only been recently and scantily addressed. Gann and Salter (2000) and Keegan and Turner (2002) both address innovation activities on business projects. The management of development projects in project-based firms is not addressed in literature.

Currently, project-based firms contribute considerably to the gross national product of most Western economies (Gann and Salter 2000). In the survey sample, developed for this dissertation, the number of project-based firms in the Dutch IT and Construction industries equalled respectively 25% and 77%. From Eurostat data we know that the value added, defined as the sum of the gross operating surplus and compensation of employees, by all Dutch firms in the IT and Construction industries was respectively 7.5 billion euros and 23.1 billion euros, in 2002. When we use our survey data to generalize to all IT and Construction firms in the Netherlands, we estimate that the added value by project-based firms in these industries only, is approximately € 19.7 billion. This equals 5 % of the total added value for the Netherlands in 2002. There are also many other industries, such as Engineering and Consulting, were project-based firms are typically used. We expect that, as project-based firms are system firms and since technology increasingly has a systems character, the economic importance of project-based firms will continue to grow in the future. Better insights in the management of innovation in project-based firms will contribute to the innovativeness of these firms.

Research question

The innovation management literature has predominantly considered development projects of manufacturing firms (Montoya-Weiss and Calantone 1994), while project-based firms are distinctly different from manufacturing firms in several ways. Firstly, project-based firms have a different organizational structure. In project-based firms functional departments have become secondary or even obsolete (Hobday 2000). Business projects influence the decision-making process and the leaders of these projects are responsible for the coordination of the daily business (Hobday 2000). These responsibilities typically lie within functional departments in a functional organization, or within the divisions in a divisional organization (Burton and Obel 1998). Secondly, project-based firms have also different capabilities. They are able to handle emerging problems in production, respond flexibly to changing client needs, and are effective at integrating different types of knowledge and skills, while coping with the project risks and uncertainties common in business projects (Hobday 2000). Thirdly, project based firms are inherently weak where functional and divisional organizations are strong; in performing routine tasks and achieving economies of scale (Galbraith 1971). Furthermore project-based firms have difficulty coordinating cross-

project resources, facilitating company wide technical development (Hobday 2000), and promoting organization-wide learning (Ayas 1997; Gann and Salter 2000). As such, we expect that development projects, which require coordination of cross-project resources, company wide technical development and organizational learning, face different challenges in project-based firms than in functionally or divisionally organized firms.

Project-based firms also have capabilities and routines that positively differentiate the organizational characteristics of these firms from that of non-project-based firms for innovation. Operational capabilities in the area of internal collaboration, project management and collaboration with outside parties such as customers and suppliers can be valuable sources of knowledge for development projects of project-based firms.

Assuming that development projects are the most important mechanism for renewal within project-based firms, and given the currently limited understanding of executing development project in project-based firms, the research questions we address in this dissertation are:

- *To what extent are success factors for development projects of project-based firms different from success factors of development projects described in the innovation management literature?*
- *What is the impact of the specific organizational characteristics provided by project-based firms on management practices for development projects?*

Contribution to literature

There is a wealth of literature on how development projects are managed (Brown and Eisenhardt 1995; Cooper 2001; De Brentani and Ragot 1996; Griffin 1997; Henard and Szymanski 2001; Montoya-Weiss and Calantone 1994; Van de Panne 2003; Wheelwright and Clark 1992). In general, innovation management literature mentions the following success factors:

An idea that is developed into a new product should be in line with a firm's strategy (Roussel, Saad and Erickson 1991). During the predevelopment phase, market demand should be investigated as well as the technical feasibility of the idea (Cooper 1999; Ernst 2002). When potential rewards outweigh the risks (Cooper 2001) and the risk profile of the development project fits within the portfolio of development projects (Wheelwright and Clark 1992), senior management can give their approval. Senior management approval should not only consist of tangible support by providing resources, but also of intangible support (Cooper and Kleinschmidt 1987). A project leader should be assigned who is capable of understanding the demands of various disciplines, is familiar with the customers, takes responsibility for the development, and acts as a champion of the new product (Wheelwright and Clark 1992). Multidisciplinary teams are typically used for the execution of the development project (Brown and Eisenhardt 1995; Cooper 2001; De Brentani and Ragot 1996; Griffin 1997; Lovelance, Shapiro and R. 2001; Song and Montoya-Weiss 2001) The execution plan can be either sequential with some overlap in the phases (De Meyer, Loch and Pich

2002; Lindkvist, Södrlund and Tell 1998), or iterative (Eisenhardt and Tabrizi 1995). Iterative planning methods are preferred for development projects dealing with uncertain technologies and / or uncertain market demands (Eisenhardt and Tabrizi 1995). Involvement of suppliers can speed up the process (Brown and Eisenhardt 1995). Customer involvement leads to products that are better adapted to market needs (Cooper 2001; Rothwell, Freeman, Horlsey, Jervis, Robertson and Townsend 1974; Von Hippel 1986). Once a prototype has been developed it can be tested (Thomke and Bell 2001) and subsequently improved (Cooper 1999). After having completed the testing phase successfully, the new product can be launched (Langerak, Hultink and Robben 2004). New products that are unique, superior, and in line with a firm's current competences and customers have a larger chance to be successful. Still it takes 6.6 ideas to generate one success, and only 59 % of the products which make it to the market are successful (Griffin 1997).

New product and new service development literature typically considers the management of development projects, as described above, independent of firm characteristics. As Eisenhardt and Martin (2000. p 1108) state, "commonalities arise because there are more and less effective ways of dealing with the specific organizational, interpersonal and technical challenges that must be addressed … Just as there are better and worse ways to hit a golf ball or ski a mogul field, there are more and less effective ways to execute new product development projects". However, as Gerwin and Barrowman (2002) comment, the new product development literature has rarely considered the interactions among success factors of the development process, or the influence of effects outside the development process on the success factors.

If differences in success factors between development projects are considered, it usually concern differences in what is produced, i.e. new service versus new product development (De Brentani 1989; Henard and Szymanski 2001), or radical products versus incremental products (Song and Montoya-Weiss 1998). Instead we focus on the influence of characteristics outside the development process; the differences between the characteristics of project-based and non-project based firms. And investigate to which extent differences in organizational characteristics; i.e. differences in the organizational structure, the capabilities and routines between these types of firms, affects the management of development projects.

In the meta-studies of Gerwin and Barrowman (2002) and Montoya-Weiss and Calantone (1994) the impact of organizational characteristics is addressed. This however concerns the effect of organizational characteristics on the performance on development projects, not the effect of organizational characteristics on the management practices for these projects. For example Liker, Collins and Hull (1999) have found that tall hierarchy and job specialization lead to longer lead times, and that collaboration amongst employees leads to shorter lead times. This study relates the organizational characteristics directly to performance of development projects. It did not investigate the impact of the organizational characteristics on certain management practices, e.g. the impact of tall hierarchy or job specialization on the functioning of multidisciplinary teams.

The Organizational literature has also addressed the influence of organizational characteristics, but then on a firm's innovative performance. Particularly the influence of specialization, functional differentiation, and centralization have been

the focus, see the meta-review of Damanpour (1991) for an overview. The influence of capabilities and routines, which are included in our definition of organizational characteristics, on firm performance has been widely discussed in the strategic management literature (Barney 1991; Nelson 1991; Peteraf 1993; Prahalad and Hamel 1990; Teece, Pisano and Shuen 1997; Wernerfelt 1984). This literature has focused on the effect of capabilities and routines on firm performance in general, not necessarily at a firm's innovative performance. Both the organizational and the strategic managment literature have considered the innovation process as a black box.

Summarizing, the new product development literature has predominantly addressed success factors of development projects, i.e. the relationship between management practices and the performance of these projects, see relationship (a) in figure 1.1. In addition, sometimes also the relationship between organizational characteristics and the performance of development projects have been addressed, relationship (b) in figure 1.1. Both the organizational and strategic management literature have addressed the relationship between organizational characteristics and a firm's (innovative) performance, relationship (c). In this dissertation, we will focus on the relationships (d) and (e), and investigate whether difference exist in the management of development project of project-based firms compared to non-project-based firms, and whether these difference can be explained by differences in organizational characteristics between these types of firms. That organizational characteristics, particularly capabilities, affect the management of development projects, has been illustrated qualitatively (see for instance Iansiti and Clark 1994; Leonard-Barton 1992), but these relationships have not been addressed quantitatively, nor is the impact of a firm's organizational structure addressed in these studies.

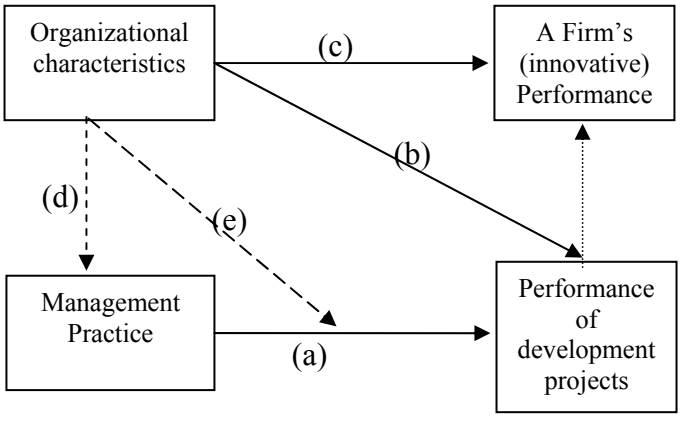

Figure 1.1 Overview of the relationships addressed in the innovation, organization and strategic management literature and this dissertation

Outline of the Study

This dissertation consists of four articles. The content of each chapter is shortly discussed below.

Exploring innovation management in project-based firms

In chapter 2, we explore the management of development projects within project-based firms. To what extent do the success factors known from the innovation management literature apply to project-based firms, and what is a plausible explanation for observed differences? Six development projects of 4 project-based firms are investigated in depth. The cases suggest that there are differences in the importance of factors between those described in the innovation management literature and those observed in the cases. The capabilities and routines of a project-based firm seem a plausible explanation for the observed differences.

The findings of the exploratory study are used to develop hypotheses. To test the generalizibility of these hypotheses, a large scale survey was held in the Dutch IT, Engineering, Construction, and related industries. This survey provides the data for the subsequent chapters. The survey contains data of the organizational structure, relevant capabilities and the research and development organization of 203 firms. Furthermore, it provides information about the execution of 144 development projects, in a subset of 96 firms. The performance of each development projects is assessed by both the R&D manager and the project leader.

Definition of the dependent variable: performance of a development project

Chapter 3 is a critical assessment of performance measures for development projects. One of the difficulties we encountered in the exploratory phase was defining the performance of a development project. The concept of performance is ill defined and depends upon the field in which a researcher operates (Brown and Eisenhardt 1995). However, even constructs based on the same items diverge, due to the methods applied to define the constructs. Another problem is that performance of development projects is typically assessed subjectively. However, the extent to which respondent bias plays a role has not yet been investigated. The obtained performance assessments of both R&D managers and project leaders are used to illustrate the impact of the above indicated problems on performance assessment of development projects. The findings of chapter 3 show that an alternative approach is needed to derive constructs for the performance of development projects than is currently common practice (Mackenzie, Podsakoff and Jarvis 2005). Furthermore we show that respondent bias has a significant impact on the validity of performance assessment of development projects.

Project-based firms compared with non-project-based firms

In chapter 4, we investigate quantitively the differences in success factors for the execution of development projects between project-based and non-project-based firms. This comparative study confirms that there are differences in success factors, between both types of firms. Multidisciplinary teams and planning hamper development projects in project-based firms while heavyweight project leaders are more important than in non-project-based firms.

The influence of operational capabilities and routines

In the chapters 2 and 4, we related the observed differences in success factors for the development process to the differences in organizational structure and capabilities

between project-based and non-project-based firms. In the next chapter we investigate the effect of executing development projects in a dedicated R&D department versus executing these projects within the operational environment. We focus thereby not on project-based firms, but on the existence of specific operational capabilities. We propose three alternative models of how operational capabilities and the execution of development projects within the operational environment, affect the use and effectiveness of multidisciplinary teams and supplier involvement in the development process.

The findings of this chapter show that executing development projects in the operational environment in combination with the existence of operational collaborative capabilities is a powerful combination. This combination enhances the effectiveness of multidisciplinary teams and supplier involvement in the execution of development projects. At the same time we find that integration only has a moderating effect on the contribution of multidisciplinary teams to the performance of development projects.

Conclusions

Chapter 6 presents the overall conclusions of the research findings. In this chapter we discuss the similarities and discrepancies between the findings of the chapters 2, 4 and 5. We also discuss the theoretical and practical relevance of our findings. In addition, the shortcomings are addressed and suggestions for further research are provided.

REFERENCES

Ayas, K. 1997. Design for Leaning for Innovation; Project Management for New Product Development. Rotterdam, Erasmus University**:** 242.

Barney, J. B. 1991. "Firm Resources and Sustained Competitive Advantage." *Journal of Management* 17(1): 99-120.

Bernasco, W., P. C. De Weerd-Nederhof, et al. 1999. "Balanced Matrix Structure and New Product Development Process at Texas Instruments Materials and Controls Division." *R&D Management* 29(2): 121-131.

Brown, S. L. and K. M. Eisenhardt 1995. "Product Development: Past Research, Present Findings, and Future Directions." *Academy of Management Review* 20(2): 343-378.

Burton, R. M. and B. Obel 1998. *Strategic Organizational Diagnosis and Design: Developing Theory for Application*. Norwell, Kluwer Academic Publishers.

Christensen, C. M. and B. Baird 1997. "Cultivating Capabilities to Innovate; Booz Allen & Hamilton." Harvard Case # 9698027.

Cooper, R. G. 1999. "From Experience: The Invisible Success Factors in Product Innovation." *Journal of Product Innovation Management* 16: 115-133.

Cooper, R. G. 2001. *Winning at New Products, Accelerating the Process from Idea to Launch*. Cambridge, Massachusetts, Perseus.

Cooper, R. G. and E. J. Kleinschmidt 1987. "New Products: What Separates Winners from Losers?" *Journal of Product Innovation Management* 4: 169-184.

Damanpour, F. 1991. "Organizational Innovation: A Meta-Analysis of Effects of Determinants and Moderators." *Academy of Management Journal* 34(3): 555-590.

De Brentani, U. 1989. "Success and Failure in New Industrial Services." *Journal of Product Innovation Management* 6: 239-258.

De Brentani, U. and E. Ragot 1996. "Developing New Business-to Business Professional Services: What Factors Impact Performance." *Industrial Marketing Management* 25: 517-530.

De Meyer, A., C. H. Loch, et al. 2002. "Managing Project Uncertainty: From Variation to Chaos." *MIT Sloan Management Review* 43(2): 60-67.

Defillippi, R. J. and M. B. Arthur 1998. "Paradox in Project-Based Enterprise: The Case of Film Making." *California Management Review* 40(2): 125-139.

Eisenhardt, K. M. and J. A. Martin 2000. "Dynamic Capabilities: What Are They?" *Strategic Management Journal* 21: 1105-1121.

Eisenhardt, K. M. and B. N. Tabrizi 1995. "Accelerating Adaptive Processes: Product Innovation in the Global Computer Industry." *Administrative Science Quarterly* 40: 84-110.

Ernst, H. 2002. "Success Factors of New Product Development: A Review of the Empirical Literature." *International journal of management reviews* 4(1): 1-40.

Fosstenlokken, S. M., B. R. Lowendahl, et al. 2003. "Knowledge Development through Client Interaction: A Comparative Study." *Organization Studies* 24(6): 859-879.

Galbraith, J. R. 1971. "Matrix Organization Designs: How to Combine Functional and Project Forms." *Business Horizons* 14(1): 29-40.

Gann, D. M. and A. J. Salter 2000. "Innovation in Project-Based, Service-Enhanced Firms: The Construction of Complex Products and Systems." *Research Policy* 29: 955-972.

Gerwin, D. and N. J. Barrowman 2002. "An Evaluation of Research on Integrated Product Development." *Management Science* 48(7): 938-953.

Greenwood, R., S. X. Li, et al. 2005. "Reputation, Diversification, and Organizational Explanations of Performance in Professional Service Firms." *Organization Science* 16(6): 661-673.

Griffin, A. 1997. "PDMA Research on New Product Development Practices: Updating Trends and Benchmarking Best Practices." *Journal of Product Innovation Management* 14: 429-458.

Henard, D. H. and D. M. Szymanski 2001. "Why Some New Products Are More Successful Than Others." *Journal of Marketing Research* 38(3): 362-375.

Hobday, M. 2000. "The Project-Based Organisation: An Ideal Form for Managing Complex Products and Systems?" *Research Policy* 29: 871-893.

Iansiti, M. and K. B. Clark 1994. "Integration and Dynamic Capability: Evidence from Product Development in Automobiles and Mainframe Computers." *Industrial and Corporate Change* 3(3): 557-605.

Keegan, A. and J. R. Turner 2002. "The Management of Innovation in Project-Based Firms." *Long Range Planning* 35: 367-388.

Klastorin, T. 2004. *Project Management: Tools and Trade-Offs*, John Wiley.

Knight Wendling Consulting 2000. Bedrijfstaktoets 2000, Ministerie van economische zaken.

Langerak, F., E. J. Hultink, et al. 2004. "The Impact of Market Orientation, Product Advantage, and Launch Proficiency on New Product Performance and Organizational Performance." *Journal of Product Innovation Management* 21: 79-94.

Leonard-Barton, D. 1992. "Core Capabilities and Core Rigidities: A Paradox in Managing New Product Development." *Strategic Management Journal* 13.

Liker, J. K., P. D. Collins, et al. 1999. "Flexibility and Standardization: Test of a Contigency Model of Product Design-Manufacturing Integration." *Journal of Product Innovation Management* 16(3): 248-267.

Lindkvist, L. 2004. "Governing Project-Based Firms: Promoting Market-Like Processes within Hierarchies." *Journal of Management and Governance* 8: 3-25.

Lindkvist, L., j. Södrlund, et al. 1998. "Managing Product Development Projects: On the Significance of Fountains and Deadlines." *Organization Studies* 19(6): 931-951.

Lovelance, K., D. L. Shapiro, et al. 2001. "Maximizing Cross-Functional New Product Teams' Innovativeness and Constraint Adherence: A Conflict Communications Perspective." *Academy of Management Journal* 44(4): 779-793.

Mackenzie, S. B., P. M. Podsakoff, et al. 2005. "The Problem of Measurement Model Misspecification in Behavioral and Organizational Research and Some Recommended Solutions." *Journal of Applied Psychology* 90(4): 710-730.

Maister, D. H. 1982. "Balancing the Professional Service Firm." *Sloan Management review* 24(1): 15-29.

Maister, D. H. 1985. "The One-Firm Firm: What Makes It Successful." *Sloan Management review* 27(1): 3-14.

Maister, D. H. 1996. "It's About Time." *Legal Business* 9(2): 62-66.

Maister, D. H. 2001. "What Drives Profits in Consulting Firms?" *Consulting to Management* 12(2): 45-51.

Montoya-Weiss, M. M. and R. Calantone 1994. "Determinants of New Product Performance: A Review and Meta-Analysis." *Journal of Product Innovation Management* 11: 397-417.

Nambisan, S. 2001. "Why Service Businesses Are Not Product Businesses." *MIT Sloan Management Review* 42(4): 72-80.

Nelson, R. R. 1991. "Why Do Firms Differ, and How Does It Matter?" *Strategic Management Journal* 12(1): 61-74.

Panne, G. van de 2003. "Success and Failure of Innovation: A Literature Review." *International Journal of Innovation Management* 7(3): 309-338.

Peteraf, M. A. 1993. "The Cornerstones of Competitive Advantage." *Strategic Management Journal* 14(3): 179-191.

Prahalad, C. K. and G. Hamel 1990. "The Core Competence of the Corporation." *Harvard Business Review* 68(3): 79-91.

Prencipe, A., A. Davies, et al., Eds. 2003. *The Business of Systems Integration*. Oxford, Oxford University Press.

Prencipe, A. and F. Tell 2001. "Inter-Project Learning: Processes and Outcomes of Knowledge Codification in Project-Based Firms." *Research Policy* 30: 1373-1394.

Robertson, M., H. Scarbrough, et al. 2003. "Knowledge Creation in Professional Service Firms: Institutional Effects." *Organization Studies* 24(6): 831-857.

Rothwell, R., C. Freeman, et al. 1974. "Sappho Updated." *Research Policy* 3: 258-291.

Roussel, P. A., K. N. Saad, et al. 1991. *Third Generation R&D: Managing the Link to Corporate Strategy*. Boston, Harvard Business School Press.

Salter, A. J. and D. M. Gann 2003. "Source of Ideas for Innovation in Engineering Design." *Research Policy* 32: 1309-1324.

Song, M. and M. M. Montoya-Weiss 2001. "The Effects of Perceived Technological Uncertainty on Japanese New Product Development." *Academy of Management Journal* 44(1): 61-80.

Song, X. M. and M. M. Montoya-Weiss 1998. "Critical Development Activities for Really New Versus Incremental Products." *Journal of Product Innovation Management* 15: 124-135.

Teece, D. J., G. P. Pisano, et al. 1997. "Dynamic Capabilities and Strategic Management." *Strategic Management Journal* 18(7): 509-533.

Thomke, S. and D. E. Bell 2001. "Sequential Testing in Product Development." *Management Science* 47(2): 308-323.

Turner, J. R. 1999. *The Handbook of Project-Based Management*. Berkshire, McGraw Hill.

Volberda, H. W. 1998. *Building the Flexible Firm, How to Remain Competitive*. Oxford, Oxford University Press.

Von Hippel, E. 1986. "Lead Users: A Source of Novel Product Concepts." *Management Science* 32(7): 791-805.

Wernerfelt, B. 1984. "A Resource-Based View of the Firm." *Strategic Management Journal* 5: 171-180.

Werr, A. and T. Stjernberg 2003. "Exploring Management Consulting Firms as Knowledge Systems." *Organization Studies* 24(6): 881-908.

Wheelwright, S. C. and K. B. Clark 1992. *Revolutionizing Product Development*. New York, The Free Press.

Whitley, R. 2006. "Project-Based Firms: New Organizational Form or Variations on a Theme?" *Industrial and Corporate Change* 15(1): 77-99.

Chapter 2

EXPLORING INNOVATION MANAGMENT IN PROJECT-BASED FIRMS

INNOVATION IN PROJECT-BASED FIRMS: THE CONTEXT DEPENDENCY OF SUCCESS FACTORS

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Accepted in

Research Policy

We gratefully acknowledge the useful comments and suggestions made at the EIASM International Product Development Management Conference, Brussels, 2003, and at the R&D Management Conference, Sesimbra Portugal 2004. We are also grateful to two anonymous referees for their helpful comments and insights.

Chapter 2

Exploring Innovation Management in Project-Based Firms

ABSTRACT

Innovation management literature typically concerns functionally organized firms. In this paper we investigate innovation management in a different type of firm, the project-based firm. Project-based firms, such as Engineering and Construction companies, Consultancies and System Integrators, are service firms that solely execute projects for clients. We focus on new service development projects in these firms. Based on an in-depth study of six projects in four different firms, we develop hypotheses on differences between success factors for development projects in project-based firms and in functionally organized firms. Some of the success factors for functionally organized firms, as described in the literature, appear to be more important in project-based firms, others seem redundant. Our findings suggest that the specific structure and capabilities of project-based firms provide an explanation for these differences.

INTRODUCTION

Most literature on innovation management implicitly or explicitly concerns manufacturing and other technology firms (Montoya-Weiss and Calantone 1994). Many of these firms are functionally organized. The question is whether the findings from this literature are also valid for firms with a different type of organizational structure.

In this paper we study innovation processes in project-based firms. Project-based firms have a project-based organization (Hobday 2000) and use projects to provide unique services to their clients. These services can be combinations of custom-designed products and related services. Examples are Engineering and Construction companies, Consultancies and System Integrators. Project-based firms contribute considerably to the gross national product of most Western economies (Gann and Salter 2000; Knight Wendling Consulting 2000). Innovation in these firms involves developing new or improved services for current or prospective customers, or developing new technologies that can be used to solve clients' problems better than existing technologies.

The organization of project-based firms is clearly distinct from functionally organized firms, such as most manufacturing firms (Hobday 2000). The starting point of this research is the assumption that organizational context, or more specifically the structure and capabilities required for the execution of projects to customer order, affects the management of development projects. As a project leader of an innovation project in a project-based firm explained to us: "New product development seems to be all about project management and we know how to manage projects". In our opinion also managers of project-based firms can learn from the innovation management literature, if the findings of this literature are re-investigated for this type of firm.

Project-based firms

Project-based firms are firms that are set up around projects (Gann and Salter 2000), and that produce complex services for their clients (De Brentani and Ragot 1996; Prencipe, Davies and Hobday 2003). The services usually consist of the integration of products or systems, such as IT systems, delivered in a business-to-business environment. Hobday (2000) distinguished between project-based and project-led organizations. A project-based organization is an organization in which the functional organization has become completely obsolete, without formal functional coordination of activities. Such an organization is entirely dedicated to one or more projects. In a project-led organization the needs of projects outweigh the functional influence on decision-making. A project-led firm still has some characteristics of a functional firm, since there is some coordination of functionally equivalent activities. Our definition of project-based firms encompasses both the project-led and the project-based organization. Although accountancy firms and lawyer's offices also carry out projects, we exclude these firms in this paper, since their projects often concern specialized services of limited size and not the integration of products and systems.

Business projects are those projects of project-based firms that are executed by order of a specific external client. These project offer unique solutions to each client (Hobday 2000).Clients typically initiate a business project, define the specifications, provide financial resources, and at the end benefit from the deliverables (Turner 1999). Business projects are managed autonomously (Hobday 2000), primarily bounded by the contractual agreement with a client (Turner 1999). Frequently, a multidisciplinaryteam is used to execute a business project and more disciplines will be involved if a project is more complex. Expertise and reputation of personnel is important for the success of business projects, although many project-based firms counterbalance fluctuations in demand with temporary personnel. Business projects differ across firms with respect to duration, content, and project size. For instance, the content of a construction project bears little resemblance with that of an IT project. Despite such differences, the phases of such projects show many similarities, from concept definition, design, construction, implementation, to testing and operation, although not necessarily every project includes all phases.

On top of business projects, project-based firms also perform *development projects.* Development projects are projects aimed at innovation, and take place separately from business projects. In development projects new services are developed for a range of customers with the objective to commercialize these services. These development projects are the central subject of this paper.

Few authors have studied innovation activities in project-based firms. Gann and Salter (2000), who were the first to address this subject, noted that innovation activities in project-based firms are typically not executed in separate R&D departments, but performed within or closely related to business projects. Execution of development projects with the same resources as used for business activities is typical for service firms (Sundbo 1997; Sundbo and Gallouj 2000). Keegan and Turner (2002) have pointed out the reluctance of managers to develop innovations within business projects. Moreover, they point out that for innovations developed within business projects, the application of traditional linear project management practices have a negative impact on the success of these innovative activities.

We will demonstrate that this latter problem also applies to development projects that take place separately from business projects. Gann and Salter (2000) suggest that project-based firms could better make a more strict distinction between their generic business processes, including research and development, and business projects. At the same time they note that separating these activities will likely hamper knowledge transfer between R&D and business projects.

In this paper we focus on development projects of project-based firms. Development activities that are part of business projects are excluded, since these activities are usually customer specific and not intended for further commercialization. Moreover, the embeddedness of development activities within business projects hinders the study of the management of these activities and reduces the comparability with development projects in other firms and industries. Focusing on development projects of project-based firms makes it possible to compare new service development in project-based firms with the existing literature on new service and new product development. This approach also enables the investigation of the impact of the structure and capabilities of project-based firms on the management of development projects.

New service development

Since most project-based firms are service firms, the findings of the literature on new service development (Cooper and Edgett 1999; De Brentani 1989; Martin Jr. and Horne 1993; Sundbo 1997) apply to project-based firms. Many authors on new service development argue that differences in product and service firms' output affect the success factors for innovation. They mention in particular the intangibility and perishability of services, and the required user participation in their delivery (De Brentani 2001; Gallouj and Weinstein 1997). Factors that are considered more important for new service development projects than for new product development projects are: having a distinct and reliable concept (De Brentani and Ragot 1996), synergy with the firm's current business (De Brentani and Ragot 1996; Martin Jr. and Horne 1993), senior management support (Cooper 2001; De Brentani 2001; Griffin 1997), and customer involvement (Bowen and Ford 2002; de Jong, Bruins, Dolfsma and Meijaard 2003; Martin and Horne 1993). On the other hand a structured approach would be less important (De Brentani 2001; Griffin 1997; Martin and Horne 1993) However, in their meta study, Henard and Szymanski (2001) found only a few differences between success factors for new service and new project development: a higher importance of market synergy, a lower importance of a structured approach and of cross-functional teams. The higher importance of market synergy can be explained with reference to the specific character of services, since the intangibility of a service makes it more difficult to explain the advantages of a new service in advance. As a consequence the acceptance of a new service depends on the already established reputation of the firm in that specific area (De Brentani 1989; De Brentani and Ragot 1996). There is, however, no obvious relation between the specific character of services and the other two differences, lower importance of a structured approach and cross-functional teams.

Because of the limited results of the literature on new service development, in this paper we investigate new service development projects from a different perspective. We do not focus on the effect of the difference in what is produced, but on

the effect of the organizational context. New service development in project-based firms could be quite different from what is described in the new product and service development literature, because of the different organizational structure and capabilities of these firms, compared to other service or manufacturing firms. Firstly, project-based firms deliver unique and complex services that ask for an organizational structure with less hierarchy and a higher span of control compared to manufacturing firms (Woodward 1980). Secondly, in project-based firms business projects are more important than the functional organization (Hobday 2000). Often project-based firms are even organized per area of expertise, combining sales, research and production in one department dedicated to this specific area, making functional departments entirely redundant (Hobday 2000). Thirdly, project-based organizations have unique capabilities with respect to project-management, internal collaboration and collaboration with customers and suppliers. We expect that the these differences have more impact on the management of development projects, than the impact due to different idiosyncratic features in what is developed e.g. services versus products.

We choose an exploratory approach because of the limited availability of publications on innovation management in project-based firms. Based on qualitative case-study research we develop hypotheses on success factors for new service development projects in project-based firms, compared to success factors for new product and new service development projects in other firms. We define a *success factor* as a factor that has a significant positive impact on the success of a development project and thus contributes to explaining the difference between success and failure of development projects, within a specific group of firms. Our definition of success factors does not imply that these factors are easily imitable; compliance with a factor can still be difficult. The reason to use success factors is that the innovation management literature has provided an extensive set of such factors, which facilitates the comparison between project-based firms and current literature. Secondly, these factors refer to a broad range of aspects of development projects, and therefore form a good starting point for an exploratory study (Eisenhardt 1989). Finally, despite the exploratory character of this study, we do not want to confine ourselves to a descriptive approach only. Success factors facilitate the investigation of the effects of specific behaviours and conditions on performance within project-based firms, and thus also the development of hypotheses regarding these effects (Brown and Eisenhardt 1995; Ernst 2002; Montoya-Weiss and Calantone 1994). Moreover we address the influence of the specific structure and capabilities of project-based firms on these success factors.

METHODOLOGY

Sample

The four companies, in which we studied the development projects, concerned an engineering firm, an engineering-consultancy firm, a construction company, and a financial consultancy firm. As suggested by Eisenhardt (1989, p. 537), variety in industries and size within our sample enabled us to control environmental variation, while the focus on project-based firms constrained variation due to organizational differences amongst these firms. We therefore selected different types of project-based

Table 2.1 Case descriptions

Cases	
Outsourcing	A dedicated development team of a financial consultant gathered knowledge of three outsourcing projects of this firm and combined it into one integral outsourcing concept. Experienced but mostly junior staff executed this project. The result was a successful new service. It was tested directly on a business project. The new concept made it possible to efficiently and effectively organize and execute subsequent outsourcing trajectories. Only minor refinements and adaptations had to be made to the concept, based on the experiences of the first business project.
Water Contest	A governmental prize contest was used to develop the concept of a radical new solution for water management by an engineering firm. Participation in the prize contest resulted in a nomination amongst the best 5 in the first round, leading to a lot of free publicity for the firm. The prize itself was not won, and the developed concept as a whole was not a business success, because it was too radical. However, the knowledge gained, the obtained publicity, and parts of the concept were considered very valuable by the engineering firm.
Soil Cleaning	An engineering firm developed, with a government grant, a new soil cleaning technology. Pilot projects were successful, but technology development is still ongoing, which delays commercialization.
Building Modules	A construction company tried to apply Building Modules in their construction process. They developed the concept in combination with the pre-design of two buildings as part of business projects, in order to have concrete examples. The clients of the business projects did not contribute to these development efforts. Coincidentally both business projects have been put on hold (for other reasons), which implied that the implementation of building models in the construction process was put on hold as well.
e-Business	An engineering consultancy firm developed a gearbox for the e-business market. The initiative was taken by a group of juniors, which convinced senior management that the firm should enter the e-business advice market on the basis of their logistic knowledge. Management was rather sceptical but agreed to fund the development project, and it gave the juniors the task to prove their concept by finding a first client. Without further guidance from senior management, the juniors developed the gearbox. Although clients had been consulted on the concept, the project team failed to find a first client. This was partly due to collapse of the internet hype in the meanwhile.
Architecture	A financial consultant wanted to create a state-of-the-art business architecture for the insurance and banking business of their clients. After a first attempt the project made a restart, but there was still little consensus about what needed to be developed. This second attempt was put on hold half-way, because another development project got priority.

firms. The size of these firms varied from approximately 80 employees for the financial consultant to more than a 1000 for both the engineering and the engineering-consultancy firm. Also ownership differed. One consultancy firm had a partnership

structure; the other consultancy firm was a subsidiary of a firm listed on Euronext. The construction firm was family owned and two foundations owned the engineering firm.

We also constrained variation by investigating the development projects of these project-based firms and excluding innovation efforts on business projects. Each of the four firms had development projects that were executed separately from their business activities, and none of the firms had a separate R&D department. Two of the four firms had development committees to guide the firm's new service development efforts. The construction firm was renowned for its innovativeness. Within the consultancy firm development projects were well institutionalised. The sample had a slight bias towards project-based firms with a prospector strategy (Miles and Snow 1978), thus towards firms that try to be ahead of the competition by being the first with new products, new technologies, or with entering new markets. The reason was that firms with a tradition of innovation appeared to be more interested to participate in this research. None of the firms operated in truly dynamic markets with frequent changes in technology. One business unit of the engineering firm was involved in the relatively dynamic market of Soil Cleaning, a market that in the Netherlands started in the 1980s and has been growing since.

To achieve theoretical replication (Yin 1994), we asked each firm to select a successful and a less successful or failed project. The construction firm had only one project available for our study. One project in one of the other firms had to be skipped, as it concerned the improvement of an internal process rather than the development of a new service. The six remaining projects were all recently completed or about to be finalized (see Table 2.1). The sample included incremental as well as radical innovations (Garcia and Calantone 2002): Water Contest was a new to the world service concept and targeted at a new market. Architecture was a new to the world concept targeted at the firm's existing market. Soil Cleaning was an addition to existing lines, with new to the world technology. E-Business was new to the firm, Building Modules an addition to existing services and Outsourcing was an improvement of an existing service.

For each project we interviewed at least three persons: the project leader, his or her supervisor from senior management, and one or more project members. In total we conducted twenty-one interviews, each about 1.5 hours, which were taped and subsequently transcribed (NVivo program, Richards 1999). The interviews were semi-structured, ensuring that at least the items listed in Table 2.2 were addressed. The respondents also got ample opportunity to express their views on the most important success factors in their project. During the interviews with senior management we also queried the more general characteristics of the firm, the structure of the firm and the capabilities needed to execute business projects. In addition, we studied project documentation, such as project plans, minutes of meetings, progress and final reports, in company archives.

Success factors

We derived a set of success factors from five meta-studies on new product and new service development (Brown and Eisenhardt 1995; Ernst 2002; Henard and Szymanski 2001; Montoya-Weiss and Calantone 1994; Van de Panne 2003), see Table 2.2. The meta-reviews were not conclusive about planning of work. Some recommend a rather

structured approach of planning and effective execution (Ernst 2002; Henard and Szymanski 2001). Others advocate a more contingent approach – planning and effective execution for incremental projects and a more organic approach for radical development projects (Brown and Eisenhardt 1995; Van de Panne 2003). We have included both in Table 2.2. A detailed description of each factor is given in the results section. We limited ourselves to process factors, because of our focus on the organization and management of development projects. Other types of success factors, such as product features, market characteristics or price, were therefore excluded.

Table 2.2 Overview of success factors from literature

Success factors mentioned in the literature	Sources
Planning of work	
- Planning and effective execution	- 2,5
- Contingent approach	- 1,4
Senior management involvement	- 1,2,3,4,5
Team	
- Cross-functional teams	- 1,2,4
- Expertise	- 1,4
- Heavyweight project leader	- 1,2
- Product champion	- 2,4
- External communication	- 1,2
Involvement of outside parties	
- Customer involvement	- 1,2
- Supplier involvement	- 1
Activities undertaken	
- Pre-development	- 2,3,5
- Market research and testing	- 2,3,5
- Launch	- 4,5

Used meta reviews: 1 = (Brown and Eisenhardt 1997), 2 = (Ernst 2002), 3 =(Montoya-Weiss and Calantone 1994), 4 = (Van de Panne 2003), 5 = (Henard and Szymanski 2001)

We defined project success by means of a multiple-criteria scale, including the following indicators (Adapted from Griffin and Page 1996):

- Project performance: on time, within budget, quality;
- Market performances: use of service by clients, possibly as part of other services, impact on reputation of the firm;
- Learning effects for future innovation activities.

We included reputation as it appeared to be a relatively important goal for the development projects within the firms we studied (see also De Brentani 1989). For instance, a new technology was introduced not to gain market share, but to demonstrate the firm's state-of-the-art knowledge. We had to exclude some performance criteria from the list of Griffin and Page (1996), such as the ROI rates, increase of market share, profit margins and turnover, since the project-based firms in our sample had not tracked these data for the development projects. In line with the literature, which indicates that rating success by multiple sources increases validity (Hoegl and Gemuenden 2001; Yin 1994), we asked three respondents - a team member, the project leader and the supervisor from senior management - to rate the project's performance.

Procedure

As a starting point we investigated for each project how the project had scored on our performance indicators, and whether the project had complied with the factors listed in Table 2.2. If a respondent indicated that a project did not comply we inquired after the reasons. Since most respondents worked or had worked on business projects, they could provide us with good insights in each firm's structure and capabilities, particularly as present in business projects. It was difficult for the respondents to assess whether a firm's characteristics, such as the organizational structure or capabilities, affected the degree of compliance with a factor, because most respondents had no reference point other than their own firm or other project-based firms they worked for.

Next we assessed the impact of each factor on the success of each development project. This assessment was based on the discussions we had with the respondents about whether or not the factors as described in Table 2.2 contributed significantly to success, or upon absence were perceived as omission negatively impacting project's success. The respondents could clearly indicate whether or not a factor had been relevant for the success of their respective project. During this whole procedure we kept receptive of other potential sources of differences or similarities, in line with Eisenhardt's suggestion for exploratory case study research (Eisenhardt 1989). Alternative explanations of our findings are addressed in the discussion session.

The hypotheses regarding success factors for development projects in project-based firms are derived in two ways:

The *degree of compliance* refers to relationship (1) in figure 2.1. In the event of a relatively low compliance with a specific factor, potentially due to the structure or capabilities of the project-based firms, we hypothesize that project-based firms can improve the performance of development projects by adhering to this factor. In case the structure or capabilities of the project-based firms seemed to lead to a high degree of compliance with a specific factor, we hypothesize that such an omnipresent factor will not differentiates between successful and failed development projects, nor do we expect that additional adherence to such a factor contributes significantly to performance of development projects within this group of firms.

When our observations suggested that the project-based context influenced the degree of compliance with the success factors, we hypothesize that the context affects the importance of this success factor as indicated by relationship (2) in figure 2.1.

The *need to comply* with a specific success factor refers to relationship (3) in figure 2.1. Most success factors in the innovation management literature are aimed at overcoming specific problems in a development project (for instance related to internal or external collaboration). In the event of reduced problem(s) targeted by a factor in project-based firms, we expect that the need to comply with that factor is limited and that the success factor is thus less important. On the contrary, in the case that the structure or capabilities of the project-based firms seemed to increase the problem, or led to the introduction of new problems, we hypothesize that the respective factor is more important for development projects in project-based firms compared to other firms. The need to comply is thus also expected to affect the importance of a success factor.

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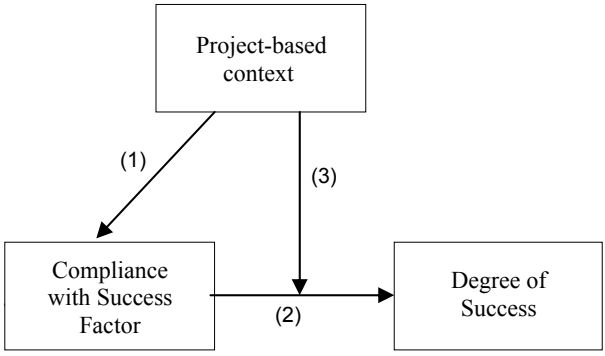

Figure 2.1 The influence of the project-based context on success factors for development projects within project-based firms

RESULTS

Table 2.3 summarizes the perceived performance of the six development projects. With respect to market performance, only Outsourcing was truly successful, underscoring the problems project-based firms have in exploiting new services. Five of the six projects were considered successful with respect to the project performance criteria 'on time' and 'within budget'. Only one project was said to have delivered superior quality; the quality delivered by the other projects was perceived as mediocre or even insufficient. Active promotion and positive reputation effects were evident in three of the projects. Two projects failed to capture learning effects. For the other projects, presentations were held to introduce the concept to colleagues. In one of these cases (e-Business) this knowledge transfer was ineffective, because the concept eluded the audience. In each case, there appeared to be a high degree of consensus amongst the respondents about the project's performance. Overall we classified two of the projects as successful, two as mediocre, and two as failed.

In what follows, we discuss our results by factor. We give a short description of each factor based on innovation management literature and describe how the projects in our sample complied with the success factor and to which extent compliance with the factor contributed or potentially could have contributed to the success of the development projects. Next we discuss how the context of the project-based firms influenced the compliance with each success factor and to what extent the context increased or reduced a factor's contribution to success. Finally, we formulate hypotheses regarding the relative importance of the success factor for development projects of project-based firms, compared to development projects in functionally organized firms.

Planning of work

Cooper (2001) stresses the importance of planning and effective execution of development projects. Several authors add that overlapping phases and iteration positively affect performance, particularly in case of projects with a high uncertainty,

such as radical development projects (Brown and Eisenhardt 1997; De Meyer, Loch and Pich 2002; Eisenhardt and Tabrizi 1995).

Table 2.3 Perceived performance assessment of the projects

	Out-sourcing	Water Contest	Soil Cleaning	Building Modules	e-Business	Archi-tecture
Project performance	++	++	+/-	-	+	--
- Time:	++	+/-	+	+	+	+/-
- Budget:	++	+/-	+/-	+	-	--
- Quality:						
Market performance	++	+/-	-	-	--	--
- Use by clients	++	++	++	-/+	-	--
- Reputation						
Learning effects						
- Exchanged knowledge with colleagues	++	++	++	+/-	-	--
- Captured knowledge for future reference	++	+	++	+/-	--	--
Overall performance	++	+	+/-	-/+	-	--

In all our cases we found a straightforward project planning approach in development projects. The planning procedures were similar to those used in business projects, in which on-time delivery in accordance with the contractual agreements is important. The firms applied the same methods to their development projects; projects were planned sequentially and executed strictly according to these plans. As a consequence, the project leaders considered changes or delays in development projects undesirable; they even perceived changes and delays as failure. They did not apply iterative planning methods, not even in the radical projects. The experiences from the more radical cases suggest that the uncertainty in these projects made the straightforward planning ineffective. An illustrative example was the project Architecture, where the project leader forced a time boxing approach upon his team members, while it was a radical project with many uncertainties. The team failed to comply since they did not know what they should, and could deliver within each time box. This resulted in conflicts and frustrations within the team, reducing the team's productivity dramatically. It clearly precipitated the team's downfall.

The project-based firms applied straightforward planning methods, because of their experience on business projects with this method. This core competence seemed to have become a core rigidity (Leonard-Barton 1992), as project-based firms have difficulty to adapt to a contingent planning approach (Keegan and Turner 2002), also for their development projects. We suspect that adherence to a contingent planning

approach in accordance with uncertainty could have significantly improved performance of the development projects we studied. We therefore hypothesize that a contingent planning approach is a more important success factor for development projects for project-based firms compared to functionally organized firms.

Senior management

Project selection

Effective selection procedures, exemplified in the so-called funnel, contribute to the success of development projects, since weak projects are cancelled and more resources remain for the other ones (Cooper 2001; Cooper, Edgett and Kleinschmidt 1998; Wheelwright and Clark 1992).

No explicit selection criteria existed for project selection in the four firms. The responsible executives, either senior managers or development committees, intuitively made approval decisions. Moreover acceptance criteria appeared to depend on availability of employees. For example, e-Business was rejected at first, but when a few consultants 'sat on the bench' it got approved after all.

Senior management assigned a budget to each approved project. However, the resources necessary were not always made available. The development projects competed for the same resources as the business projects, while development projects rarely got priority over business projects. This resulted in frequent changes in the composition of the development project-teams; sometimes even the whole core team had changed before the project finished. Clearly such changes had a negative impact on project performance. In spite of the resource constrains the project teams still delivered on time. Team members often worked (unpaid) overtime to meet their deadlines. Most project members did not mind the overtime, because they took pleasure in the development projects. This implied that a smaller number of registered hours were spent than expected and that most projects reported within time and budget. However, the lack of resources and the strict keeping to deadlines resulted in a decreased quality of the output. The trade-off between time and quality is mentioned in the literature (Cooper 2001; Wheelwright and Clark 1992), but the scale rarely tips to time above quality. This preference is especially awkward, since the firms we studied operated in rather stable markets where speed is presumed to be less important (Cooper 2001; Eisenhardt and Tabrizi 1995; Eppinger 2001; Wheelwright and Clark 1992)

In the firms with a development committee responsible for the execution of development projects, assignment of resources and budget was more in balance. In addition, we observed that in one firm more explicit project selection increased the visibility of development projects. In this firm, employees were freed from business projects during the period they were scheduled on a development project, resulting in fewer changes within the development project teams. On the contrary, the firms without a development committee executed any development project that seemed reasonable, as long as surplus resources were available. Especially in these firms the many dispersed initiatives were not always taken seriously. In most project-based firms employees will be shared between development projects and the always more urgent business projects (Sundbo and Gallouj 2000). It is likely that explicit project selection will increase the status of development projects and as such will make it easier to free and retain

resources for development projects. We hypothesize therefore that in project-based firms explicit selection of development projects is a more important success factor than in functionally organized firms.

Support

Support from senior management is a crucial success factor for development projects (Brown and Eisenhardt 1995; De Brentani and Ragot 1996; Wheelwright and Clark 1992). Such support should consist not only of tangible support as addressed above, but also of intangible support (Ernst 2002). Senior management has to exert 'subtle control', by providing a vision on the targeted outcome of the project (Brown and Eisenhardt 1995), but should not disturb the project on a daily basis or strangle the project by too much control (Bonner, Ruekert and jr. 2002; Gersick 1994).

Although senior management or the development committee initially approved plans for each development project, 'subtle control' and a vision of senior management on the contents of the projects appeared to be absent in all projects. Detailed process or end product requirements and a vision on the product as a whole were missing in the project plans. Only occasionally and mainly informally senior management was informed about progress. As one of the respondents said "I would appreciate it when they (senior managers) would inquire about the project now and then, as recognition of the work we do, but apparently they have a lot of trust in us". At the same time, senior managers complained that they had little grasp on the projects and felt unsure about the outcome. Apparently senior management did not realize that their involvement, beyond conflict resolution, would be appreciated. Some senior managers were afraid that involvement in the contents of a development project would be interpreted as mistrust. As a consequence of the low degree of management involvement, the project teams could rather easily lower the quality of the deliverables, in order to cope with the resource limitations. Two projects in which external parties played an important role, Soil Cleaning and Water Contest, clearly differed in this respect. These projects had fixed quality objectives, and these objectives were supervised and used as yardsticks by the external parties.

The reluctance of senior management to become more involved in projects seemed to originate from business projects, in which they only interfered in case of troubles. Business projects operate completely autonomously in some project based firms (Hobday 2000). In all four firms, senior management was also used to delegate much authority to business project leaders. This autonomy worked well for business projects, which are usually bound by contracts with clients, but the development projects without external control wandered off without additional guidance. We therefore hypothesize that within project-based firms senior management support, i.e. the provision of a clear vision on the outcome of the project (Brown and Eisenhardt 1995), is more important for the performance of development projects than in functionally organized firms.

Team structure

Cross-functional teams

The innovation management literature emphasizes the importance of cross-functional teams and effective collaboration within those teams as success factors (Brown and Eisenhardt 1995; Cooper 2001; Cooper and Edgett 1999; De Brentani and Ragot 1996; Griffin 1997; Lovelace, Shapiro and R. 2001; Song and Montoya-Weiss 2001).

The core of each project team with three to four people was rather small in our sample. No functional departments (R&D, marketing, operations, sales etc.) existed and hence the concept of cross-functional teams is irrelevant in the context of project-based firms. Within this specific structure we viewed multidisciplinarity as the equivalent of multifunctionality. The team members of the projects we investigated were familiar with operating in multidisciplinary teams. Collaboration amongst project members of various disciplines was in general judged as very good, also within the under-performing projects.

The project organization of the firms we studied enhanced the collaboration between different disciplines. Employees were familiar with the requirements and needs of the other disciplines and were used to collaborating. Because the level of compliance with multidisciplinary collaboration was high in the project based firms we studied, multidisciplinary collaboration appeared neither a necessity, nor a differentiating factor between success and failure of the development projects. Each project benefited from the already present understanding of team members' backgrounds and disciplinary needs. We expect that multidisciplinary collaboration is omnipresent in most project-based firms (Hobday 2000) and consequently also exists on development project. We therefore hypothesize that in project-based firms a multidisciplinary development team is a less important success factor compared to functionally organized firms.

Expertise

The availability of relevant expertise contributes to the success of development projects (Brown and Eisenhardt 1995; Cooper 2001; Cooper and Edgett 1999; De Brentani and Ragot 1996; Griffin 1997). In many functionally organized firms a lot of attention is therefore dedicated to the provision of knowledgeable staff for development projects (Pinto and Covin 1989).

In the cases we studied, team members were typically chosen on the basis of availability, not expertise. Adequate sourcing of expertise was an important condition for success. For the project Architecture, for instance, the architecture experts were only advisers to the project team, not members. From the sideline these experts still tried to leave their mark on the project, which confused and frustrated the project team. On the other hand, the Soil Cleaning team had all expertise on board, which contributed to the effectiveness of this team. Experts were typically the driving force behind many business projects and as such only partly available for development work. Availability of expertise seemed to add significantly to the effectiveness of the development teams we observed, but was not a prerequisite for approval of development projects. Since in project-based firms employees are typically selected on the basis of availability instead

of expertise (Pinto and Covin 1989), we hypothesize that in these firms expertise is an more important success factor for development projects than in functionally organized firms.

Project leaders

Many scholars plea for heavyweight project leaders (Brown and Eisenhardt 1995; Rothwell, Freeman, Horlsey, Jervis, Robertson and Townsend 1974; Wheelwright and Clark 1992). Wheelwright and Clark (1992, p 195) have defined heavyweight project leaders as leaders that are capable of interpreting the market, understand the multi-languages of different departments, deal with engineering issues, communicate effectively inside the team as well as outside, while guarding the concept, and resolve conflicts. They consider such heavyweight project leaders important to overcome department silos and to pull a development project together. They consider a lightweight project leader to be ineffective for more radical projects, because he or she is rather a messenger than a manager (Wheelwright and Clark 1992).

A heavyweight project leader headed one project, Building Modules. Less experienced project leaders from middle and junior management led the other projects. Senior managers we interviewed did not complain about the ineffectiveness of project leaders, and no project leader said to have had difficulties with the above described tasks. Only conflict resolution was not their task, but their superiors'. A handicap of the use of lightweight project leaders is resource allocation. As said before, most project leaders had difficulties in obtaining and retaining resources for their development projects; not because of their limited weight, but predominantly because of low commitment of senior management (Turner 1999). Hence, as we observed, the project leaders could rather easily accomplish their tasks; heavyweight leaders seemed to have been superfluous.

Project leaders of project-based firms are in the 'main line of communication and can exercise control to coordinate and integrate specialists and functions in creative new ways, focusing on the needs of the projects. Because there are few internal lines of command and communication to interfere with project objectives, the internal coordination tasks become thus simpler and clearer' (Hobday 2000, p. 890). This also seems to hold for the tasks of a leader of a development project. We hypothesize therefore that heavyweight project leaders are less important as a success factor for development projects in project-based firms.

Product champions

The presence of a product champion is important for the promotion of an development project (Ancona and Caldwell 1992; Brown and Eisenhardt 1995; Rothwell et al. 1974). A product champion should preferably be the initiator of a new product and stay involved in a project throughout its life-cycle (Van de Panne 2003). The literature leaves open whether a project leader or someone from senior management better fulfil this role (Ernst 2002).

In four of our projects the project leader acted as the product champion. In one project, Architecture, the product champion was someone from senior management,

which appeared unsuitable. Not fully aware of all the issues going on within the development project, he pushed the project too much. For the other cases an enthusiastic, highly involved promoter of the concept within and outside the firm contributed to the credibility of each of the projects. Such a product champion was able to gain commitment of each team member. In this respect we found no indications that the role of a product champion would be different in project-based firms than elsewhere. This leads to the hypothesis that a product champion contributes to the success of development projects in project-based firms to an equal degree as in functionally organized firms.

External team communication

Ancona and Caldwell (1992) found that teams that focus their external interaction both to persuade others of the importance of a team's work and to coordinate, negotiate, and obtain feedback from outside groups, make these teams move ahead quickly on budgets and schedule in the short term, and manage to produce the most innovative products over the course of the development process. This finding is confirmed by our more successful projects (Outsourcing, Water Contest, Soil Cleaning, Building Modules), which were actively promoted within their respective firms. Such external team communication also helped to reduce resource constraints. The less successful projects lacked this kind of communication, because these project members had little to share, hence external team communication boosts the success of already promising projects only.

Our findings confirm that external team communication is important for development projects, leading to the hypothesis that external team communication contributes to the success of development projects in project-based firms to an equal degree as in other firms.

Outside parties

Customer involvement

Customer involvement is essential for development projects (Brown and Eisenhardt 1995; Ernst 2002; Von Hippel 1986), at least in incremental projects. In radical projects it is less important since customers cannot anticipate the problems and opportunities involved in such a product (Christensen 1997). Customers were involved in two of our projects. In Soil Cleaning, a customer provided a testing site but had little role in the project itself. In Building Modules, a client's building requirements of a business project was used as a blueprint. In both cases, the clients were thus hardly involved in the development activities. Outsourcing deliberately did not involve target customers; the project leader was of the opinion that the team had enough experience and insights in customer demands. The involvement of customers seemed to add little to the already known information on customer needs and demands, and as such did not seem to contribute to the success of the development projects we studied.

Close collaboration with customers is typical for business-to-business project-based firms (De Brentani and Ragot 1996; Gann and Salter 2000). Firms that know their customers well have less need to investigate customer needs (Maidique and Zirger

1985). We therefore hypothesize, in line with the reasoning of Maidique and Zirger, that customer involvement contributes less to the success of development projects in project-based firms compared to functionally organized firms.

Supplier involvement

Suppliers should be involved as early as possible in development projects to improve quality and to prevent delays (Clark, Chew and Fujimoto 1987; Iansiti and Clark 1994). In two of the development projects, early collaboration with suppliers, sharing technical know-how, was meaningful. Both these development projects were executed under the control of the respective project-based firms; thus, the suppliers were not co-producers. The respondents perceived collaboration with suppliers as a common business procedure, since their firms already collaborated with these suppliers on business projects. The respondents indicated that supplier involvement made the development projects more complex, for instance complicating negations about license agreements for business projects-to-be-acquired in the future. This latter problem seemed to be closer related to the inexperience with licensing, than with difficulties related to supplier collaboration. The other projects required no supplier involvement, because the expertise of suppliers was already present, or could be developed in-house.

Project-based firms generally have extensive and close relationships with suppliers (Gann and Salter 2000), and as we observed, the development projects made use of these existing supplier networks. Supplier obstructionism, which jeopardizes the contribution of supplier involvement to project performance (Primo and Amundson 2002), did not seem to play a role.

From our observations it seems likely that in case supplier collaboration is needed, suppliers are indeed being involved. The level of compliance to this factor is thus high in project-based firms. We did observe that supplier involvement made the development project more complex, but according to our respondents, the added complexity did not negatively affect project performance. We did not observe that supplier involvement was a differentiating factor between success and failure, since suppliers were involved in all projects in which this was appropriate, and in the other projects we could not find indications that supplier involvement would have improved project performance. Therefore, we hypothesize that supplier involvement is a less important success factor in project-based firms than in functional firms.

Activities undertaken

Pre-development

In the pre-development stage, commercial and technical feasibility are investigated (Ernst 2002), which can be used for project approval. Project selection was already discussed above, here we focus on feasibility studies; the creation of a business case.

Business cases with financial and market forecasts were lacking in five of the six projects. For one project, Architecture, the project leader made a financial forecast, based on his experience only. Although the most successful project, Outsourcing, had no business plan, and the least successful project, Architecture, contained the most

elaborate business plan, we claim that a business case contributes to project performance. Not in particular related to the six projects that were subject of our investigation, but based on the many other development initiatives within these firms that were not specifically addressed in this research; business cases could facilitate early project closure of less promising projects.

The firms in our sample had little experience in making business cases. Business projects clients typically investigate the feasibility of a project themselves. In general, the creation and approval of business plans helps to gain more realistic insight in the potential of an invention (Cooper 2001), and also contributes to portfolio management of development projects initiatives (Roussel, Saad and Erickson 1991). Since project-based firms likely lack capabilities in this area, we hypothesize that creating a business case, or executing a pre-development phase, is a more important success factor for development projects in project-based firms than in functionally organized firms.

Market research

Market research is an important success factor for development projects, at least for incremental projects (Brown and Eisenhardt 1995; Ernst 2002; Montoya-Weiss and Calantone 1994). Market research does not contribute to the success of more radical development projects (De Brentani 2001; Song and Montoya-Weiss 2001). Firms that know their customers well can rely on their gut feeling to determine the preferences of their customers (Maidique and Zirger 1985).

The respondents had the idea that they clearly understood the preferences of their potential customers. Consequently none of the project teams performed market research. When there were doubts - as was the case in the more radical projects Water Contest and e-Business - some of the potential customers were contacted. For instance the e-Business team consulted two potential customers for the tool's specifications, but these same clients were not willing to buy the tool afterwards. Later, one of these clients came back with a request for a similar e-business solution. Unfortunately by that time the involved employees with the necessary e-business expertise had left the firm. For the more radical development projects market research did not seem to have added to project success, which corresponds with the findings of De Brentani (2001) and Song and Montoya-Weiss (2001).

We got the impression from our respondents that customer's needs were well understood, because of the good contacts senior managers, project leaders and team members had with potential customers. As said before, close collaboration with customers is typical of project-based firms and in general will make market research information redundant (Maidique and Zirger 1985). Most of the new developed services never reached the market, it was therefore difficult to assess whether or not customer needs were indeed fulfilled. In addition, as explained above, most projects lowered quality targets due to time constrains. We think that the problem of insufficient quality was not due to a lack of understanding customer needs, but in not adhering to the quality objectives set in order to meet these customer needs. We therefore hypothesize that market research contributes less to the success of development projects in project-based firms, than in functionally organized firms.

Testing

Another way to investigate whether a new service fulfils customer needs, is to test it (Edvardsson and Haglund 1995; Thomke 2003). Testing a service is more complex than testing products because it can be done only in collaboration with customers (Bowen and Ford 2002; De Brentani and Ragot 1996; Shostack 1984; Thomke 2003). Five of our projects created testable services. Only one project, Soil Cleaning, actually included intermediate testing in pilot projects, to refine and update the technology. Outsourcing was tested on the first business project and refined. In the project "Water Contest", the contest was not used as a test to upgrade the concept. After the nomination the concept was slightly adapted to suit the wishes of the jury, but when the final concept was not awarded, it was not developed further to suit its potential customers.

Since market research does not seem very useful in project-based firms, testing may offer a better opportunity to adapt a new service to customer needs. Just as in other service firms, the testing phase seems to be the most appropriate moment to adapt a service to customer needs (Martin Jr. and Horne 1993; Thomke 2003). We hypothesize therefore that in project-based firms testing will contribute more to the success of development projects than in functionally organized firms.

Launch

Launch activities create awareness of a new product or service amongst target customers (Van de Panne 2003). De Brentani and Ragot (1996) stress that it is important that professional services are promoted to customers. "It is not enough that new service products solve client problems; their benefits must be clearly understood and perceived as superior to competitive offerings".

Some teams considered their task completed when they had developed a concept. Few of the projects plans incorporated strategies to enter the market, whereas some projects were used to promote the firm's reputation in general. For example the Soil Cleaning project was used to show that the engineering firm was the absolute expert in the area of soil cleaning and capable to handle all soil pollution problems with the most recent technologies. Team members presented at conventions, seminars and workshops to promote the firm's reputation in general, not the new service in particular.

Outsourcing promoted its new service through a workshop with a limited number of potential clients. Shortly thereafter the firm acquired the targeted number of contracts for new outsourcing projects. A respondent stated: "It is a market in which you need to make a lot of noise, to ensure that the name of your firm immediately pops up, when clients think about outsourcing.' The team noted that the firm had to avoid creating capacity problems: "These are not the type of jobs (business projects) of which we can run 5 or 6 in parallel, because especially in the implementation phase you need a large crew". Hence Outsourcing provides a good example of how a balanced launch campaign can be used to promote a new service without creating an over-demand.

Like business-to-business firms, also project-based firms seem to have to promote their new service more actively (De Brentani and Ragot 1996). Such launching efforts have to be balanced to ensure that human resources can keep up with the demand. If orders cannot be executed properly, a firm's reputation can become damaged, and for project-based firms reputation is very important (Gann and Salter

2000). We hypothesize therefore that for development projects in project based firms a (balanced) launch is a more important success factor than for development projects in functionally organized firms.

DISCUSSION

We have investigated to which extent success factors from the new product and new service development literature can be applied to development projects in project-based firms. We excluded innovative activities on business projects, the projects performed for a specific client. We made an in-depth investigation of six cases of development projects in four project-based firms. These cases suggest that success factors frequently mentioned within the literature also apply to some extent to project-based firms. However, there are remarkable differences, both positive and negative, in the degree that these firms conform to these factors and in the importance of these factors (see Table 2.4). Some success factors seem to be more important for project-based firms compared to other firms: the application of contingent planning approaches, explicit project selection, senior management support, the availability of sufficient experts, making business cases and testing and launching the new services. Other factors seem to be less important: the use of cross-functional teams, heavyweight project leaders, collaboration with customers and suppliers and performing market research. The involvement of product champions and external team communication seem to be equally important for the success of new service development projects compared to functionally organized firms. Characteristics of project-based firms that could explain these differences are the structure of these firms consisting of multidisciplinary departments, leading to capabilities in internal collaboration, the autonomy of the project leaders relative to senior management, the guidance of business projects by clients, leading to a high priority of business projects over other activities, and the capabilities in external collaboration.

We used success factors as a reference. This approach allowed us to explore systematically the differences between project-based firms and the literature on functionally organized firms. Distinguishing between the actual compliance on success factors and the need to comply took us away from a purely descriptive approach and facilitated developing hypotheses. Moreover, this approach stimulated a vision on innovation management that takes into account the wider firm context and the resulting requirements with respect to the organization and management of development projects.

Our paper contributes to the literature on innovation management in project-based firms, by providing insights in the management of development projects in project-based firm. Furthermore we investigated how the organizational structure and capabilities of these firms impacted the management of the development projects. We thereby challenge the claim of Eisenhardt and Martin (2000) that success factors for innovation management are universal:

Table 2.4 Summary and hypothesized differences between project-based firms and functionally organized firms

Set of success factors	Compliance with factor of observed development projects	Observed contribution to success	Contextual influences	Hypothesized relative contribution to success
Planning of work				
Planning and contingent approach	No use of contingent planning approaches	Straightforward planning approach hindered especially the more radical development projects	Capabilities in straightforward planning made appliance of more contingent planning tools difficult.	More important
Senior management involvement				
Project selection	Explicit project selection only in firms with development committee	Selection increased visibility and status, subsequently more resources were available	Competition for resources with more urgent business projects hindered resource allocation,	More important
Support	Projects operated autonomously without much senior management support	Too much autonomy made that the projects wandered off, either in the wrong direction or toward insufficient quality	Senior management was used to give much autonomy to projects. External clients usually guard the quality of projects. This led to a low degree of senior management support for development projects	More important
Team				
Multi-disciplinary teams	Multidisciplinary collaboration was self evident and equally present on all six projects.	Multidisciplinary collaboration did not seem to differentiate the successful from the less successful projects	Multidisciplinaryproject organization enhanced collaboration and created a high level of mutual understanding	Less important
Expertise	Experts not always sufficiently available for development projects	Absence of experts decreased performance	Competition for experts with more urgent business projects reduced their availability.	More important
Heavyweight project leader	Heavyweight project leaders were rarely used	Light or medium weight project leaders were sufficient to manage the development projects	Each organization was fully geared towards the execution of projects, which facilitated the task of the project leaders.	Less important
Product champion	Enthusiastic and driven individuals	Product champions promoted their projects effectively	None	Equally important

	championed the projects and products			
External team communi-cation	Successful projects used external communication channels to promote their projects within the firm	External promotion enhances the visibility of projects (for successful projects only),	None	Equally important
Involvement of outside parties				
Customer involvement	Sufficient knowledge present within team, clients were contacted for radical development projects	Customer needs seemed well understood. Clients were not a good source of information for the more radical projects.	Close collaboration with customers on business projects made that client needs were well understood, leading to a lower need to involve customers.	Less important
Supplier involvement	When needed suppliers were involved. Collaboration with suppliers went smooth.	Involvement of suppliers did not seem to differentiate the successful from the less successful projects.	Development projects made use of the existing relationships with suppliers.	Less important
Activities undertaken				
Predevelop-ment	Only for one project a business case was made	Business cases will help to create more realistic expectations of development projects and can also be used for project selection	The project-based firms had little experience with making business cases..	More important
Market research	No market research was done	Customer needs seemed well understood	Close collaboration with customers on business projects made that client needs were well understood.	Less important
Testing	Some projects tested the new services.	Testing was perceived useful to adapt the developed service to the customer needs, especially for the projects in which customers had not been involved.	None	More important
Launch	Project launch not integral part of development projects	Balanced launched campaign, in which the capacity to deliver was taken into account, made the project Outsourcing successful.	The project-based firms were used to wait for requests from customers for business projects. Organized launch activities were an exception.	More important

> *"commonalities arise because there are more and less effective ways of dealing with the specific organizational, interpersonal and technical challenges that must be addressed … Just as there are better and worse ways to hit a golf ball or ski a mogul field, there are more and less effective ways to execute new product development projects".*

Instead we argue for a more contingent approach with respect to the management and organization of new product and service development activities. Our results support some of the findings of new service development literature. For instance, Griffin (1997) found that new service development projects have fewer phases than new product development projects, particularly in underperforming firms. The omission of pre-development, market research, testing and launch activities in some of our projects supports this finding. As we indicated in the introduction, we relate the differences between project-based firms and other firms to firm characteristics, whereas authors on new service development relate their findings to the characteristics of what is produced. Our approach may provide new explanations for findings from the new service development literature. For instance, in the introduction we mentioned that Henard and Szymanski (2001) found a lower need for multidisciplinary teams in new service development activities, but that this lower need can hardly be attributed to the different character of services compared to products. We also found a lower need for multidisciplinary teams, but we relate this to the capabilities of project-based firms in internal collaboration.

Managerial implications

For managers of project-based firms our findings imply that the current innovation management literature is useful as a reference, but that the situation of their own firm requires considerable adaptation of the findings.

In accordance with the findings of Engwall (2003), our study shows that the management of development projects was influenced by the experience of project-based firms with business projects, which are performed in a complex but rather stable environment. It was difficult for the project-based firms to execute development projects with high uncertainty, unclear targets and lower complexity. Separatingdevelopment projects from the rest of the organization leads to undesired side-effects (Gann and Salter 2000), particularly in the form of reduced exchange of information (Griffin and Hauser 1996). This was exactly the reason why one firm had dismantled its R&D organization in the past, and integrated these activities within its business organization. We would therefore suggest keeping development projects close to the business activities, but explicitly applying different managerial procedures, as indicated in this paper.

LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

This study has several limitations. We investigated only six development projects in four firms, in which we explored the effects of capabilities on the organization and the success of development projects, and compared our findings with the innovation management literature. To confirm the generalizibility of our findings future research is

needed using a larger sample of development projects of both project-based and functionally organized firms. Moreover, such research can include factors not addressed in this paper, such as the effects of co-production of new services and collaboration with external parties such as research institutes.

Furthermore we focused on the similarities between firms. There were significant differences between the four project-based firms in size, industry and ownership. We did not find effects of these differences in our study of development projects. For instance, the differences in ownership structure between the family-owned firm and the subsidiary of a firm listed on Euronext were not reflected in differences in the attention of top management for innovation or on innovative performance. The larger firms had more resources available (one of the key success factors), but they did not seem to perform better in innovation.

On the other hand the variety in our sample was also limited. All firms operated in supplier-driven industries (Pavitt 1984), produced no extremely complex services (Hobday 2000), they all had a prospector strategy (Miles and Snow 1978), and operated in a rather stable environment. Future research involving more firms and more development projects will be necessary to investigate the effects of firm differences. Particularly research on project-based firms in more science-based sectors and on firms with different strategies may reveal other firm influences on success factors for innovation.

In the paper we paid little attention to differences between the six development projects regarding their technological diversity, relative importance for the firm, or size. However, it appeared that these differences did not impact the way development projects were managed. The managers were always enthusiastic, relatively young employees, who had an enormous drive to develop something new for the benefit of their firm. None of the projects were driven by customers, nor co-produced with suppliers, albeit two projects were guided by external parties, a subsidy provider and a contest committee. The involvement of such outside parties made a difference, since these projects had a structure more in accordance with that of business projects. Further research is required to investigate the effects of differences in project characteristics.

The interplay between innovation activities on business projects and the development projects is another area for further research. As we noted in the introduction, part of the innovation activities in project-based firms is performed within business projects. An interesting issue for further research is the interplay between the experiences and outcomes of these activities and those of dedicated development projects.

A more methodological issue for future research involves the specific performance measures for development projects of project-based firms, and the appropriate respondents to measure these. The traditional success measures such as return on investments and market share (Griffin and Page 1996) were not applicable to evaluate the success of development projects in project-based firms. For instance, our respondents considered it impossible to calculate break-even points or return on investment of development projects, since they could not determine the contribution of development projects to the acquisition of new contracts. On the other hand, contribution to the reputation of the firm appeared to be an important performance

measure, since reputation is of great importance for project-base firms (Gann and Salter 2000; Hoch, Roeding, Purkert and Lindner 2000). The common way to assess reputation is by asking respondents for the perceived contribution of a new service to the reputation of the firm in that particular area (De Brentani, 1989). The reliability of this approach may be questionable, but better measurement methods for reputation effects of individual new service development projects still have to be developed.

The exploration of these issues will enhance our understanding of the specifics of innovation management in project-based firms, and the characteristics of project-based firms in general.

REFERENCES

Ancona, D. G. and D. F. Caldwell 1992. "Bridging the Boundary: External Activity and Performance in Organizational Teams." *Administrative Science Quarterly* 37(4): 634-651.

Bonner, J. M., R. W. Ruekert, et al. 2002. "Upper Management Control of New Product Development Projects and Project Performance." *Journal of Product Innovation Management* 19: 233-245.

Bowen, J. and R. C. Ford 2002. "Managing Service Organizations: Does Having A "Thing" Make a Difference." *Journal of Management* 28(3): 447-469.

Brown, S. L. and K. M. Eisenhardt 1995. "Product Development: Past Research, Present Findings, and Future Directions." *Academy of Management Review* 20(2): 343-378.

Brown, S. L. and K. M. Eisenhardt 1997. "The Art of Continuous Change: Linking Complexity Theory and Time-Paced Evolution in Relentlessly Shifting Organizations." *Administrative Science Quarterly* 42: 1-34.

Christensen, C. M. 1997. *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*. Boston, Boston business school press.

Clark, K. B., W. B. Chew, et al. 1987. "Product Development in the World Auto Industry." *Brookings Papers on Economic Activity* 3: 729.

Cooper, R. G. 2001. *Winning at New Products, Accelerating the Process from Idea to Launch*. Cambridge, Massachusetts, Perseus.

Cooper, R. G. and S. J. Edgett 1999. *Product Development for the Service Sector*. Cambridge, Massachusetts, Perseus Books.

Cooper, R. G., S. J. Edgett, et al. 1998. *Portfolio Management for New Products*. Reading, Mass, Addisson-Wesley.

De Brentani, U. 1989. "Success and Failure in New Industrial Services." *Journal of Product Innovation Management* 6: 239-258.

De Brentani, U. 2001. "Innovative Versus Incremental New Business Services: Different Keys for Achieving Success." *Journal of Product Innovation Management* 18: 169-187.

De Brentani, U. and E. Ragot 1996. "Developing New Business-to Business Professional Services: What Factors Impact Performance." *Industrial Marketing Management* 25: 517-530.

de Jong, J. P. J., A. Bruins, et al. 2003. Innovation in Service Firms Explored: What, How and Why? Literature Review. Zoetermeer, EIM Business & Policy Research**:** 73.

De Meyer, A., C. H. Loch, et al. 2002. "Managing Project Uncertainty: From Variation to Chaos." *MIT Sloan Management Review* 43(2): 60-67.

Edvardsson, B. and L. Haglund 1995. "Analysis, Planning, Improvisation and Control in the Development of New Services." *International Journal of Service Industry Management* 6(2): 24-35.

Eisenhardt, K. M. 1989. "Building Theories from Case Study Research." *Academy of Management Review* 14(4): 532550.

Eisenhardt, K. M. and J. A. Martin 2000. "Dynamic Capabilities: What Are They?" *Strategic Management Journal* 21: 1105-1121.

Eisenhardt, K. M. and B. N. Tabrizi 1995. "Accelerating Adaptive Processes: Product Innovation in the Global Computer Industry." *Administrative Science Quarterly* 40: 84-110.

Engwall, M. 2003. ""No Project Is an Island: Linking Projects to History and Context"." *Research Policy* 32: 798-808.

Eppinger, S. D. 2001. Innovation at the Speed of Information. *Harvard Business Review***:** 3-10.

Ernst, H. 2002. "Success Factors of New Product Development: A Review of the Empirical Literature." *International journal of management reviews* 4(1): 1-40.

Gallouj, F. and O. Weinstein 1997. "Innovation in Services." *Research Policy* 26: 537-556.

Gann, D. M. and A. J. Salter 2000. "Innovation in Project-Based, Service-Enhanced Firms: The Construction of Complex Products and Systems." *Research Policy* 29: 955-972.

Garcia, R. and R. Calantone 2002. "A Critical Look at Technological Innovation Typology and Innovativeness Terminology: A Literature Review." *Journal of Product Innovation Management* 19: 110-132.

Gersick, C. J. G. 1994. "Pacing Strategic Change: The Case of a New Venture." *Academy of Management Journal* 37(1): 9-45.

Griffin, A. 1997. "PDMA Research on New Product Development Practices: Updating Trends and Benchmarking Best Practices." *Journal of Product Innovation Management* 14: 429-458.

Griffin, A. and J. R. Hauser 1996. "Integrating R&D and Marketing: A Review and Analysis of the Literature." *Journal of Product Innovation Management* 13: 191-215.

Griffin, A. and A. L. Page 1996. "PDMA Success Measurement Project: Recommended Measures for Product Development Success and Failure." *Journal of Product Innovation Management* 13(4): 478-496.

Henard, D. H. and D. M. Szymanski 2001. "Why Some New Products Are More Successful Than Others." *Journal of Marketing Research* 38(3): 362-375.

Hobday, M. 2000. "The Project-Based Organisation: An Ideal Form for Managing Complex Products and Systems?" *Research Policy* 29: 871-893.

Hoch, D. J., C. R. Roeding, et al. 2000. *Secrets of Software Success: Management Insights from 100 Software Firms around the World*. Boston, Massachusetts, Harvard Business School Press.

Hoegl, M. and H. G. Gemuenden 2001. "Teamwork Quality and the Success of Innovative Projects: A Theoretical Concept and Empirical Evidence." *Organization Science* 12(4): 435-449.

Iansiti, M. and K. B. Clark 1994. "Integration and Dynamic Capability: Evidence from Product Development in Automobiles and Mainframe Computers." *Industrial and Corporate Change* 3(3): 557-605.

Keegan, A. and J. R. Turner 2002. "The Management of Innovation in Project-Based Firms." *Long Range Planning* 35: 367-388.

Knight Wendling Consulting 2000. Bedrijfstaktoets 2000, Ministerie van economische zaken.

Leonard-Barton, D. 1992. "Core Capabilities and Core Rigidities: A Paradox in Managing New Product Development." *Strategic Management Journal* 13.

Lovelace, K., D. L. Shapiro, et al. 2001. "Maximizing Cross-Functional New Product Teams' Innovativeness and Constraint Adherence: A Conflict Communications Perspective." *Academy of Management Journal* 44(4): 779-793.

Maidique, M. A. and B. J. Zirger 1985. "The New Product Learning Cycle." *Research Policy* 14: 299-313.

Martin, C. R. and D. A. Horne 1993. "Service Innovation: Successful Versus Unsuccessful Firms." *International Journal of Service Industry Management* 4(1): 49-65.

Martin Jr., C. R. and D. A. Horne 1993. "Service Innovation: Successful Versus Unsuccessful Firms." *International Journal of Service Industry Management* 4(1): 49-65.

Miles, R. E. and C. C. Snow 1978. *Organizational Strategy, Structure, and Process*. New York, McGraw-Hill.

Montoya-Weiss, M. M. and R. Calantone 1994. "Determinants of New Product Performance: A Review and Meta-Analysis." *Journal of Product Innovation Management* 11: 397-417.

Panne, G. van de 2003. "Success and Failure of Innovation: A Literature Review." *International Journal of Innovation Management* 7(3): 309-338.

Pavitt, K. 1984. "Sectoral Patterns of Technical Change: Towards a Taxonomy and a Theory." *Research Policy* 13: 343-373.

Pinto, J. K. and J. G. Covin 1989. "Critical Factors in Project Implementation: A Comparison of Construction and R&D Projects." *Technovation* 9: 49-62.

Prencipe, A., A. Davies, et al., Eds. 2003. *The Business of Systems Integration*. Oxford, Oxford University Press.

Primo, M. A. M. and S. D. Amundson 2002. "An Exploratory Study of the Effects of Supplier Relationships on New Product Development Outcomes." *Journal of Operations Management* 20: 33-52.

Richards, L. 1999. *Using Nvivo in Qualitative Research*. Bundoora, Victoria, Qualitative Solutions and Research Pty.Ltd.

Rothwell, R., C. Freeman, et al. 1974. "Sappho Updated." *Research Policy* 3: 258-291.

Roussel, P. A., K. N. Saad, et al. 1991. *Third Generation R&D: Managing the Link to Corporate Strategy*. Boston, Harvard Business School Press.

Shostack, G. L. 1984. Designing Services That Deliver. *Harvard Business Review***:** 133-139.

Song, M. and M. M. Montoya-Weiss 2001. "The Effects of Perceived Technological Uncertainty on Japanese New Product Development." *Academy of Management Journal* 44(1): 61-80.

Sundbo, J. 1997. "Management of Innovation in Services." *The Service Industries Journal* 17(3): 432-455.

Sundbo, J. and F. Gallouj 2000. "Innovation as a Loosely Coupled System in Services." *International Journal of Services Technology and Management* 1(1): 15-35.

Thomke, S. 2003. R&D Comes to Services: Bank of America's Pathbreaking Experiment. *Harvard Business Review*. 81**:** 70-79.

Turner, J. R. 1999. *The Handbook of Project-Based Management*. Berkshire, McGraw Hill.

Von Hippel, E. 1986. "Lead Users: A Source of Novel Product Concepts." *Management Science* 32(7): 791-805.

Wheelwright, S. C. and K. B. Clark 1992. *Revolutionizing Product Development*. New York, The Free Press.

Woodward, J. 1980. *Industrial Organization: Theory an Practice*. Oxford, Oxford University Press.

Yin, R. K. 1994. *Case Study Research Design and Methods*. Thousand Oaks, SAGE Publications, inc.

Chapter 3

DEFINITION OF THE DEPENDENT VARIABLE;
PERFORMANCE OF A DEVELOPMENT PROJECT

A CRITICAL ASSESSMENT OF PERFORMANCE MEASUREMENT OF NEW PRODUCT DEVELOPMENT PROJECTS

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12th International Product Development Management Conference

We gratefully acknowledge the useful comments and suggestions made at the EIASM International Product Development Management Conference, Copenhagen, 2005, and at the Academy of Management Conference, Hawaii 2005. We are also grateful for the helpful comments of Sheryl Jarvis and Ale Smidts.

Chapter 3

Definition of the Dependent Variable; Performance of a Development Project

ABSTRACT

Performance of development projects is a central issue in innovation management research. However the definition of performance currently seems to be guided by correlations between variables rather than theory. This has led to widely diverging constructs which jeopardizes the validity of research findings and hampers the comparability of research outcomes in the field of innovation management. In this paper we argue that the definition of performance of development projects should be based on theoretical grounds, and consists of two concepts: project and market success. We discuss the model implications of commonly used subjective performance measures and investigate the effects of respondent bias. Based on the performance assessment of 257 development projects, of which 144 are assessed both by R&D managers and project leaders, we show that an alternative methodology has to be applied to validate the performance model, especially the project success construct. We will also show that better measures are needed to evaluate quality and captured knowledge of project success and non-financial aspects of market success, since the perceptions of both project leaders and R&D managers suffer from random error and systematic bias.

INTRODUCTION

Performance measurement is a central issue in innovation management literature, however there is little consistency in how it is measured. Different research streams within innovation management each use their own concepts to capture the performance of development projects. Brown and Eisenhardt (1995) define three research streams: rational planning, communication web, and disciplined problem solving. The rational planning stream, which roots in the marketing tradition, typically emphasizes performance aspects related to market success, using items such as financial performance and market share (Cooper and Kleinschmidt 1979; Cooper and Kleinschmidt 1987; Maidique and Zirger 1985; Rothwell, Freeman, Horlsey, Jervis, Robertson and Townsend 1974). More recently, this stream has expanded the definition of performance to contain also project success parameters such as adherence to schedule, budget and quality targets (see for instance Griffin 1997; Hultink and Robben 1995; Langerak, Hultink and Robben 2004). This expansion yields a rather hybrid view of performance of development projects. Within the communication web stream, project and process aspects are stressed in the assessment of performance of projects (Brown and Eisenhardt 1995). Softer issues, like conflict and learning in project teams, are often also taken into consideration (Ancona and Caldwell 1992; Hoegl and Gemuenden 2001; Keller 1986). The third stream, disciplined problem solving, strongly emphasizes speed and productivity as performance measures (Eisenhardt and Tabrizi 1995; Iansiti and Clark 1994). Operations management research falls outside the scope of the three streams of Brown and Eisenhardt (1995), as it does not necessarily concern innovation projects. In operations management, performance assessment of projects is

again defined differently. Here it is typically confined to project items such as adherence to schedule, budget and quality targets (Klastorin 2004; Lock 2003).

Apart from the differences in the definition of performance between the research streams, within research stream variations exist as well, with respect to the items that are used to define the constructs. The rational planning stream typically uses the items advanced by Griffin and Page (1993; 1996). They collected the more popularly applied items amongst practitioners and researchers and group these into three constructs: customer-based success, financial success and technical performance success. The formation of these three constructs is by no means undisputed. Langerak et al. (2004) for instance, use the same items, but group them into five constructs. Moreover, Langerak et al. (2004) had to skip 7 of the 17 items during scale construction.

Examples from the other research streams mentioned, also show that similar items are repeatedly grouped into different constructs. For instance, in the communication web stream, team performance is often not treated as a single construct, but divided into two constructs, one related to efficiency (adherence to schedule and budget), and another related to effectiveness (adherence to quality targets); see for example Hoegl and Gemuenden (2003) or Lovelace et.al. (2001). Yet another example, within operations management literature, Tatikonda and Montoya-Weiss (2001) treat adherence to schedule, budget and quality targets as separate constructs rather than combining them into one project success construct.

The above described differences can be attributed to the construct validation procedures that are currently commonly applied. The analytical procedure that is used to validate constructs involves exploratory factor analysis, followed by a reliability check with Cronbach's alpha. For several reasons this approach is inappropriate to assess the validity and reliability of the construct used to assess the performance of a development projects.

Firstly, the prerequisites for this procedure are linearity, homoscedasticity, normality and positive correlations between the items (Nunally and Bernstein 1994). However, the items used to assess the performance of new product development projects often do not fulfill these prerequisites. For example, items such as adherence to schedule, budget and quality targets are rarely positively correlated (Cohen, Eliashberg and Ho 1996). Project leaders typically have to make a trade-off between quality and time, or quality and budget, the notorious project performance triangle (Lock 2003). Reverse coding of the negatively correlating items is not a solution, because a successful project still has to be on time, within budget and at the specified quality, in spite of the trade-offs made during the process.

Secondly, as Bollen and Lennox (1991, p 307) state: 'Researchers relying on factor analyses or the examination of correlation matrices for selecting indicators may be overlooking valid measures of a construct if the indictors determine the latent variable'. For the performance of a development project, it are the indicators that determine the latent variable. Adhering to schedule, budget and quality targets define project success. Performance of a development project does not cause projects to be on time, within budget, at the specified quality, being profitable or gain a large market share. Different procedures, than commonly applied, are needed to validate defined

construct such as the performance of development projects (Jarvis, Mackenzie and Podsakoff 2003; Mackenzie, Podsakoff and Jarvis 2005).

Thirdly, the performance of development projects is often assessed using subjective measures, which are especially susceptible to common method bias (Podsakoff, Mackenzie, Lee and Podsakoff 2003). Respondents have a propensity to try to maintain consistency in their responses to questions. As a consequence, measures of two related constructs, answered by the same respondent, may exert a systematic affect on the observed correlation between measures (Podsakoff et al. 2003). As we will demonstrate, this means that various aspect of the performance model, as for instance project and market success, become indistinguishable due to the high correlations and shared variance between these constructs. According to exploratory factor analysis and Cronbach's alpha such properties point at uni-dimensional, highly valid, and reliable constructs. In reality, theoretically different notions are captured within the same performance construct, as a result of common method bias.

The differences in performance constructs as existing in current innovation literature can thereby be explained from the validation theory that is currently commonly applied: exploratory factor analyses and Cronbach's alpha. This method generates methodological acceptable models that meet the criteria of this validation theory. Such models however, depend on the correlations existing between items in the data set. As a result each time different constructs may arise, depending on the correlations existing between the items of a dataset. The validity of the derived results is thereby questionable (Borsboom, Mellenbergh and Van Heerden 2004; Rossiter 2002). The measures of project success are likely to be divided in different constructs, due to lack of correlation between the items of for instance project success. At the same time items related to either project or market measures, which correlate due to common method bias, are likely to be combined, while they are conceptually different.

Research outline

This paper develops a more valid performance model for the assessment of new product or new service development projects. We will first define a theoretical model, based on existing literature. Thereafter we will discuss the consequence of using subjective measures to evaluate performance and the impact this has on the theoretical model, regarding the relationship between constructs and between a construct and its items. The developed model is tested using data of 257 development projects. We assess common method bias of the model, using 144 of the 257 development projects, for which we collected performance data of both the R&D manager and the project leader. In addition, we perform a multi-trait[1] multi-method (MTMM) analysis, to assess the random error and systematic bias for each of the items of the performance model.

THEORETICAL PERFORMANCE MODEL

In our view, performance of development projects should consists of two constructs: project success and market success, which is in line with the performance model of Tatikonda and Montoya-Weiss (2001). *Project success* covers the development process

[1] Multi trait is the equivalent of multiple indicators.

of new products and services. *Market success* covers the commercial outcome of a development project. Project and market success are clearly related, as project success increases the likelihood of market success (Tatikonda and Montoya-Weiss 2001), in spite of notorious examples that illustrate the contrary (Griffin and Page 1996). However, both are conceptually different, as project success evaluates how the project was executed, while market success evaluates the performance of what is developed, i.e. the impact a new product or new service has on the market.

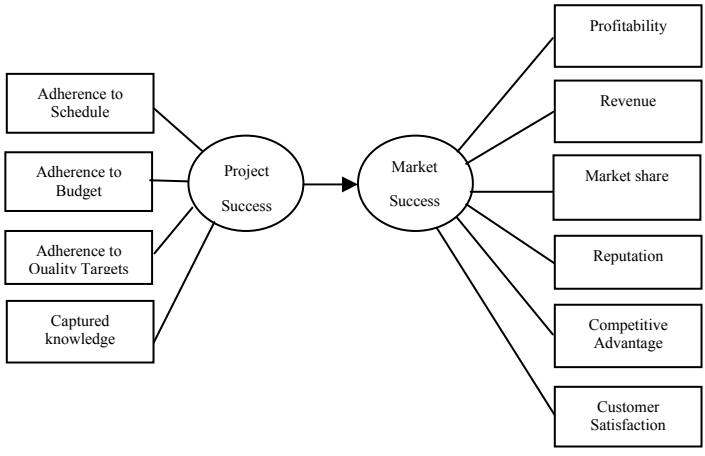


Figure 3.1 Theoretical performance model

For the content of both project and market success, we largely adhere to Griffin and Page (1996). They validated the measures to assess the performance of development project with practitioners and researchers, and that is exactly what (Rossiter 2002) proposes as the best way to validate the content of a construct.

Project success includes the items traditionally related to project management: adherence to schedule, budget and quality targets (Lock 2003). It addresses to which extent the project was executed in accordance with the plan. It is similar to Griffin and Page's (1996) technical performance success, with the exception of competitive advantage. We exclude the latter item from the project success construct, as competitive advantage reflects an outcome of the process, instead of assessing how the process was executed. By contrast, we add 'captured knowledge', since organizations should also be able to benefit from the knowledge gained on a project (Ayas 1997). 'Captured Knowledge' is especially important for radical and more research-oriented development projects (Maidique and Zirger 1985).

Market success consists of both financial and customer based performance indicators, although many authors consider financial and customer based performance to be separate constructs (see for example Cooper and Kleinschmidt 1987; see for example Griffin and Page 1996; Langerak et al. 2004). The reason for doing so is that in some markets it is common to 'buy' market share, by promoting products through price reductions. As a consequence, the gain in market share negatively impacts financial performance. In our view market success of a new product should therefore reflect both market impact and financial performance. The items of market success are:

profitability, generated revenues, gained market share, competitive advantage, and customer satisfaction of the new product or service (Griffin and Page 1993). We add contribution to reputation, since this is an important aspect when commercializing new services (De Brentani 1989). Competitive advantage is not part of Griffin and Page's (1996) customer-based success. As explained above, we consider it an outcome of the process and included it therefore in the market success construct, instead of in the project success construct.

Subjective performance assessment

Clearly, objective data of adherence to schedule, budget, return on investment etc. are to be preferred over subjective data; data related to a respondent's perception of the adherence to these criteria (Brown and Eisenhardt 1995; Montoya-Weiss and Calantone 1994). However, informants often lack reliable knowledge about objective financial performance measures (Ernst and Lechler 2003). Even when they have such knowledge, they are generally unwilling to share it because of confidentiality. As a consequence, asking for objective data in innovation surveys jeopardizes the response rate of a survey (Hart 1993). Most studies use therefore perception of performance, instead of objective performance measurements.

Subjective measures may suffer from respondent bias (Podsakoff et al. 2003). We discuss the potential impact of two forms of respondent bias, common method bias (Podsakoff et al. 2003) and informant bias (Ernst 2001).

Common method bias arises because respondents want to be consistent in their response. 'People responding to questions posed by researchers would have a desire to appear consistent and rational in their responses and might search for similarities in the questions asked of them – thereby producing relationships that would not otherwise exist at the same level in real-life settings … This is called the consistency motif… and is likely to be particularly problematic in those situations in which respondents are asked to provide retrospective accounts of their attitudes or perceptions' (Podsakoff et al. 2003, p 881). Since development projects are evaluated in retrospect, common method bias is likely to occur. One of the possible consequences is that market success affects a respondent's perception of project success. It is thereby likely that informants will evaluate project success of commercially successful projects more positively. To investigate the size of this affect, we will model the relationships between perceived project success and perceived market success reciprocally.

Informant bias arises because the perspective of a respondent influences his or her perception of performance (Ernst 2001; Ernst 2002; Hart 1993; Henard and Szymanski 2001; Montoya-Weiss and Calantone 1994). Hoegl and Gemuenden (2001) found that team members lack sufficient insight to evaluate the overall performance of a project. Project leaders may be better informed about team performance, but rarely stick with a project from its start all the way to the market introduction (Ernst 2002). They will therefore not always be able to assess market performance. R&D managers have less insight into project details, but their overview enables them to evaluate a project in its context (Hoegl and Gemuenden 2001). Based on a comparison with other fields, Ernst (2002) estimates that informant bias can account for more than 30% of the total explained variance in studies of new product development project performance. The impact of informant bias of project leaders or R&D managers, the most commonly

used respondents in innovation management research (Montoya-Weiss and Calantone 1994), on their assessment of performance has not yet been investigated.

Reflectively and formatively indicated constructs

In general, two approaches exist to define latent constructs of items of observed associated characteristics such as project and market success: reflectively and formatively-indicated constructs. A *reflectively-indicated construct* is defined such that the items reflect the construct (Bollen 1989). Reflectively-indicated constructs are applied in most product development studies. A *formatively-indicated construct* is defined such that the items together define the construct (Diamantopoulos and Winklhofer 2001; Jarvis et al. 2003). For instance Edwards and Bagozzi (2000) present socioeconomic status as a formatively-indicated construct defined in terms of a person's occupation, education and income. The difference between reflectively-indicated and formatively-indicated constructs concern the causal direction of the effect between items and constructs[2]. In a reflectively-indicated construct it is from construct to items, the latter proposed as observable consequences of variations in a latent construct. In a formatively-indicated construct, it is from measurable items to the construct, which is defined in underlying items. (Bollen and Lennox 1991). For assessing internal consistency of the indicators, reflective items should be positively correlated. This is reflected by high Cronbach's alpha's (Nunally and Bernstein 1994), while this is not necessarily the case, nor required, for formative items (Diamantopoulos and Winklhofer 2001; Jarvis et al. 2003).

In the theoretical model, project and market success are formatively defined constructs, as both constructs are defined by the items. However, instead of objective measurements of market and project success, it is more common to adopt perception-based measures. Edwards and Bagozzi (2000) claim that 'specification of constructs as formative or reflective should be based on a priori conceptual criteria, not on post hoc empirical evidence'. Jarvis et.al. (2003) and Edwards and Bagozzi (2000) both propose criteria to determine a priori, whether items should be considered as reflective or formative. Edwards and Bagozzi (2000) criteria concern the causal relationship between the item and the construct only. The first criterion of Jarvis et.al (2003) also addresses the causality between items and construct, this criterion is similar but less detailed than the causality criteria of Edwards and Bagozzi (2000). In addition, Jarvis et.al consider three other criteria, related to the nomological net surrounding the items. We discuss both guidelines below.

Causal relationship between construct and items

In reflectively-indicated constructs, the latent factor is assumed to affect the observed items. For instance, perceived project success modeled as a reflectively-indicated construct, should cause the perception that a project was within budget, on schedule and within quality targets. This is highly unlikely. Project success will be evaluate on the

[2] Mathematically a reflectively-indicated construct is modeled as : $y_i = \lambda_{i1}\eta_i + \varepsilon_i$, a formatively-indicated construct is modeled as $\eta_1 = \gamma_{11}x_1 + \gamma_{12}x_2 + \ldots + \gamma_{1q}x_q + \zeta_1$ (Edwards and Bagozzi 2000 p.161).

perceptions of the adherence to budget, schedule and quality targets, assuming that at the moment of assessment the project has been completed. In a formatively-indicated construct, the items affect the construct. Perceived project success modeled as a formatively-indicated construct implies that the perception of adherence to budget, schedule and quality targets determines the perception of project success. According to the causality criteria (Edwards and Bagozzi 2000; Jarvis et al. 2003), project success seems thereby to be a formatively-indicated construct.

The other construct, the perception of market success, consists of the perception of the profitability, the revenues, the gains in market share, the competitive advantage, the affect on reputation and the satisfaction of the customers. A respondent will either evaluate market success based on their expectations of the future or in retrospect, depending on the time that has elapsed between the introduction and the assessment of market performance. Usually the assessment takes place shortly after the market introduction (Hultink and Robben 1995). This implies that his or her perceptions reflect his or her prognosis of market success. In this case, the respondent's expectation of market success is likely to determine his perception of the profitability of the product and the satisfaction of the customers. When the evaluation takes place long after the market introduction, implying that the respondent evaluates market success retrospectively, it is more likely that the perceptions of turn over, customer satisfaction etc. together determine his or her perception of market success. Whether market success is a reflectively or a formatively indicated indicator, depends thus on the timing of the assessment relative to the market introduction of the new product.

In addition, Edwards and Bagozzi (2000) assess temporal precedence to determine the direction of causality. In a reflectively-indicated construct, the construct precedes a change in the measure. As all the items are associated, a change in one item will be accompanied with changes in the other items. Likewise, the impact of a change in each of the items will be similar. In a formatively-indicated construct, the construct follows a change in the items. A change in one item is not necessarily accompanied by a change in the other items. Nor is the impact of a change the same for each item. For perceptions this becomes a rather dubious exercise, because which perception comes first is more likely to dependent on the timing of the assessment relative to the occurrence of the project execution or market introduction, than to the causal relationship between items and construct.

Furthermore, Edwards and Bagozzi (2000) point at the elimination of rival explanations for the presumed causal relationship between a construct and an item. For project-success we cannot think of a rival causal explanation. A rival explanation for market success could be the characteristics or the new development product. The launch of the newly developed product precedes market success. It is therefore likely that there exists a spurious relationship between project and market success, the newly developed product as outcome of a development project. A unique product of superior quality will causes market success by gains in market share, revenue growth etc (Brown and Eisenhardt 1995). The items we assigned to market success could thus instead be items belonging to the construct 'the new product'. Since a unique and superior product causes profits and customer satisfaction (Brown and Eisenhardt, 1995), the new product construct is clearly a reflectively indicated construct.

Nomological net surrounding the items

The second criterion, proposed by Jarvis et al. (2003) relates to the interchangeability of items. According to Jarvis et.al (2003), reflectively-indicated constructs have items that are exchangeable, since they cover the same conceptual domain. In a formatively-indicated construct, each item covers a part of the conceptual domain, they are not necessarily interchangeable nor can they be omitted without altering the definition of the construct.

In the case of the perception of project success, each of the perceptions of adhering to schedule, budget and quality targets, and capturing knowledge have a different content and theme. They are clearly not interchangeable, nor is it possible to drop one of these items without altering the meaning of the perception of project success. Hence this second criterion suggests also that project success is a formatively-indicated construct, which is consistent with the outcome of the first criterion.

For market success, the items for the perception of profitability and revenues are to a certain extent interchangeable. They both represent related aspects of financial performance. Items such as the perception of customer satisfaction and profitability are not interchangeable, still they both capture the notion of market response. Market success is thereby more likely to be a reflectively than a formatively indicated construct, according to this second criterion.

The third criterion of Jarvis et.al (2003) relates to the covariance between the items of a construct (Jarvis et al. 2003). The covariance between the items should be positive in the case of reflectively-indicated constructs, because the items share a common cause (Mackenzie et al. 2005). Positive covariance is not necessary for formative items, as each formative item covers a different conceptual domain and each domain may behave differently. As stated above, perceptions in general will covary, as respondent have a tendency to make their answers consistent. This would imply that both constructs could be reflectively-indicated constructs.

In their fourth criterion, Jarvis et al. (2003) mention that items of reflectively-indicated constructs should have the same antecedents and consequences, because reflective items all reflect the same underlying construct. Formative items do not necessarily have the same antecedents and consequences (Jarvis et al. 2003). It is difficult to interpret this rule of theirs, because, by definition, reflective items share the same antecedent and formative items share the same consequence. Since project success precedes market success, all items of project success have the same consequence, and since market success follows project success, all these items have the same antecedent. This would imply that project success is a formatively indicated construct and market success a reflectively indicated construct.

Conclusion

The causality criterion for the perception of project success points towards a formatively-indicated construct, assuming that the assessment of project success takes place when the project phase has been completed. Market success should be considered a reflectively-indicated construct. The rival explanation for market success, the new product as outcome of the development project, is likely to be the cause of the items of

market success. Furthermore, the assessment of market success most likely reflects the expectations of market success, which also points at a reflectively-indicated construct.

Jarvis et al. (2003) defined three additional criteria, related to the interchangeability of items, the covariance amongst the items and the nomological net surrounding the items. From a validation theory perspective, these are all important characteristics for reflectively indicated constructs, however such methodological requirements can never test construct validity (Borsboom et al. 2004). Another weak point in these latter criteria is that they are very stringent for reflectively indicated constructs, while they are flexibly interpretable for formatively indicated constructs. As a consequence, constructs not fulfilling the stringent criteria of reflective indicators seem to become formatively indicated construct, which cannot be the intention of these decision criteria (Edwards and Bagozzi 2000). The causality criterion is thus the most important criterion to decide a priori whether a construct is a formatively or a reflectively indicated construct. We therefore conclude that project success is a formatively-indicated construct and market success is a reflectively-indicated construct.

In the empirical section we will test the validity and reliability of the mixed formatively-reflectively indicated perceived performance construct. In the discussion session we will discuss the implication of a completely formatively versus a completely reflectively defined performance model.

METHODS

Sample

Our sample consists of data collected on development projects of firms with more than 50 employees in the Dutch IT (Bik code 72), Engineering (Bik code 74), Construction industries (Bik code 45) and related industries. In total approximately 1200 firms were randomly selected form the Reach database in the selected industries. To increase the response rate, representatives of the industry organizations were asked to inform their members about our research. This means that our population does not only consist of selected industries, but also contains a fourth group of related industries.

Each firm was invited by telephone to participate in an internet-based questionnaire. We developed two questionnaires, one for R&D managers and one for project leaders. Each R&D manager was asked to name and assess two development projects in his firm, a successful and a less successful project. In addition, we asked each project leader to assess the performance of their own development project.

From the 1200 firms approached by telephone, 720 R&D or other managers responsible for development projects agreed to participate; 205 (22 %) of these R&D managers actually did respond to the questionnaire. They named 257 development projects and provided the e-mail addresses of 213 project leaders. 148 of these project leaders responded (69%). Four projects were deleted because the project's name provided by the project leader did not match the name mentioned by the R&D manager.

Measures

R&D managers and project leader were asked the same questions about the performance of each development project. These questions cover their perception of both project and market success. The assessment of project success consists of 6 questions; see appendix 3.A. Adherence to schedule, budget and quality targets are adapted from Griffin and Page (1993; 1996) and Langerak et al. (2004), adhering to project goals is taken from Hoegl and Gemuenden (2001). Captured knowledge consists of two items, one related to the knowledge gained by the team members, the other related to the anchoring of this knowledge within the organization (adapted from Hoegl and Gemuenden 2001). Furthermore, the project leader's questionnaire contains two additional questions; open questions asking for the planned duration (in month) and the actual duration of the development project (in month). These two questions are used as objective measurement for adherence to schedule.

The assessment of market success also consists of 6 questions. Overall satisfaction has been adapted from Hoegl and Gemuenden (2001). Four items, profitability, revenue, competitive advantage, customer satisfaction are adapted from Griffin and Page (1993, 1996) and Langerak et.al. (2004). During the pre-test, informants commented that some questions were inadequate for evaluation of development projects in their firms. Especially items related to market share and return on investment of development projects (Griffin and Page 1996; Langerak et al. 2004) were considered inappropriate. Service firms in the IT industries, for instance, often do not use market share as performance item (Hoch, Roeding, Purkert and Lindner 2000). These items were subsequently deleted from the survey. The item market share, as shown in figure 3.1, is therefore absent in the empirical analyses. The perceived increase in reputation in the area of the new product or new service is added, since it is an important aspect of performance in service firms (De Brentani 1989).

Structural equation modeling with formatively-indicated constructs

Structured equation modeling has been applied to test the mixed performance model. Procedures for structural equation modeling of reflectively-indicated constructs are well established (Bollen 1989; Nunally and Bernstein 1994), but procedures for formatively-indicated constructs are not (Diamantopoulos and Winklhofer 2001; Edwards and Bagozzi 2000; Jarvis et al. 2003). Mackenzie et al. (2005) proposed guidelines for developing and evaluating formatively-indicated constructs. In the next section, we first discuss the procedure used to assess the validity and reliability of the items. Next we describe our procedure to assess the reliability and validity of the formatively-indicated construct. Lastly, we explain the assessment of informant bias of the mixed model, consisting of a reflectively and a formatively-indicated construct.

Item reliability and validity

We test the validity of the formative items by means of one of the outgoing paths which are needed for the identification of formatively-indicated constructs (Bollen 1989; Diamantopoulos and Winklhofer 2001; Jarvis et al. 2003; Nunally and Bernstein 1994). Such an outgoing path is typically referred as the *global item*. Each global item has to 'summarize the essence of the construct that the index purports to measure'

(Diamantopoulos and Winklhofer 2001). Consequently, each item should correlate significantly with the global item(s) in order to be valid (Diamantopoulos and Winklhofer 2001; Jarvis et al. 2003).

A second way to test the validity of (formative) items (Nunally and Bernstein 1994), makes use of multi-method data, applying the convergent validity criteria of Campbell and Fiske (1959). However, this approach does not show which method, i.e. the project leader or the R&D manager, is more reliable (Rossiter 2002), nor does it distinguish between random and systematic method errors (Bagozzi, Yi and Phipllips 1991).

We could assess reliability only for the item adherence to schedule, as only for this item both an objective and a subjective measure is available in the project leaders' questionnaire (Campbell and Fiske 1959).

Low item validity or reliability does not imply that such an item should automatically be removed from a formatively-indicated construct. Elimination of items carries the risk of changing the construct itself and should therefore always be applied with caution (Bollen and Lennox 1991; Diamantopoulos and Winklhofer 2001). Hence, despite the methods described above, there are no "set" standards to evaluate the validity of formative items (Mackenzie et al. 2005).

Construct reliability and validity

Although formatively-indicated constructs are examples of multivariate models, measures from multiple regression techniques for the assessment of construct validity and reliability cannot be applied (Bollen 1989). Assessment of reliability by means of Cronbach's alpha is not applicable for formatively-indicated constructs (Bollen 1989; Edwards and Bagozzi 2000; Jarvis et al. 2003).

We test for criterion validity, the degree of correspondence between a construct and an independent criterion variable (Bollen 1989), by using 'overall satisfaction' as a general measure for the performance of the development projects and assessing whether the means of the project and market success constructs significantly differ for each step within the scale of 'overall satisfaction'.

To assess convergent and discriminant validity, exploratory factor analysis is typically used for reflectively-indicated constructs. However this method is not suitable for formatively indicated constructs (Bollen 1989; Edwards and Bagozzi 2000; Jarvis et al. 2003). As an alternative, since we have MTMM data, we use the procedure of Bagozzi et.al. (1991) to assess convergent and discriminant validity of the entire performance model. Assessment of convergent validity of a model - demonstrating that two independent methods of inferring an attribute lead to similar ends - involves comparison of confirmatory factor analysis models (Bagozzi et al. 1991). Using the nesting sequence, significance of trait and method effects are tested with χ^2 difference tests (Bagozzi et al. 1991; Kim and Lee 1997). Convergent validity is achieved when a significant portion of the variance is explained uniquely by trait factors (Bagozzi et al. 1991). Discriminant validity, the degree to which two conceptually similar attributes are distinct, is achieved when the correlations amongst the constructs, in the trait-method model, significantly differ from unity (Bagozzi et al. 1991).

Table 3.1 MTMM correlations

		μ (se)	range	R&D manager								
				1.	2.	3.	4.	5.	6.	7.	8.	9.
R&D Manager	1.Adherence to schedule	2.46 (0.08)	1-5									
	2.Adherence to budget	2.64 (0.07)	1-5	0,49**								
	3.Quality	5.40 (0.12)	1-7	-0,10	-0,21*							
	4.Captured knowledge	5.02 (0.11)	1-7	-0,12	-0,21*	0,50**						
	5.Adhering to project goals	4.53 (0.16)	1-7	0,19*	0,16	0,47**	0,49**					
	6.Overall satisfaction	4.96 (0.15)	1-7	-0,07	-0,04	0,55**	0,65**	0,79**				
	7.Profitability	2.73 (0.08)	1-5	0,04	0,05	0,28**	0,29**	0,49**	0,56**			
	8.Revenue	2.74 (0.08)	1-5	0,04	0,13	0,19*	0,25**	0,42**	0,52**	0,78**		
	9.Competitive advantage	5.29 (0.12)	1-7	-0,06	-0,07	0,56**	0,59**	0,54**	0,64**	0,53**	0,48**	
	10.Reputation	5.05 (0.13)	1-7	0,06	-0,02	0,53**	0,51**	0,47**	0,48**	0,36**	0,32**	0,68**
	11.Customer satisfaction	5.37 (0.13)	1-7	-0,03	-0,05	0,56**	0,55**	0,59**	0,65**	0,50**	0,45**	0,74**
Project Leader	1.Adherence to schedule	2.54 (0.07)	1-5	0,19*	0,12	0,15	0,16	0,34**	0,33**	0,31**	0,25**	0,29**
	2.Adherence to budget	2.67 (0.07)	1-5	0,32**	0,58**	-0,11	0,01	0,26**	0,13	0,21*	0,34**	0,09
	3.Quality	5.21 (0.13)	1-7	0,03	-0,13	0,54**	0,31**	0,28**	0,28**	0,29**	0,21*	0,43**
	4.Captured knowledge	5.39 (0.10)	1-7	0,15	-0,02	0,32**	0,42**	0,27**	0,25**	0,21*	0,18*	0,34**
	5.Adhering to project goals	4.85(0 .14)	1-7	0,28**	0,17	0,39**	0,32**	0,62**	0,53**	0,48**	0,38**	0,50**
	6.Overall satisfaction	5.48 (0.14)	1-7	0,16	0,05	0,46**	0,37**	0,59**	0,65**	0,52**	0,41**	0,57**
	7.Profitability	2.76(0 .07)	1-5	0,07	0,08	0,26**	0,22*	0,46**	0,46**	0,68**	0,50**	0,49**
	8.Revenue	2.91 (0.07)	1-5	0,02	0,05	0,22*	0,23*	0,34**	0,42**	0,54**	0,48**	0,46**
	9.Competitive advantage	5.31 (0.14)	1-7	0,13	-0,04	0,35**	0,33**	0,32**	0,37**	0,43**	0,36**	0,59**
	10.Reputation	5.12 (0.13)	1-7	0,04	-0,10	0,29**	0,35**	0,35**	0,35**	0,43**	0,33**	0,49**
	11.Customer satisfaction	5.49 (0.12)	1-7	0,12	-0,03	0,25**	0,32**	0,41**	0,46**	0,47**	0,32**	0,49**

Note: N = 144

* p < 0.05

** p < 0.01

*** p < 0.001

	Project leader											
	10.	**11.**	**1.**	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**
1.Adherence to schedule												
2.Adherence to budget												
3. Quality												
4.Captured knowledge												
5.Adhering to project goals												
6.Overall satisfaction												
7.Profitability												
8.Revenue												
9.Competitive advantage												
10.Reputation												
11.Customer satisfaction	0,54**											
1.Adherence to schedule	0,31**	0,27**										
2.Adherence to budget	0,07	0,05	0,27**									
3.Quality	0,40**	0,42**	0,09	-0,15								
4.Captured knowledge	0,40**	0,33**	0,12	-0,01	0,50**							
5.Adhering to project goals	0,48**	0,47**	0,36**	0,27**	0,43**	0,46**						
6.Overall satisfaction	0,50**	0,57**	0,33**	0,13	0,51**	0,51**	0,76**					
7.Profitability	0,38**	0,46**	0,30**	0,27**	0,20*	0,22*	0,52**	0,54**				
8.Revenue	0,40**	0,49**	0,23**	0,20*	0,19*	0,16	0,43**	0,52**	0,64**			
9.Competitive advantage	0,49**	0,56**	0,18*	-0,01	0,60**	0,48**	0,53**	0,68**	0,47**	0,37**		
10.Reputation	0,53**	0,45**	0,13	0,06	0,43**	0,51**	0,53**	0,57**	0,37**	0,37**	0,72**	
11.Customer satisfaction	0,46**	0,60**	0,26**	0,02	0,58**	0,49**	0,56**	0,71**	0,49**	0,44**	0,65**	0,58**

MTMM analyses applied on formatively-indicated constructs

The procedure to use MTMM data to assess informant bias, is well described for reflectively-indicated constructs (Bagozzi et al. 1991; Kim and Lee 1997), but has not been applied to formatively-indicated constructs.

In a MTMM model, each reflective item loads on a trait and a method construct. Systematic method and random errors are thereby separately modeled in an MTMM model. The estimated coefficients, or estimated variance for the trait and method and error of each item, provide subsequently insights in the validity of each item.

Formative items are modeled per construct in one equation, while reflective items are each modeled in a separate equation (Bollen and Lennox 1991; Diamantopoulos and Winklhofer 2001). When trait effects are to be modeled formatively as determined by the decision rules for formatively-indicated constructs (Edwards and Bagozzi 2000; Jarvis et al. 2003), method effects should also be modeled formatively, in our opinion. Consequently, when MTMM is applied on a formatively-indicated construct, one equation contains the information of the trait effects of all items, while the method effects of the items are modeled in separate equations for each method. As a consequence, MTMM analyses of formatively-indicated constructs is not as informative as it is for reflective items, because it is not possible to divide the total variance into trait, method and error variance for each item separately, similarly as it is applied for reflective items. However when the magnitude of each coefficient is considered as validity coefficient (Bollen 1989), the respective magnitude of the unstandarized coefficients in the trait and method equations provide insight in informant effects. At the same time, including measurements of both methods in one regression potentially leads to excessive collinearity among items in the trait equation. Excessive collinearity could jeopardize the validity of the MTMM assessment, since the magnitudes of the coefficients would become meaningless (Bollen 1989). We assess collinearity with the VIF values that were obtained by modeling the trait equation as multiple regression equation, using the global item as dependent variable. As cut-off value we use a VIF of 10 (Neter, Wasserman and Kutner 1990).

RESULTS

Data description

The empirical analyses have been performed on the dataset consisting of 257 projects assessed by R&D managers, with the exception of the analyses that require MTMM data. These latter analyses have been performed on the subset of 144 projects.

The R&D manager's data (N=257), with a mean for overall satisfaction of 4.88 and a variance of 2.78 (on a scale from 1-7), is biased for more successful projects. The deviation of the mean of the R&D manager's data ($\mu_{R\&D} = 4.88$) from the mean of the sub-sample of 144 projects ($\mu_{R\&D} = 4.96$) does not significantly differ from zero ($p = 0.65$). Project leaders appear to have a more positive view, with a mean for overall satisfaction of $\mu_{PM} = 5.48$ (N = 144), see Table 3.1.

The means, standard errors and correlations of the items used in the MTMM analysis are in Table 3.1. The Kolmogorov-Smirnov test shows that the normality assumption is not violated, neither for the R&D nor for the project-managers data. The project leaders data are more skewed, with skewness values of -1.4 and kurtosis values above 1.5 for overall satisfaction and customer satisfaction, while the skewness and kurtosis values for the R&D managers data are all below 1 (Bollen 1989).

Item reliability and validity

Adhering to project goals is used as global indicator to define the project success construct. The items of the project success construct correlate significantly with the global item, adhering to project goals (see Table 3.2). Furthermore all mono-trait-multi-method correlations, on the diagonal of the lower square of Table 3.2, are significantly different form zero and sufficiently large. This implies that convergent validity of the items is achieved (Bagozzi et al. 1991; Campbell and Fiske 1959). The mono-trait-multi-method correlation for adherence to schedule is comparatively low 0.19, however no rules exist with respect to a required minimum value (Bagozzi et al. 1991). We subsequently examined the reliability of adherence to schedule, based on the correlation between the subjectively and objectively measures for adherence to schedule, the latter being defined as the difference between planned and actual project duration. The correlations are significant, 0.47 for the project leaders and 0.28 for the R&D managers 0.28 (both $p \leq 0.01$). The subjective measure of adherence to schedule is thereby reliable. For the other items we do not have duplicate measures.

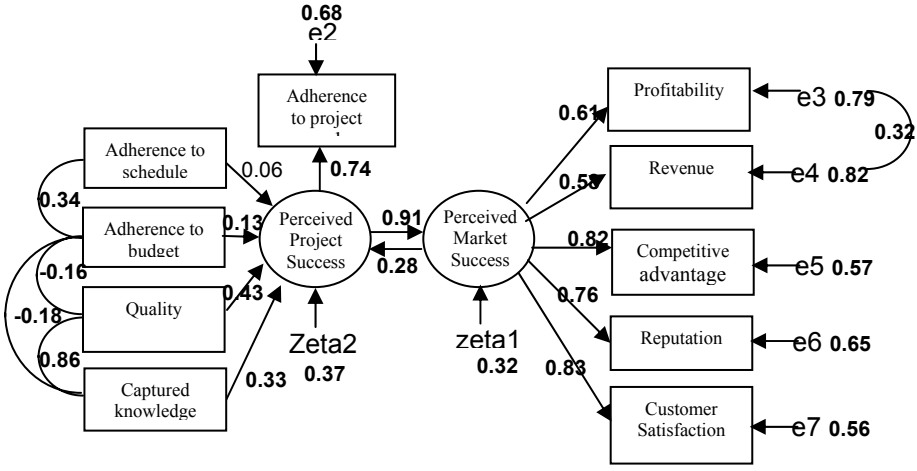
Construct validity and reliability

The mixed perceived performance model is slightly different from the theoretical model presented in figure 3.1. Firstly, not the actual, but the perception of each item is measured. Secondly, the relationship between market and project success is modeled reciprocally, to account for common method bias. Thirdly, a formatively indicated constructs needs two outgoing path to be identified(Bollen 1989; Diamantopoulos and Winklhofer 2001; Jarvis et al. 2003; Nunally and Bernstein 1994). One path is the path from project to market success, for the other we used a global indicator, the perception of adherence to project goals, see figure 3.2.

For the perception of market success construct, we find using exploratory factor analysis, one component with 65 % explained variance, principal component analysis with eigenvalues > 1, Cronbach's alpha is equal to 0.85 (N = 257). As explained above, exploratory factor analysis and Cronbach's alpha's are only relevant for reflective constructs (Jarvis et.al, 2003).

The mixed model has a moderate fit ($\chi^2 = 81.2$, df = 24, p = <0.001, AIC = 33.2, GFI = 0.93, RMR = 0.07). The estimates for the coefficients are in accordance with our expectations from theory, see figure 3.2. Successful projects lead to market success (0.91), and there is a reversed effect from market success to project success (0.28). Customer satisfaction (0.83) and competitive advantage (0.82) contribute most, and revenue (0.58) and profitability (0.61) contribute least to market success. Quality (0.43) contributes most to project success, next to captured knowledge (0.33). The

influence of adherence to budget is rather small (0.13). The influence of adherence to schedule is even insignificant.



Notes : Covariance, ML estmiation, SAS program. Significant relationships ($p \leq 0.05$) in bold, (N = 219)

Figure 3.2 The mixed R&D manager's perceived performance model

The mixed model fulfills the criterion validity criterion. The means of both the project success and market success constructs differ significantly for all 7 intervals of the overall satisfaction item (for project success $F = 14.79$, $p < 0.001$, $R^2 = 0.39$, $\eta^2 = 0.43$, for market success $F = 28.79$, $p \leq 0.001$, $R^2 = 0.61$, $\eta^2 = 0.62$).

Analysis of discriminant validity shows that the difference between project success and market success is small. The model in which project success equals market success has a similar fit ($\chi^2 = 86.1$, with $df = 27$, $p \leq 0.0001$, GFI = 0.93, RMR = 0.08) as the mixed model. The correlation between market and project success is 0.73 ($p \leq 0.01$), which means that approximately 50 % of the variance is shared. We have to conclude that for the R&D mangers data it is not possible to discriminate between project success and market success.

Respondent bias

We use the MTMM mixed model to gain insight in respondent bias, see figure 3.3. The fit of the MTMM mixed model is not very good ($\chi^2 = 180.7$, $df = 114$, $p > 0.001$, GFI = 0.85, RMR = 0.07).

There are some notable difference between the model presented in figure 3.2, which was based on the R&D manager's data only and the MTMM model, figure 3.3. The models are similar, with the exception that all items are duplicated in the MTMM model and that method effects are modeled, at the right side of the model. Furthermore the covariances between items and errors are included. De reversed effect from market to project success is insignificant in the MTMM model. The effect of project success on market success is only 0.54, instead of 0.91 in the R&D model. For market success,

especially competitive advantage, reputation and customer satisfaction have lower trait effects in the MTMM model, for both the R&D and the project leader items, than the factor loadings in the R&D manager's model.

In the R&D manager's model, quality and captured knowledge have the highest estimates. In the MTMM model, adherence to schedule and budget have the highest trait estimates. The trait estimates for quality and captured knowledge are insignificant in the MTMM model.

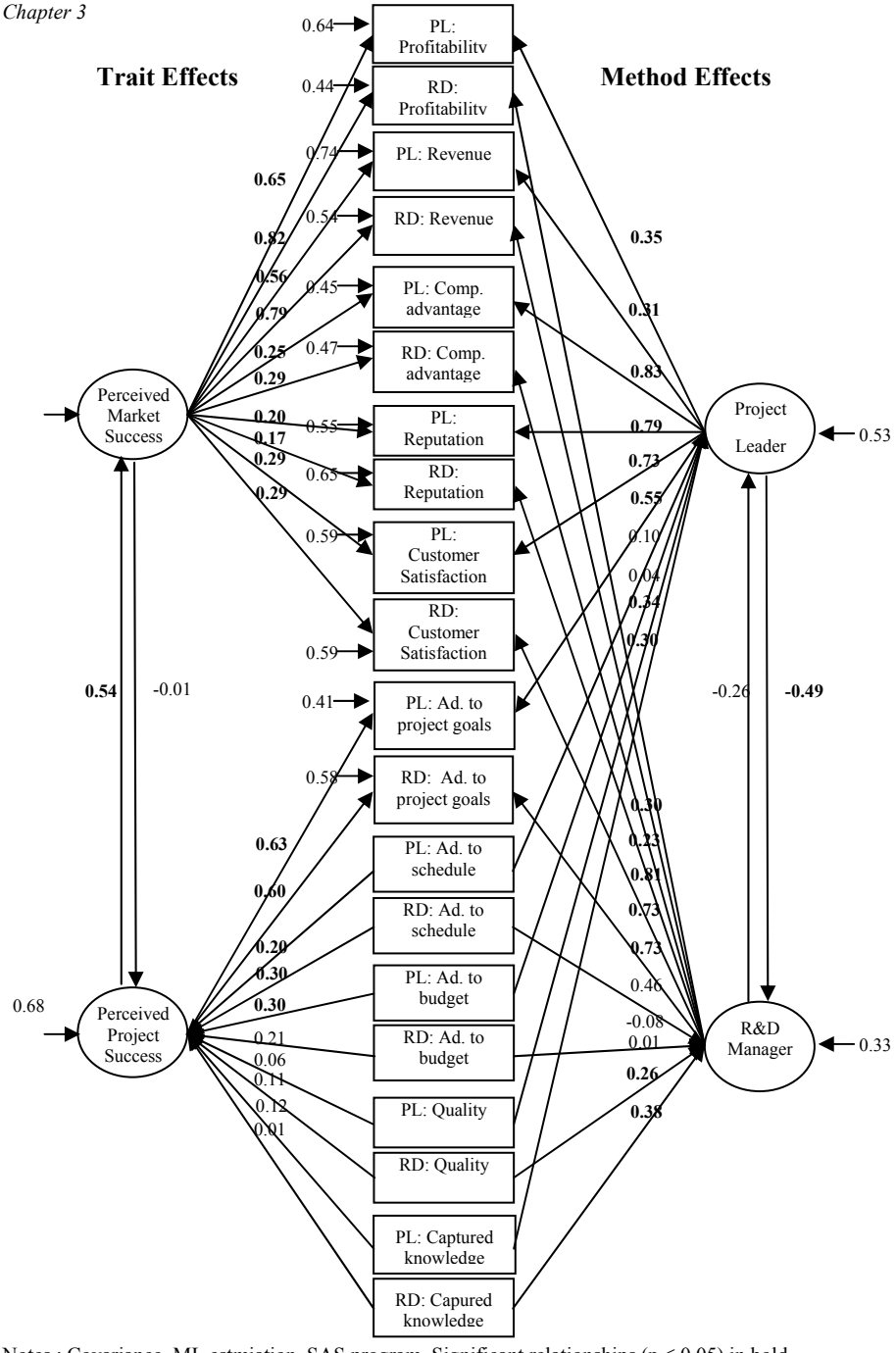
Table 3.2 Summary of Nested Confirmatory Factor Analysis tests for Trait and Method Effects

Model	df	χ^2 test	P
Null	190	1259.1	> 0.001
Method-only	138	352.6	> 0.001
Trait-only	138	369.9	> 0.001
Trait-Method	114	180.7	> 0.001
Null – Trait-only	52	889.2	> 0.001
Method only – Trait-Method	24	171.9	> 0.001

Comparing the trait-only model with the null model and the trait-method model with the method-only model shows, that the addition of trait effects significantly improves model fit, respectively a χ^2 change of 889.2 and 171.9. Hence, convergent validity is present for the mixed MTMM model.

Discriminant analyses using the MTMM data reveals that project and market success are distinct. In the mixed MTMM model, in which trait and method effects are separated, the χ^2 difference between the model with and without constraint equals 113.9 ($p \leq 0.001$). Moreover, the standardized coefficients between project and market success in the mixed MTMM model without constrains are 0.54 (t-value 2.73), which is significantly different from 1.0. The reversed effect has disappeared in the MTMM model (-0.01, t-value -0.09). We thereby have support, when taking into account method effects, that the two traits, the perception of project success and the perception of market success, are distinct from each other (Kim and Lee 1997).

Table 3.3 shows the results of the MTMM analysis for the reflectively indicated perceived market success constructs (Bagozzi et al. 1991; Kim and Lee 1997). The estimates of the trait, method and errors effects are provided for each item. The estimated variance of the method effects gives insights in the size of the systematic error due to method effects. The estimated variance due to error gives insights in size of the random error. The trait variance can be attributed to the actual effect. The measurements used to assess the perception of profitability and revue appear reliable for the R&D manager (trait variances of respectively 0.67 and 0.62 for the R&D managers versus 0.42 and 0.31 for the project leader). The trait variances of the items, the perception of competitive advantage, reputation and customer satisfaction, are between 0.03 and 0.08, are far below the 0.50 rule of thumb for convergent validity (Bagozzi et al. 1991; Kim and Lee 1997).



Notes : Covariance, ML estmiation, SAS program. Significant relationships ($p \leq 0.05$) in bold

Figure 3.3 The mixed MTMM perceived performance model

The global indicator, adhering to project goals, used to define the formatively indicated project success construct has a trait variance of 0.36 for R&D managers and 0.40 for project leaders. This is below the 0.50 rule, at the same time these trait effects are larger than the method and error effects, see Table 3.3.

Table 3.3 Informant bias market success part of the mixed MTMM model

	Trait	Method		Estimated variance due to		
		R&D	PM	Trait	Method	Error
Profitability assessed by						
R&D	0,82(0.18)	0,30(0.04)		0,67	0,09	0,18
PM	0,65(0.16)		0,35(0.05)	0,42	0,12	0,43
Revenue assessed by						
R&D	0,79(0.19)	0,22(0.04)		0,62	0,05	0,30
PM	0,56(0.17)		0,31(0.05)	0,31	0,10	0,59
Competitive advantage assessed by						
R&D	0,29(0.20)	0,81(0.06)		0,08	0,66	0,22
PM	0,25(0.26)		0,83(0.08)	0,06	0,69	0,18
Reputation assessed by						
R&D	0,17(0.28)	0,73(0.06)		0,03	0,53	0,40
PM	0,20(0.29)		0,79(0.08)	0,04	0,62	0,31
Customer Satisfaction assessed by						
R&D	0,29(0.29)	0,73(0.06)		0,08	0,53	0,35
PM	0,29(0.23)		0,73(0.07)	0,08	0,53	0,22
Adhering to project goals assessed by						
R&D	0,60(0.11)	0,46(0.08)		0,36	0,21	0,35
PM	0,63(0.11)		0,55(0.09)	0,40	0,30	0,22

Note: Standard errors in parentheses, all estimates are significant at $p < 0.05$

The results of the MTMM analysis of the formatively indicated project success construct are shown in Table 3.4. In Table 3.3 the regression equations underlying the MTMM model are presented vertically, while they were presented horizontally for the formatively indicated project success construct in Table 3.4. Trait, method and error estimates are not provided for each item, as method effects for the R&D and project leader and the trait effects are modeled in three separate equations. The error, or unexplained variance of each equation, is listed at the bottom of Table 3.4. To assess informant bias of the formative project success construct, we compared the magnitude of the unstandardized coefficients of the trait effect equation with the method effect equations of project success for each the R&D and the project leaders.

Collinearity of the project success trait equation in the MTMM analysis was assessed through multiple regression of both R&D and project leaders' project items, with 'adhering to project goals' as dependent variable. This resulted in VIF values all below 1.89. Using 'adhering to project goals' as dependent variable from either the R&D manager or the project leaders' datasets led to similar results.

Table 3.4 Informant bias project success part of the mixed MTMM model

	Trait	Method	
		R&D	PM
Market success	-0.06 [a] (-0.01)*0.73*		
R&D manager's perception			
Adherence to schedule	0.69(0.27) *0.30*	-0.25 [a] (0.20) *-0.08*	
Adherence to budget	0.47[a](0.30) *0.21*	0.04 [a] (0.20) *0.01*	
Quality	0.15 [a] (0.19*) 0.11*	0.48(0.14) *0.26*	
Captured knowledge	0.02 [a] (0.19) *0.01*	0.72(0.14) *0.38*	
Project leader		-0.65(0.14) *-0.49*	
Project manager's perception			
Adherence to schedule	0.41(0.21) *0.20*		0.21 [a] (0.15) *0.10*
Adherence to budget	0.66(0.29) *0.30*		0.08 [a] (0.17) *0.04*
Quality	0.07 [a] (0.18) *0.06*		0.42(0.11) *0.34*
Captured knowledge	0.18 [a] (0.21) *0.11*		0.47(0.14) *0.30*
R&D manager			-0.19 [a] (0.11) *-0.26*
Error	*0.68*	*0.33*	*0.54*
R^2	0.54	0.89	0.71

Standard errors in parentheses, standardized coefficients in cursive, N = 91
[a] not statistically significant

For adherence to schedule both R&D managers and project leaders seem reliable. The estimates for adherence to schedule in the trait equation are significant for both the R&D manager and the project leader, respectively 0.69 (se 0.27) and 0.41 (se 0.21). While adherence to schedule is insignificant in both method equations, respectively -0.25 (se 0.20) and 0.21 (se 0.15). Project leaders appear to be more reliable informants for adherence to budget than R&D manager (0.66 versus insignificant 0.47 in the trait equation). The estimates in the method effect equations for adherence to budget are both insignificant (0.04 for the R&D managers leaders and 0.08 for the project leaders). Both informants seem unreliable concerning quality and captured knowledge; insignificant trait effects (0.15 and 0.02 for the R&D manager's items and 0.07 and 0.18 for the project leader items) and significant method effects (0.48 and 0.72 in the R&D manager's and 0.42 and 0.47 in the project leader's method equation). Furthermore the project leader construct is rather dominant in the R&D-manager method equation -0.65 (0.49). The R&D manager construct is insignificant in the project leader method equation -0.19(0.26).

DISCUSSION

We showed that in the innovation management literature currently performance measurement of development project suffers from inconsistencies due to the applied construct validation theory. We developed a theoretical performance assessment model,

consisting of project and market success. We reasoned that project success is a formatively-indicated construct, and market success a reflectively-indicated construct. We tested this model, using the perceptions of R&D and project leaders for each of the items. When R&D managers assess the performance of a development projects, project and market success are indistinguishable. However project and market success are two separate constructs when common-method bias effects are taken into account.

It is not straightforward to choose between formative and reflectively-indicated constructs. It can be ambiguous to make a priori a choice between a formatively or a reflectively-indicated construct. Reversed causality is the only good reason for the definition of formatively-indicated construct, and low reliability of a construct can never justify the use of formative items (Diamantopoulos and Winklhofer 2001; Edwards and Bagozzi 2000; Jarvis et al. 2003). In that respect are the decisions rules of Edwards and Bagozzi (2000) probably more useful than those of Jarvis et al. (2003). Jarvis et al. (2003) rely, besides the causality argument, on the nomological net surrounding items. They do however not state which of their four rules is more important, while Borsboom et al. (2004) clearly explain why a nomological net should not be used to guide construct development.

Post hoc there are no criteria that can be used to distinguish between a formatively or a reflectively indicated model. Formatively indicated models probably always fit better, because fewer criteria are to be fulfilled.

The perception of project success should be modeled as a formatively-indicated construct. Considering project success as a reflectively-indicated construct leads to invalid results. Exploratory factor analysis leads to the conclusion that the project success construct is not uni-dimensonal, as it consists of two components, together explaining 74 % of the variance, principal component analysis with eigenvalues > 1. Cronbach's alpha is equal to 0.25 (N = 257). These results would lead to the elimination of items, or to splitting the project success construct in two parts. As we illustrated in the introduction, this indeed often occurs in the current literature.

For market success it was more difficult to determine whether it is a formatively or reflectively-indicated construct. This depends on the time that has elapsed between market introduction and the assessment. There exists also a rival explanation (Edwards and Bagozzi 2000) for market success, which is the developed new product, which is clearly a reflectively indicated construct. A new unique and superior product causes profits, gains in market share etc (Brown and Eisenhardt 1995). We therefore considered market success a reflectively-indicated construct. We compared the empirical results of a completely formatively and the proposed mixed perceived performance assessment model. The completely formatively perceived performance model has, as could be expected, a better fit (χ^2 = 12.6 df = 6 p < 0.05, AIC = 0.57, GFI = 0.99, RMR = 0.03) versus (χ^2 = 81.2, df = 24, p = <0.001, AIC = 33.2, GFI = 0.93, RMR = 0.07) than the mixed perceived performance model. There are several reasons to model market success as a reflectively-indicated construct. Firstly, as we explained above the causality criterion should be used to determine a priory the causal relationship between items and construct. Secondly, when market success and project success are both modeled formatively, distinct independent global measures are needed for both constructs. We applied adhering to project goals and overall satisfaction as global measures in the formatively-indicated performance model, which

appeared to be too closely related. As a consequence, in this formatively-indicated model, market success is nearly equivalent to the global item, overall satisfaction. The estimates of the other coefficients are consequently rather low. The coefficient estimates in the mixed model are better in accordance with theory, because in this case there is no second global indicator that distorts the model. Thirdly, fit indices to chose between both models should be used with care, as reflectively and formatively indicated models are not nested models, furthermore formatively indicated models probably always perform better, due to the less stringent requirements imposed on such a model. Fourthly, reflectively-indicated constructs facilitate the comparability of results of studies in different industries. Since reflectively-indicated constructs retain their content even if the items are altered, as long as the items are a proper sample of the construct (Bollen and Lennox 1991). Fifthly, reflectively-indicated constructs need to be less explicitly defined and do not render problems of redundancy. Formatively indicated construct need to be defined more concisely. All aspects that belong to a formatively-indicated construct should be included, while redundancy may lead to multicollinearity issues (Bollen and Lennox 1991).

Our study also has implications for the choice of informant groups. Project and market success are only distinguishable constructs when method effects are taken into account. Discriminant analysis on the R&D manager's data did not reveal a difference between market and project success. It seems that R&D managers judge project success predominantly on the outcomes of market success, and not on the outcome of the project phase itself. For instance, R&D managers may judge adherence to schedule based on the timeliness of the market introduction, whereas project leaders judge the difference between planned and actual duration of the project. This also explains the low convergent validity for this measure. In addition, we suspect that R&D managers somehow take the competence of the project leader into consideration in their assessment of project success, given the relative high contribution of the project leader in the R&D manager's method equation. Project leaders seem to have less insight in market success.

The MTMM correlations, Table 3.1, show that there is convergent validity (Campbell and Fiske 1959) in the answers of both the R&D and the project leaders for all items, with exception of the adherence to planning. Comparison of the objective and subjective measurement shows a significant correlation, indicating the subjective adherence to planning measure is reliable. Hence, the measures we used, the perceptions of either the project leader or the R&D manager on each of the measures lead to similar outcomes. However, the MTMM analysis shows that many measures of either the R&D manager or the project leader suffer from random and systematic error due to method variance, with the exception of profitability, revenue, adherence to schedule, and the project leader's perception of adherence to budget. The validity of the other measures is thus questionable, although the fit of our MTMM model was not very good.

Ketokivi and Schroeder (2004) found that perceptional measures were accurate to assess the performance of a firm's operations, especially more concrete perceptions as that of pricing. Our findings concur partially with their findings. Also our perceptions of concrete issues as adherence to budget, adherence to schedule and financial performance appear to perform satisfactorily as replacement for their objective

measures. However our findings show that the other perceptions are not valid enough, these items suffer to a large extent from random error and systematic bias. Only MTMM analysis can account for these biases in the perceptual measures.

For most items the paired means of the R&D and project leaders' data do not differ significantly. There are a few exceptions. Project leaders have a more positive view on items as overall satisfaction ($p< 0.001$) and adhering to project goals ($p<0.10$). Furthermore the means differ significantly for quality ($p< 0.05$), captured knowledge ($p< 0.01$), and revenues ($p< 0.05$). For these items it will be necessary to distinguishing between R&D managers and project leaders as respondents in a dataset, in order to have comparable input (Steenkamp and Baumgartner 1998).

Averaging the results of R&D managers and project leaders is unlikely to solve the validity problem. For the items where invariance does not exist between the measures of the R&D managers and the project leaders (Steenkamp and Baumgartner 1998) it will even produce even less valid results (Van Bruggen, Lilien and Manish 2002).

Further research is required to find more valid measures to assess items as customer satisfaction, reputation, competitive advantage, quality, and captured knowledge, since the perception of these items of neither project mangers nor R&D managers are valid measures. In case MTMM data is absent, we would advise using project leaders as informants to evaluate project success, and R&D managers or business unit managers to assess market performance of development projects. Perhaps customers could best be asked to answer some of the customer-based performance measures. With respect to the choice between R&D manager and project leader, we realize that also other restrictions need to be taken into account. For instance when for the independent variables information about project execution is taken from the project leaders, asking these same project-leaders to assess project-performance easily leads to common-method bias between the independent and dependent variables (Podsakoff et al. 2003).

This study has several limitations. In the models, differences in definitions between the IT and Construction industries appeared to exist. Analyzing invariance by splitting the data set (Steenkamp and Baumgartner 1998) revealed that for the IT industry adherence to schedule is more important, while it was less important within the Construction industry. This corresponds with the finding of (Eisenhardt and Tabrizi 1995) that speed is especially important in dynamic markets. The industry invariance implies that project success cannot be simply compared across industries (Steenkamp and Baumgartner 1998). Further research is required on the content of performance in different industries. Moreover, in the IT, Engineering and Construction industries, market share had to be omitted as a non-representative item for market success. More studies in different industries are needed to assess the role of different items in the market success construct. Since project success should be modeled formatively, consensus on the content of this construct is required for research results to be comparable. All relevant items should be included (Bollen and Lennox 1991).

By asking R&D managers to select a successful and a less successful project, we may have introduced common method bias in the perception of the R&D managers for both types of projects. This would especially have affected the R&D manager's

model. The method effects taken into account in the MTMM model should correct for this effect.

In general, adherence to schedule, budget and quality are important aspects of project success (Klastorin 2004; Pinto 1998). In our opinion the item capturing knowledge is a valuable addition to the project success construct, especially for radical and more research oriented development projects (Ayas 1997; Maidique and Zirger 1985). Although the value of this captured knowledge only becomes clear as time evolves.

Timing of the assessment seems to play an important role. Hultink and Robben (1995) showed that especially measures such as unit sales, revenue goals, ROI/IRR, market share and profitability goals change over a longer term perspective. We did not take the timing of the assessment into account in our research. Future research is needed to show how the timing of the assessment plays a role with regard to respondent bias and the causality between the perception of market success and the perception of the performance on the individual item.

For ease of calculation, we have considered our 5- point semantic scales and 7- point Likert scales to be ordinal data. For future research we recommend to verify whether ordinal data lead to the same results, especially because skewness in combination with categorical data may lead to too high estimates of χ^2 (Bollen 1989). Skewness is likely to be always present in development project data, firstly because informants tend to fill out questionnaires only for successful projects (Montoya-Weiss and Calantone 1994), and secondly because projects are rarely finished before their due date or with an under-run on budget (Klastorin 2004; Pinto 1998).

The primary aim of this study was to increase the validity of the performance measurement applied in new product development research. Scholars investigating the management of development projects, who use project or market success as dependent variable, will benefit from our findings. We think that our study contributes to the comparability of the findings of different studies, and we hope thereby to contribute to further professionaliziation of the field of innovation management.

REFERENCES

Ancona, D. G. and D. F. Caldwell 1992. "Bridging the Boundary: External Activity and Performance in Organizational Teams." *Administrative Science Quarterly* 37(4): 634-651.

Ayas, K. 1997. Design for Leaning for Innovation; Project Management for New Product Development. Rotterdam, Erasmus University**:** 242.

Bagozzi, R. P., Y. Yi, et al. 1991. "Assessing Construct Validity in Organizational Research." *Administrative Science Quarterly* 36(3): 421-458.

Bollen, K. A. 1989. *Structural Equations with Latent Variables*. New York, John Wiley.

Bollen, K. A. and R. Lennox 1991. "Conventional Wisdom on Measurement: A Structural Equation Perspective." *Psychological Bulletin* 110(2): 305-314.

Borsboom, D., J. Mellenbergh, et al. 2004. "The Concept of Validity." *Psychological Review* 111(4): 1061-1071.

Brown, S. L. and K. M. Eisenhardt 1995. "Product Development: Past Research, Present Findings, and Future Directions." *Academy of Management Review* 20(2): 343-378.

Campbell, D. T. and D. W. Fiske 1959. "Convergent and Discriminant Validation by the Multitrait-Multimethod Matrix." *Psychological Bulletin* 56: 81-105.

Cohen, M. A., J. Eliashberg, et al. 1996. "New Product Development: The Performance and Time-to-Market Tradeoff." *Management Science* 42(2): 173.

Cooper, R. G. and E. J. Kleinschmidt 1979. "The Dimensions of Industrial New Product Success and Failure." *Journal of Marketing* 43: 93-103.

Cooper, R. G. and E. J. Kleinschmidt 1987. "New Products: What Separates Winners from Losers?" *Journal of Product Innovation Management* 4: 169-184.

Cooper, R. G. and E. J. Kleinschmidt 1987. "Success Factors in Product Innovation." *Industrial Marketing Management* 16: 215-223.

De Brentani, U. 1989. "Success and Failure in New Industrial Services." *Journal of Product Innovation Management* 6: 239-258.

Diamantopoulos, A. and H. M. Winklhofer 2001. "Index Construction with Formative Inidators: An Alternative to Scale Development." *Journal of Marketing Research* 38(May): 269-277.

Edwards, J. R. and R. P. Bagozzi 2000. "On the Nature and Direction of Relationships between Constructs and Measures." *Psychological Methods* 5(2): 155-174.

Eisenhardt, K. M. and B. N. Tabrizi 1995. "Accelerating Adaptive Processes: Product Innovation in the Global Computer Industry." *Administrative Science Quarterly* 40: 84-110.

Ernst, H. 2001. *Erfolgsfaktoren Neuer Produkte: Grundlagen Für Eine Valide Empirische Forschung*. Wiesbaden, Gabler.

Ernst, H. 2002. "Success Factors of New Product Development: A Review of the Empirical Literature." *International journal of management reviews* 4(1): 1-40.

Ernst, H. and T. Lechler 2003. The Emergence of Executive Champions and Their Impact on Innovative Performance. Scientific Working Paper Series of Otto Beisheim Graduate School of Management. Vallendar**:** 33.

Griffin, A. 1997. "PDMA Research on New Product Development Practices: Updating Trends and Benchmarking Best Practices." *Journal of Product Innovation Management* 14: 429-458.

Griffin, A. and A. L. Page 1993. "An Interim Report on Measuring Product Development Success and Failure." *Journal of Product Innovation Management* 10: 291-308.

Griffin, A. and A. L. Page 1996. "PDMA Success Measurement Project: Recommended Measures for Product Development Success and Failure." *Journal of Product Innovation Management* 13(4): 478-496.

Hart, S. 1993. "Dimensions of Success in New Product Development: An Exploratory Investigation." *Journal of Marketing Management* 9: 23-41.

Henard, D. H. and D. M. Szymanski 2001. "Why Some New Products Are More Successful Than Others." *Journal of Marketing Research* 38(3): 362-375.

Hoch, D. J., C. R. Roeding, et al. 2000. *Secrets of Software Success: Management Insights from 100 Software Firms around the World*. Boston, Massachusetts, Harvard Business School Press.

Hoegl, M. and H. G. Gemuenden 2001. "Teamwork Quality and the Success of Innovative Projects: A Theoretical Concept and Empirical Evidence." *Organization Science* 12(4): 435-449.

Hultink, E. J. and H. S. J. Robben 1995. "Measuring New Product Success: The Difference That Time Perspective Makes." *Journal of Product Innovation Management* 12: 392-405.

Iansiti, M. and K. B. Clark 1994. "Integration and Dynamic Capability: Evidence from Product Development in Automobiles and Mainframe Computers." *Industrial and Corporate Change* 3(3): 557-605.

Jarvis, C. B., S. B. Mackenzie, et al. 2003. "A Critical Review of Construct Indicators and Measurement Model Misspecification in Marketing and Consumer Research." *Journal of Consumer Research* 30(2): 199-218.

Keller, R. T. 1986. "Predictors of the Performance of Project Groups in R&D Organizations." *Academy of Management Journal* 29(4): 715-726.

Ketokivi, M., A. and R. G. Schroeder 2004. "Perceptual Measures of Performance: Fact or Fiction?" *Journal of Operations Management* 22: 247-264.

Kim, C. and H. Lee 1997. "Development of Family Triadic Measures for Children's Pruchase Influence." *Journal of Marketing Research* 34: 307-321.

Klastorin, T. 2004. *Project Management: Tools and Trade-Offs*, John Wiley.

Langerak, F., E. J. Hultink, et al. 2004. "The Impact of Market Orientation, Product Advantage, and Launch Proficiency on New Product Performance and Organizational Performance." *Journal of Product Innovation Management* 21: 79-94.

Lock, D. 2003. *Project Management*. London, Gower.

Lovelace, K., D. L. Shapiro, et al. 2001. "Maximizing Cross-Functional New Product Teams' Innovativeness and Constraint Adherence: A Conflict Communications Perspective." *Academy of Management Journal* 44(4): 779-793.

Mackenzie, S. B., P. M. Podsakoff, et al. 2005. "The Problem of Measurement Model Misspecification in Behavioral and Organizational Research and Some Recommended Solutions." *Journal of Applied Psychology* 90(4): 710-730.

Maidique, M. A. and B. J. Zirger 1985. "The New Product Learning Cycle." *Research Policy* 14: 299-313.

Montoya-Weiss, M. M. and R. Calantone 1994. "Determinants of New Product Performance: A Review and Meta-Analysis." *Journal of Product Innovation Management* 11: 397-417.

Neter, J., W. Wasserman, et al. 1990. *Applied Linear Statistical Models: Regression, Anaslysis of Variance and Experimental Designs*. Homewood, Irwin.

Nunally, J. C. and I. H. Bernstein 1994. *Psychometric Theory*. New York, McGraw-Hill inc.

Pinto, J. K. 1998. *The Project Management Institute Project: Project Management Handbook*. San Francisco, Jossey-Bass Business&Management Series / Project Management Institute.

Podsakoff, P. M., S. B. Mackenzie, et al. 2003. "Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies." *Journal of Applied Psychology* 88(5): 879-903.

Rossiter, J. R. 2002. "The C-Oar-Se Procedure for Scale Development in Marketing." *International Journal of Research in Marketing* 19: 305-335.

Rothwell, R., C. Freeman, et al. 1974. "Sappho Updated." *Research Policy* 3: 258-291.

Steenkamp, J.-B. E. M. and H. Baumgartner 1998. "Assessing Measurement Invariance in Cross-National Consumer Research." *Journal of Consumer Research* 25(1): 78-90.

Tatikonda, M. V. and M. M. Montoya-Weiss 2001. "Integrating Operations and Marketing Perspectives of Product Innovation: The Influence of Organizational Process Factors and Capabilities on Development Performance." *Management Science* 47(1): 151-172.

Van Bruggen, G. H., G. L. Lilien, et al. 2002. "Informants in Organizational Marketing Research: Why Use Multiple Informatns and How to Aggregate Responses." *Journal of Marketing Research* 49(November): 469-478.

APPENDIX 3.A

Questionnaire questions related to success evaluation

To what extent do you agree with the following statements?

(1 = totally disagree, 7 = fully agree, 8 = not applicable)

- As a consequence of this project the reputation of our organization in the area related to this project is increased
- The new or improved product / service provides us a competitive advantage
- The new or improved product / service fulfils the needs of the clients
- The new or improved product / service is of excellent (technical) quality
- All project targets were met
- Knowledge and experienced gained by the project members is of large value for subsequent development projects
- The knowledge gained on this project is well secured in our organization
- The project-team can be very satisfied with the final results.

Achieved results of the development project?

–	De expenditures of the project were …?[R]	Very much lower than expected	1	2	3	4	5	Very much higher than expected
–	The project duration was...?[R]	Very much shorter						Very much longer
–	The gained profit is …?	Very much lower than expected						Very much higher than expected
–	The achieved revenue is…?	Very much lower than expected						Very much higher than expected
–	What was developed came … on the market?[D]	Far too early						Far too late

Note: The questions were in Dutch, R&D managers and project leaders were asked the same questions. The R&D managers had to answer the questions twice; for the successful and for the less successful project.

Note: [R] reversed coded, [D] item deleted.

Chapter 4

PROJECT-BASED FIRMS COMPARED WITH NON-PROJECT-BASED FIRMS

DOES INNOVATION MANAGEMENT IN PROJECT-BASED FIRMS HAVE TO BE DIFFERENT? A COMPARISON OF SUCCESS FACTORS

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Jan van den Ende

We gratefully acknowledge the useful comments and suggestions made at the EIASM International Product Development Management Conference, Copenhagen, 2005. We are also grateful to Donald Gerwin and Ale Smidts for their helpful comments.

Chapter 4

Project-Based Firms Compared With Non-Project-Based Firms

ABSTRACT

Project-based firms, with their project-based instead of functional organization, have specific characteristics. In this paper we address the effects of these specific characteristics on the management of innovation. We performed regression analyses on a sample of 135 development projects in project-based and non-project-based firms to investigate differences in success factors for innovation. Our results show that planning and multidisciplinary teams hamper development projects of project-based firms, while the weight of a project leader of a development project appears to be more important in project-based firms than in non-project-based firms. We relate these differences to the specific characteristics of project-based firms compared to other firms, such as their organizational structure and capabilities, and discuss the implications of our findings for the innovation management literature.

INTRODUCTION

Project-based firms form a large part of Western economies (Gann and Salter 2000; Knight Wendling Consulting 2000). Project-based firms are organized around projects (Gann and Salter 2000), produce complex systems by order of their clients (Hobday 2000), and usually operate in a business-to-business environment (Prencipe, Davies and Hobday 2003). Examples are Engineering and Construction Companies, Consultancies and System Integrators in the Information Technology (IT) industry. Recently, project-based firms are receiving more attention in the management literature, addressing issues such as the characteristics of project-based organizations (Greenwood, Li, Prakash and Deephouse 2005; Hobday 2000), the transformation of functional organizations to project-based organizations (Bernasco, De Weerd-Nederhof, Tillema and Boer 1999; Lindkvist 2004), and knowledge exchange within these organizations (Prencipe and Tell 2001; Robertson, Scarbrough and Swan 2003; Salter and Gann 2003; Werr and Stjernberg 2003).

In this paper we address another, yet crucial, process in project-based firms, the new product and new service development process. Some authors claim that the characteristics of project-based firms make these firms more flexible, and as such more innovative compared to other types of firms (Hobday 2000; Volberda 1998). Others have found that these firms have difficulty to innovate their product or service portfolio (Ayas 1997; Christensen and Baird 1997; Gann and Salter 2000; Nambisan 2001). In this paper we investigate how the specific characteristics of project-based firms influence their innovative activities. We analyze the influence of the characteristics of project-based firms on the success factors for development projects by comparing development projects of project-based firms with those of non-project-based firms.

This study contributes to the literature on innovation management in two ways. First, most innovation management literature has studied product development in manufacturing firms (Montoya-Weiss and Calantone 1994), which typically have a

functional type of organization. We contribute by investigating innovation in a different type of firms, project-based firms. Second, the innovation management literature has derived many lessons from studies in manufacturing firms (Cooper 2001; Wheelwright and Clark 1992), without emphasizing the influence of firm characteristics on these lessons. Eisenhardt and Martin (2000, p. 1108) even explicitly claim that there exist a best practice to execute development projects: "Just as there are better and worse ways to hit a golf ball or ski a mogul field, there are more and less effective ways to execute new product development projects". To date, other authors have studied how best practices in innovation management are affected by project characteristics (Song and Montoya-Weiss 2001), by industry effects (Pavitt 1984), by the characteristics of what is produced, a new product versus a new service, and by the available knowledge in the firm Ethiraj, Kale, Krishnan and Singh (2005). We add that the characteristics of a firm affect the strength and weaknesses of a firm's innovation activities. Firm characteristics are thereby a contingency for best practices in innovation management. For this purpose we compare success factors for the development of new services and products between project-based and non-project-based firms and address differences in firm characteristics such as the organizational structure of a firm, and the capabilities and routines used in a firm's operational process.

Project-based firms perform their activities in projects. We make a distinction between *business projects* and *development projects* of project-based firms. Business projects are the projects that are executed to customer order. An example of a project is the implementation of a CRM (Customer Relations Management) system for a bank by an IT firm. We define development projects as the projects that are aimed at the development and commercialization of new systems, products or services for a range of customers. In development projects project-based firms usually develop the basic features of the new system, product or service, to customize it later for specific clients. An example is an IT firm that develops a mobile service for banks, which enables the clients of the bank to make financial transactions by mobile phone. In the development project the IT firm will develop the basic technology, the financial procedures and the knowledge on for instance legal aspects, to be able to customize this technology and service for specific banks. Development projects are different from business projects, because the new system, product or service that is developed in a development project is applicable for a range of customers and is not a specific solution that suits the demands of one customer only. Development projects are therefore driven by the project-based firm itself, and not by an outside party.

Project-based firms do not only perform innovative activities in development projects, but also integrated in business projects (Gann and Salter 2000) .However, the outcome of these innovative activities appears not to have a prolonged effect, since mechanisms are lacking to harness and reproduce the developed knowledge in other projects (Gann and Salter 2000). Keegan and Turner (2002) found that business projects provided an unfavorable environment for innovative success, since the project management processes of business projects were too rigid for innovation.

For several reasons we focus on the management of development projects and not on innovative activities on business projects: the outcome of development projects are more effective for renewal of the service and product portfolio of project-based firms, than the innovations developed for a single customer on a business projects

(Christensen and Baird 1997), but still unexplored in the literature. The development projects are similar to the development projects described in the innovation management literature and can be compared with development projects in other firms. The embeddedness of innovation activities within business projects hinders their investigation.

In what follows we first develop hypotheses on the differences between success factors for development projects in project-based firms and in other firms. Subsequently we test our hypotheses based on data of development projects in firms in the IT, Engineering, Construction and related industries. The data set consists of both project-based and non-project-based firms. In the discussion section we reflect on our findings and discuss the influence of the characteristics of project-based firms on the success factors for innovation.

THEORY

Characteristics of project-based firms

We define project-based firms as firms that are organized around projects (Gann and Salter 2000), and that produce complex systems by order of their clients (Hobday 2000). These systems or services usually integrate different elements, which subsequently have to be aligned and adapted to the requirements of each customer, which is usually another firm (Prencipe, Davies and Hobday 2003). Most project-based firms manage their business projects rigorously and efficiently (Nambisan 2001), with contractually defined milestones and output targets (Turner 1999). The activities of project-based firms are knowledge intensive, and require a high degree of internal collaboration between different types of experts, and collaboration with the customer to define customer requirements and to adapt the design of the system or service to the requirements of the customer (Hobday, 2000). Since project-based firms always deliver to customer order, they have a strong service character. Some project-based firms, such as consultancy firms, deliver pure services (Greenwood et al. 2005); others deliver systems, accompanied by services.

Most project-based firms have a structure in which project leaders are more important than functional managers. Hobday (2000) distinguishes between project-based and project-led firms. In his definition, a project-based organization is an organization in which the functional organization has become completely obsolete, whereas in his project-led organization the needs of projects outweigh the functional influence on decision-making. Our definition of project-based firms encompasses both the project-based and project-led organization of Hobday (2000).

Project-based firms not only have a specific organizational structure, they also possess specific capabilities and apply certain routines to execute business projects. In general, project-based firms have strong project-management (Turner 1999) and collaborative capabilities (Hobday 2000; Whitley 2006). The project-management capabilities concern the execution of large, complex projects. Complexity stems from the many subsystems that need to be integrated and the many parties involved in each project. To keep the (changing) demands of all the parties under control, rigor and efficiency in project execution are essential, which reduces process flexibility (Nambisan 2001). Changes in goals and performance standards of business projects can

be incorporated, but authority to decide their nature and resolve disputes are allocated beforehand, as well as the procedures established to manage on-site contingencies (Whitley 2006). The collaborative capabilities concern both internal collaboration, between people with different disciplinary backgrounds (Whitley 2006), and external collaboration, with suppliers, customers and knowledge institutes (Gann and Salter 2000).

To exert these capabilities, project-based firms have developed specific routines. An example of a routine related to collaborative capabilities is: invoking different people inside and outside the organization in specific phases of a project. An example of a routine related to project-management capabilities is: providing project leaders with autonomy with respect to senior management (Hobday 2000).

Success factors for development projects

The focus of this paper is on the influence of firm characteristics, i.e. the specific structure, capabilities and routines, on the success factors for development projects. We define a *success factor* as a factor concerning the management of a development project which has a significant positive impact on the performance of a development project, within a specific group of firms. In our case the groups of firms are project-based firms and non-project-based firms (arrow 1 in figure 4.1). An example is the use of multidisciplinary teams, which is generally considered a success factor for innovation, since it relieves the problem of poor communication between functions and disciplines (Brown and Eisenhardt 1995; Ernst 2002; Van de Panne 2003).

We expect that the characteristics of project-based firms affect success factors for development projects in essentially two ways. First, the characteristics of project-based firms can affect the use of a specific factor (arrow 2 in figure 4.1). For instance, we expect that the experience of project-based firms in using multidisciplinary teams on business projects (Hobday 2000; Turner 1999), leads to a frequent use of such teams for development projects in these firms. Further improvement on such a factor, in this case strengthening the use of multidisciplinary teams in development projects, will contribute to a minor extent to the performance of development projects in project-based firms, as we expect a decrease in the marginal effect. We therefore hypothesize that if project-based firms are expected to frequently or rarely use a factor, i.e. in general score higher or lower on a factor (arrow 2 in figure 4.1) than non-project-based firms, this factor will respectively be less or more important for development projects of project-based firms than in non-project-based firms.

Second, in general success factors aim to take away specific hindrances for innovation. For instance, multidisciplinary teams may diminish communication problems between people of different departments with different ‘thought worlds’ (Dougherty 1992). The characteristics of project-based firms may increase or diminish the hindrances for innovation that a factor aims to overcome (arrow 3 in figure 4.1). The problem that multidisciplinary teams aim to solve will for instance be less urgent in project-based firms, because of the reduced importance or even absence of functional departments (Hobday 2000). This would be another reason why a factor is expected to be either more or less important in project-based firms than in non-project-based firms.

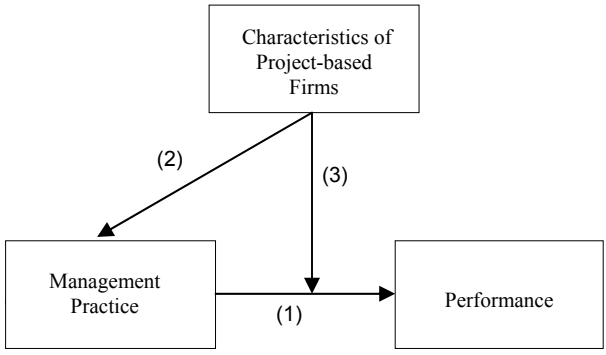

Figure 4.1 The influence of the characteristics of project-based firms on management practices for development projects

The difference between the use of and the need for a factor in a development project is an essential difference. In case the use of a factor is high in project-based firms, that factor will not be an important success factor as it only marginally contributes to performance within this group of firms. However this implies for practitioners that they still have to comply with the factor, as the absence of the factor still has a negative effect on performance. Only in case a factor is not a success factor because there is no need to comply, then a factor can be neglected.

In this paper we focus on success factors relating to the organization and management of development projects. We therefore selected process factors only. Factors, such as uniqueness of the product's features, market characteristics, and price are thus excluded. We selected five process related factors which are commonly mentioned in the literature; they are extracted from several meta-studies on new product and new service development (Brown and Eisenhardt 1995; Ernst 2002; Henard and Szymanski 2001; Montoya-Weiss and Calantone 1994; Van de Panne 2003), see Table 4.1. We selected these factors, because we expected differences in the use of, and need for these five factors in development projects of project-based versus non-project-based firms, based on the differences in characteristics of these firms. An explanation of each factor is given below, where we formulate hypotheses for each factor regarding the difference in contribution to the performance of development projects between project-based firms and non-project-based firms.

Table 4.1 Selected factors from five meta-reviews

Success factors mentioned in the literature		Sources
Planning	-	1,2,4,5
Senior management support	-	1,2,3,4,5
Multidisciplinary teams	-	1,2,4
Expertise	-	1,4
Heavyweight project leaders	-	1,2

Sources: 1 = (Brown and Eisenhardt 1997), 2 = (Ernst 2002), 3 =(Montoya-Weiss and Calantone 1994), 4 = (Van de Panne 2003), 5 = (Henard and Szymanski 2001)

Planning

Many authors stress the importance of planning and effective execution of development projects (amongst others Cooper 2001; Wheelwright and Clark 1992). Overlapping phases and iterations are considered beneficial for performance, particularly for more radical development projects (De Meyer, Loch and Pich 2002; Eisenhardt and Tabrizi 1995; Wheelwright and Clark 1992). Project planning, as essential part of project management, forms one of the strong capabilities of project-based firms. We therefore expect that development projects will always be accompanied by a thorough project plan in project-based firms. We therefore hypothesize that:

> *Hypothesis 1a*
> *Project-based firms use planning on development projects to a higher extent than non-project-based firms.*

As a consequence, we expect that further increase in planning activities contributes only marginally to the performance of development projects within the group of project-based firms, compared to non-project-based firms. Moreover, Nambisan (2001) found that development projects in project-based firms in the IT industry suffered from the application of a similar rigor and strive for efficiency as in business projects, whereas more flexibility was needed to cope with uncertainty and late changes. Keegan and Turner (2002) found a similar result for the effects of planning for innovative activities performed on business projects in project-based firms. Less planning is likely to reduce the rigor and efficiency of a plan and creates more room for flexibility in project-base firms. We therefore expect that besides the higher usage, there is at the same time a reduced need for planning on development projects within project-based firms, compared to non-project-based firms.

> *Hypothesis 1b. Planning increases the performance of development projects in project-based firms to a lower degree compared to non-project-based firms.*

Senior management support

Support from senior management is an important success factor for development projects (Brown and Eisenhardt 1995; De Brentani and Ragot 1996; Wheelwright and Clark 1992). We can distinguish between tangible and intangible support.

Tangible support concerns the provision of financial and human resources.Generally it is assumed that upon approval of development projects sufficient resources are assigned for their execution. However, in project-based firms, the employees are part-time involved in both business projects and development projects, while in most functional firms assigned employees will be dedicated to the development projects only (Sundbo and Gallouj 2000). Moreover, in many project-based firms the occupation rate of employees on business projects is one of the most important parameters affecting the financial performance of the firm as a whole (Hoch, Roeding, Purkert and Lindner 2000), and thus forms an important performance indicator of employees and units. As a result, development projects are often considered a burden in these firms, as they decrease the occupation rate. Furthermore, the

perceived urgency of business project is often higher than that of development projects. To ensure that development projects obtain and maintain sufficient resources, we expect that tangible senior management support is more important in project-based firms compared to non-project-based firms.

Intangible support involves senior management providing a vision of the targeted outcome of the project, which prevents development projects from wandering off (Wheelwright and Clark 1992). Several authors indicate that management should not disturb the project while implementing this vision, but should apply so-called 'subtle control' (Gersick 1994). Business projects in project-based firms usually operate rather autonomously with respect to management (Hobday 2000), since typically the customer provides the vision and requirements (Turner 1999). We expect that developments projects will operate also rather autonomously, and that they therefore lack guidance and a vision from senior management. We hypothesize, due to the expected lower level of support in combination with the higher need for support, that senior management support is more important for the performance of development projects within project-based firms than within non-project-based firms:

Hypothesis 2a
Development projects of project-based firms receive less senior management support than development projects in non-project-based firms.

Hypothesis 2b
Senior management support increases the performance of development projects in project-based firms to a higher degree compared to non-project-based firms.

<u>*Multidisciplinary teams*</u>

Many authors emphasize the importance of multifunctional or multidisciplinary teams and effective collaboration between functions as a success factor for innovation projects (Brown and Eisenhardt 1995; Cooper 2001; De Brentani and Ragot 1996; Griffin 1997; Lovelace, Shapiro and R. 2001). Although many authors speak of 'multifunctional teams', we label this factor as 'multidisciplinary team' since many project-based firms have no functional departments. Multidisciplinary teams can overcome interpretive barriers that may exist between the various functional departments (Dougherty 1992). We expect that project-based firms are used to apply multidisciplinary teams, and that they will also use these to a higher extent within the development process than non-project-based firms:

Hypothesis 3a
Project-based firms use multidisciplinary teams on development projects to a higher degree than non-project-based firms.

As a consequence, we expect that further increase in the use of multidisciplinary teams contributes only marginally to the performance of development projects within the group of project-based firms, compared to non-project-based firms. Moreover, employees of project-based firms are used to collaborate across disciplines and

functional departments (Hobday 2000). As a result members of development project teams are familiar with the requirements and needs of other disciplines. Consequently there will be a lower need to use multidisciplinary teams. As a result of the higher usage and the reduced need, we hypothesize that in project-based firms multidisciplinary collaboration is a less important success factor than in non-project-based firms:

> *Hypothesis 3b*
> *In project-based firms multidisciplinary teams increase the performance of development projects in project-based firms to a lower degree compared to non-project-based firms.*

Expertise

The availability of relevant expertise contributes to the performance of development projects (Brown and Eisenhardt 1995; Cooper 2001; De Brentani and Ragot 1996; Griffin 1997). Pinto and Covin (1989) showed that expertise is important in selecting members of product or service development teams in functionally organized firms, while project-based construction firms use availably as selection criterion for team members of business projects. We expect that team members of development projects in project-based firms will also be assigned on the basis of availability, instead of expertise. Furthermore, within project-based firms, experts are shared with business projects and are therefore often only partly available for development work. The occupation rate of employees on business projects in general, but of these experts in particular, is an important business parameter in many project-based firms (Hoch et al. 2000). Thus, we assume that the pressing demands of business projects and the occupation rate measured by participation on business only, limits the availability of expertise for development projects within project-based firms (Blindenbach-Driessen and Van den Ende forthcoming). We hypothesize that in development projects of project-based firms appropriate experts are available to a lower extent than in non-project-based firms, and that consequently expertise is a more important success factor for these development projects:

> *Hypothesis 4a*
> *The availability of appropriate experts is lower in development projects of project-based firms than in non-project-based firms.*
>
> *Hypothesis 4b. The availability of appropriate experts increases the performance of development projects in project-based firms to a higher degree compared to non-project-based firms.*

Heavyweight project leaders

A heavyweight project leader contributes to the performance of a development project (Brown and Eisenhardt 1995; Rothwell, Freeman, Horlsey, Jervis, Robertson and Townsend 1974; Wheelwright and Clark 1992). Wheelwright and Clark (1992, p 195) define as tasks of a heavyweight project leader: interpreting the market, understanding

the multi-languages of different departments, dealing with engineering issues, communicating effectively inside the team as well as outside while guarding the concept, and resolving conflicts. They consider a lightweight project leader to be ineffective for more radical projects of functional organized firms, because he or she is rather a messenger than a manager.

In project-based firms, a project leader's role is less demanding since the divisions between functions are more fluid: 'Because there are few internal lines of command and communication to interfere with project objectives, the internal coordination tasks become thus simpler and clearer' (Hobday 2000, p. 890). The organizational structure of project-based firms thus facilitates the tasks of a project leader, and we expect that it also facilitates the tasks of the leader of a development project. We therefore hypothesize that heavyweight project leaders are less important for the performance of development projects in project-based firms compared to non-project-based firms:

> *Hypothesis 5*
> *Heavyweight project leaders increase the performance of development projects in project-based firms to a lower degree compared to non-project-based firms.*

We expect that heavyweight project leaders are equally used in project-based and non-project-based firms.

METHODOLOGY

Sample and Data Collection

We tested the hypotheses in firms of the Dutch IT (Bik code 72), Engineering (Bik code 74), Construction (Bik code 45) and related industries. We chose these industries because we expected a sufficient number of both project-based firms and non-project-based firms in these industries. We limit the sample to firms larger than 50 employees, because smaller manufacturing firms will have too much resemblance to project-based firms. Approximately 1200 firms in the IT, Engineering and Construction industries were randomly selected from the Reach database and invited by telephone to participate in our internet-based questionnaire. To increase the response rate, several sector organizations were asked to inform their members about our research. As a consequence, our population contains a fourth group of firms from related industries.

We developed two questionnaires, one for R&D managers and one for project leaders. Each R&D manager was asked to name two development projects in his firm, a successful and a less successful project. Furthermore the R&D managers answered questions related to the characteristics of the organization as a whole, the performance of the two development projects, and the weights of the respective project leaders of these projects. We asked each project leader questions related to the execution of their development project.

From the 1200 firms approached by telephone, 720 managers, responsible for development projects, agreed to participate. 203 (22 %) Of these managers actually did respond to this part of the questionnaire. These R&D managers named 257

development projects and provided the e-mail addresses of 213 project leaders. 148 of these project leaders responded (69%). We deleted four projects, because the project's names provided by the project leaders did not match the names mentioned by the R&D managers.

In the invitation part of the survey, we made clear to the respondents that we were interested in development projects only, not in innovative activities performed within business projects. To verify that each project was a development project and not an innovative activity within a business project, the project leader's questionnaire contained questions asking for the level of involvement of customers. Eight development projects were removed from the analysis, because customers were involved to a large extent and financed the project. One project was removed because it was identified in all regression analyses as an outlier, with a Cook's D >1. As a result we used a data set of 135 projects. 33% Of the projects were from IT firms, 23% of engineering firms, 23% were from construction firms, 20% from the fourth group of firms from related industries.

Survey pre-test

The items for our survey were as much as possible chosen identical to items from surveys reported in the literature. The questionnaire was in Dutch. We pre-tested the project leader questionnaire in a face-to-face interview with an experienced manager of a project-based firm. Next we held feedback sessions on the adapted questionnaires with 16 respondents, of whom 8 filled out the questionnaire for R&D managers and 8 filled out the project leader's questionnaire. We adapted a substantial number of items, since they could not be answered by, or were unclear to, the respondents of either project-based or non-project-based firms. The consistency of the resulting questionnaire was tested in face-to-face interviews with three academics.

Measures

We verified the uni-dimensionality of each construct with exploratory factor analyses (principal component, varimax rotation). The extracted coefficients, as well as the survey questions used in each construct are listed in appendix 4.A. Cronbach's alpha was used to verify the reliability of each reflective construct. We used summed scales for the reflectively indicated constructs. For the formatively-indicated project-based firm construct we used a different procedure (Mackenzie, Podsakoff and Jarvis 2005).

Dependent variable

Performance of development projects: To assess the performance of each development project, we used the items of Griffin and Page (1996). Market share was omitted as an item during the pre-test, as it appeared to be a difficult measure for project-based firms to answer (see also Hoch et al. 2000, p. 46). The perceived increase in reputation in the area of the new product or new service is added, since it is an important aspect of performance in service firms (De Brentani 1989), and thus we expect that it also applies to project-based firms. The Cronbach's alpha of the performance construct was α = 0.86. We used the R&D managers perception of performance to avoid common method bias (Podsakoff, Mackenzie, Lee and Podsakoff 2003).

Firm level variables

Project-based firms: We considered the project-based firm construct to be formatively indicated, since a project-based firms is defined by its characteristics (Edwards and Bagozzi 2000; Jarvis, Mackenzie and Podsakoff 2003) The definition of a project-based firm encompassed six characteristics: 1) having a project-based organization; 2) experienced in the execution of projects; 3) having a project-based production process; 4) delivering customized products and/or services; 5) delivering complex products or services consisting of multiple components; and 6) involving various parties in the production process. We used a structural equation model to validate this construct (Jarvis et al. 2003; Mackenzie et al. 2005). We used Items 1 and 2 as global indicators to identify the model (Diamantopoulos and Winklhofer 2001; Jarvis et al. 2003). The project-based organization construct had a good fit ($\chi^2 = 2.2$, df = 2, p = 0.34, GFI = 0.995, RMR = 0.04). The construct divided the sample in two clearly dichotomous parts with a very low number of firms scoring around the partition. Consequently, we made the project-based firms construct a dichotonomous variable, by splitting the sample into development projects of project-based and non-project-based firms. Non-project-based firms scored between 1.47 and 3.64, with a mean of 2.98 and sd = 0.50. Project-based firms scored between 3.88 and 5.87, with a mean of 4.47 and sd = 0.40. The difference between the means is significant ($p < 0.001$).

Control variables: At the firm level, we included control variables to account for differences in firm size, industries, strategy, and for product versus service firms. Although our sample consists of firms > 50 employees only, we included firm size (small: <100 employees, medium: between 100 and 1000 employees; large >1000 employees) as control variable, since development projects in large corporations may face other challenges than development projects in small firms (Dougherty 1992). As the management of development projects may be different within the more fast moving IT industry versus the more stable Construction industry (Eisenhardt and Martin 2000), we also controlled for industry effects. We used the first two digits of the first listed Bik industry code of the Reach data base, and included three dummy variables to account for the four different industry groups. We also included strategy as control variable, to account for differences in innovativeness between the firms.

Since many project-based firms are service firms, our findings could be due the service instead of the project-based characteristics of these firms. We therefore include a control variable to account for service versus product firms.

Development project variables

Planning: Planning covered items related to the clarity of the project plan on what should be developed, when and by whom. In addition, items were included relating to the information used to take the decision to approve the development project (α = 0.84).

Senior management involvement: Senior management involvement was taken from De Brentani and Ragot (1996). It covered the culture for innovation, the tangible and intangible support for the development project provided by senior management (α = 0.74).

Table 4.2 Descriptive statistics

Variable	N	μ	Std Dev	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Service firm	135	3.28	1.12	1.00	5.00	-													
2. Construction firm	135	0.33	0.47	0.00	1.00	-0.23**	-												
3. IT firm	135	0.24	0.43	0.00	1.00	-0.02	-0.39***	-											
4. Engineering firm	135	0.20	0.40	0.00	1.00	0.45***	-0.35***	-0.28**	-										
5. Firm size	134	1.84	0.62	1.00	3.00	-0.12	0.06	-0.03	0.10	-									
6. Firm strategy	135	25.57	4.41	14.00	35.00	-0.03	-0.14	-0.07	0.06	0.00	*0.70*								
7. Project-based firm	135	0.61	0.49	0.00	1.00	0.07	0.47***	-0.34***	-0.02	-0.06	-0.09	-							
8. New	133	25.46	5.36	5.00	35.00	0.01	-0.04	-0.11	-0.01	-0.05	0.16	-0.05	*0.80*						
9. Planning	134	24.88	6.48	6.67	35.00	-0.20*	0.00	-0.10	-0.04	-0.02	0.28**	0.03	0.17	*0.84*					
10. Multi-disciplinary team	127	13.14	4.51	3.00	21.00	-0.14	0.00	-0.03	-0.05	0.04	0.05	-0.07	0.16	0.45***	*0.74*				
11. Expertise	130	10.71	2.79	2.00	14.00	-0.17	0.16	-0.12	-0.14	-0.05	0.22*	0.05	0.05	0.30***	0.20*	*0.94*			
12. Senior management support	131	25.47	5.61	5.00	35.00	-0.04	0.25**	-0.21*	-0.16	-0.18*	0.21*	0.19*	0.29***	0.39***	0.43***	0.29***	*0.74*		
13. Heavyweight project leader	132	21.35	3.67	12.00	28.00	0.12	0.16	-0.24**	0.00	-0.16	0.15	0.15	0.16	0.25**	0.07	0.02	0.24**	*0.71*	
14. Performance	130	21.34	5.32	7.00	35.00	0.06	-0.01	-0.10	-0.07	-0.02	0.26**	0.01	0.22*	0.31***	0.23*	0.30***	0.41***	0.20*	*0.86*

Note: Significant correlations ($p < 0.05$) are indicated with bold, Chronbach's Alpha is in cursive on the diagonal

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

Multidisciplinary teams: The use of a multidisciplinary team took into account the participation of different disciplines, functional departments and the involvement of marketing ($\alpha = 0.74$).

Expertise: The availability of expertise was related to the available expertise and experience within the development project team ($\alpha = 0.94$).

Heavyweight project leaders: The weight of each project leader contained items related to the authority, project management experience, knowledge of the target market and the technical capabilities of the project leader (Balbontin et al. 1999; Souder et al. 1997). The R&D managers were asked to answer the questions related to this construct ($\alpha = 0.71$).

Control variables: At the project level we included newness of the product or service ($\alpha = 0.80$) as control variable, since the management of radically new development projects may differ from that of incremental new products (De Brentani 2001; Song and Montoya-Weiss 2001).

RESULTS

Data descriptions of each variable and the correlations between the variables can be found in Table 4.2. We investigated non-response bias for the group of project-based firms. For this purpose we compared the subgroup of 43 project-based firms that did answer the R&D manager's questionnaire, but did not provide development projects, and the 82 project-based firms that provided development projects. These two subgroups did not differ with respect to firm size, number of service firms, industry differences or collaborative capabilities. The only difference was in firm strategy; the firms that provided development projects had a more progressive strategy than those that did not (mean of 21.3 versus 24.5 on a scale of 12-35, $p < 0.05$).

We used a Multivariate Analysis of Variance (MANOVA) to determine the difference in usage of the factors on the development projects of project-based firms compared to those of non-project-based firms. The MANOVA results for the development projects of project-based and non-project-based firms are shown in Table 4.3 (Wilks's labda = 0.71, multivariate $F = 3.20$, $p < 0.001$). Only two variables differ between the groups. Development projects of project-based firms are overrepresented in the Construction industry (0.51 versus 0.06, $p < 0.001$), and underrepresented in the IT industry (0.12 versus 0.42, $p < 0.01$). The differences for any of the other variables are insignificant. This implies that there is no support for the hypotheses stating that there is a difference in usage of success factors between project-based and non-project-based firms. The implications for each factor are discussed below.

We use regressions to determine whether a factor is a success factor. The difference in importance of the success factors between project-based and non-project-based firms is measured using project-based firms as interaction term. The results are shown in Table 4.4. 125 Of the 135 development projects remained after pair-wise deletion, including 82 development projects of project-based firms and 53 development projects of non-project-based firms. We excluded the control variables firm size and engineering firms from the regression equations, since these control variables did not have an influence on the model, nor did they have different values for project-based or non-project-based firms (table 4.3). Model 1 shows the effects of each of the factors on

performance. Only senior management support ($p < 0.01$) and expertise ($p < 0.05$) contributed significantly to performance. In model 2, we used the interactions of project-based firms with each factor to test for the difference in success factors between project-based and non-project-based firms. The interaction effects clearly improve the model, R^2adjusted changes from 0.20 to 0.33 (F-test for difference = 4.52, $p < 0.001$).

Planning

The MANOVA analyses (table 4.3) shows that hypothesis 1a, that project-based firms use planning on development projects to a higher extent than non-project-based firms, is not supported. Planning is used equally in the development projects in both types of firms (mean = 24.66 and 25.03, p = n.s on a scale from 6.67 – 35.00). The results imply that both types of firms score high on planning. The skewness (-0.72) and kurtosis (0.20) of the distribution for planning are within acceptable limits (Bollen 1989).

According to hypothesis 1b, planning contributes less to the performance of development projects in project-based firms than in non-project-based firms. Model 2 in Table 4.4 shows an insignificant direct contribution of planning to performance, and a significant negative interaction effect of project-based firms on planning as success factor (-0.34(*-0.20*), $p < 0.05$). This provides support for hypothesis 1b. However, planning does not only contribute less, but even negatively to the performance of development projects in project-based firms, (see figure 4.2a).

Senior management support

According to Hypothesis 2a, senior management support is lower in project-based firms than in non-project-based firms. The MANOVA results (table 4.3) show that within both types of firms development projects receive a similar level of senior management support (mean of 26.32 for project-based firms versus 24.17 for non-project-based firms, p = n.s.). We therefore have no support for hypothesis 2a.

According to hypothesis 2b, senior management support contributes more to the performance of development projects in project-based firms than in non-project-based firms. Table 4.4 shows that senior management support contributes to the performance of development projects in both types of firms (a significant direct effect of 0.26 (*0.28*) in model 1 and 0.26 (*0.27*) in model 2). The interaction effect is insignificant -0.04 (-0.02). We conclude that senior management support contributes equally to development projects of both types of firms. Hypothesis 2b is thus not supported.

Multidisciplinary teams

Hypothesis 3a states that project-based firms use multidisciplinary teams on development projects to a higher degree than non-project-based firms. The MANOVA analysis in Table 4.3 shows that multidisciplinary teams are equally applied in project-based firms and non-project-based firms. We have thus no support for hypothesis 3a.

Hypothesis 3b states that a multidisciplinary team contributes less to the performance of a development project in project-based firms than in non-project-based firms. Model 2 in Table 4.4 does not show a significant direct effect of multidisciplinary teams on performance, but it shows a significant negative interaction

effect between project-based firms and multidisciplinary teams on performance (-0.50 (-0.20), $p < 0.05$). We conclude therefore that hypothesis 3b is supported. However a multidisciplinary team does not only contribute less, but even negatively to the performance of development projects in project-based firms, see figure 4.2b.

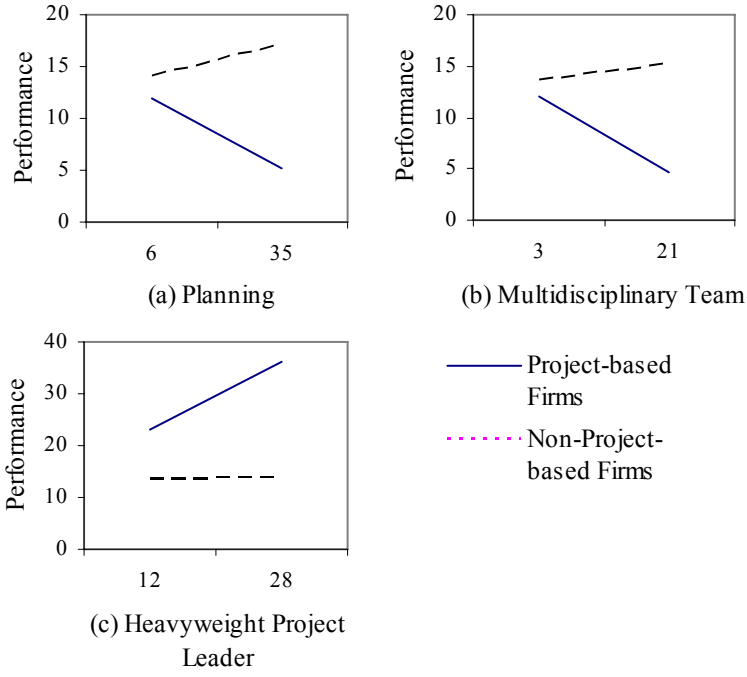

Figure 4.2 The effects of planning, multidisciplinary teams and heavyweight project leaders on performance within project-based firms and non-project-based firms

Expertise

According to Hypothesis 4a, the availability of appropriate experts is lower in development projects of project-based firms than in non-project-based firms. Table 4.3 shows no significant difference between the means of the two sub-samples (10.82 and 10.53, p = n.s.). It means that we do not have support for Hypothesis 4a. The values for the mean, (on a range from 2.00 – 14.00, Table 4.2), imply that both types of firms score rather high on expertise. The skewness (-0.95) and kurtosis (0.68) of expertise are within acceptable limits (Bollen 1989).

According to Hypothesis 4b, expertise contributes more to the performance of development projects in project-based firms than in non-project-based firms. Table 4.4 shows that expertise is a success factor in general (a significant effect of 0.35 (0.18) in model 1, and 0.36 (0.19) for the direct effect in model 2). The interaction effect is not significant. Expertise has thereby an equal effect on performance in project-based firms and non-project-based firms. Hypothesis 4b is thus not supported.

Table 4.3 Differences between project-based and non-project-based firms

Variable	Project-based Firms	Non-project-based firms	F(1,116)
Service firm	3.34	3.19	0.28
Construction firm	051	0.06	33.42***
IT firm	0.12	0.42	8.13**
Engineering firm	0.20	0.21	0.08
Firm size	1.80	1.88	0.17
Firm strategy	25.24	26.07	1.12
Newness	25.25	25.77	0.13
Planning	25.03	24.66	0.30
Senior management support	26.32	24.17	2.80
Multidisciplinary team	12.88	13.52	0.27
Expertise	10.82	10.53	0.82
Heavyweight project leader	21.78	20.69	0.94
Performance	21.39	21.25	0.03

Means are based on 82 development projects of project-based firms and 53 development projects of non-project-based.
** $p < 0.01$
*** $p < 0.001$

Heavyweight project leaders

According to Hypothesis 5, a project leader's weight is less important for development projects in project-based firms than in non-project-based firms. Model 1 in Table 4.4 does not show a significant effect for the weight of project-leader on performance. Model 2 neither shows a significant direct effect, while there is a positive interaction effect (0.80 (*0.26*), $p < 0.05$). The weight of project leaders contributes thus more instead of less to the performance of development projects within project-based firms compared to non-project-based firms. Hypothesis 5 is thereby not supported.

DISCUSSION AND CONCLUSION

The aim of this paper was to demonstrate that differences exist in success factors between development projects of project-based firms and non-project-based firms. We selected five success factors from the innovation management literature and generated hypotheses related to the use of, and the need for each factor within project-based firms. We compared a group of development projects of project-based firms in different industries with a control group of development projects of non-project-based firms in the same industries.

For none of the five factors, we found differences in scores between development projects of project-based and non-project-based firms. We thought that within project-based firms, capabilities and routines from the business projects would

also be applied to development projects. That was the reason to expect differences. Apparently, project-based firms do not simply imitate routines from their business projects in development projects. It is likely that there are many other reasons to adhere to a factor, besides operational routines. Another reason could be that project-based and non-project-based firms score both high on the same factors.

Table 4.4 Regression results[a]

	Performance of the development project					
	Model 1			Model 2		
Variable	**B**	**(s.e.)**	**β**	**B**	**(s.e.)**	**β**
Intercept	15.14***	(3.92)		13.31***	(3.74)	0.00
Service firm	0.46	(0.42)	0.10	0.52	(0.40)	0.11
Construction firm	-0.90	(1.18)	-0.08	-0.94	(1.12)	-0.08
IT firm	-0.19	(1.14)	-0.02	-0.50	(1.10)	-0.04
Firm strategy	0.12	(0.11)	0.10	0.17	(0.10)	0.14
Project-based firm[b]	-0.24	(1.03)	-0.02	0.10	(0.97)	0.01
Newness	0.08	(0.08)	0.08	0.09	(0.08)	0.09
Planning[b]	0.08	(0.08)	0.10	0.11	(0.08)	0.13
Senior management support[b]	0.26**	(0.10)	0.28	0.26**	(0.09)	0.27
Multidisciplinary team[b]	0.02	(0.11)	0.02	0.09	(0.11)	0.07
Expertise[b]	0.35*	(0.17)	0.18	0.36*	(0.16)	0.19
Heavyweight project leader[b]	0.11	(0.13)	0.08	0.02	(0.12)	0.01
PBF x planning				-0.34*	(0.15)	-0.20
PBF x Senior management support				-0.04	(0.19)	-0.02
PBF x Multidisciplinary team				-0.50*	(0.24)	-0.20
PBF x Expertise				0.33	(0.32)	0.08
PBF x Heavyweight project leader				0.80***	(0.25)	0.26
N		125			125	
$F_{\text{for regression}}$		3.87***			4.51***	
R^2		0.27			0.40	
R^2_{adjusted}		0.20			0.31	
$F_{\text{for difference}}$					4.52***	

[a] Unstandardized coefficients are reported, with standard errors in prarentheses, as well as standardized coefficients

[b] mean centered

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

At the same time, we found differences in the effectiveness of three factors. In line with our hypotheses, the use of planning appeared to be less important in project-based firms, it even has a negative effect on performance of development projects in project-based firms. We expected that planning would be less important in project-based firms, due to the high degree of application of planning and the lower need to plan. We assumed that a less detailed plan would make it easier to adapt changes within development projects of project-based firms. Our findings imply that project-management capabilities used on business projects do not lead to a routine in the application of planning in development projects, hence to a more frequent use of planning. At the same time, it seems that the capabilities in rigorous and efficient project planning are being copied from business projects to development projects. This would explain why planning contributes negative to the performance development projects, as rigorous and efficient project planning is unsuitable for development projects (Lewis, Welsh, Dehler, Green 2002).

This explanation is also in accordance with the findings of Nambisan (2001), who found that system integrators inappropriately applied their rigorous and efficient project planning methods also to new product development. Apparantly project-based firms in general apply a too rigid type of planning on their development projects. Such planning method fit the requirements of business projects, but do not meet with the flexibility that is required in development projects (MacCormack, Verganti and Iansiti 2001).

For multidisciplinary teams we expected that there would also be a higher use and a lower need within project-based firms. As with planning, we found equal usage, while multidisciplinary teams contribute negatively to the performance of development projects within project-based firms. The reason that we expected a lower contribution of multidisciplinary teams to development projects was that project-based firms have strong collaborative capabilities. We verified this assumption, using a construct for collaborative capabilities that we adapted from Pinto and Pinto (1990) (see appendix 4.A). Project-based firms have stronger collaborative capabilities, but this difference is only significant at the 10% level. We think that both the collaborative capabilities and the organizational structure of project-based firms facilitate collaboration between employees (Hobday 2000), and consequently make multidisciplinary teams redundant. Collaborative capabilities and the organizational structure are however unlikely to result in a negative effect. A possible explanation for the negative effect could be that development projects of project-based firm need specialization within in their development projects instead of collaboration between disciplines and functions. In functional firms, where each functional department has its own specialization, integration of specializations is of great importance for development projects. However, specialization is problematic in project-based firms (Galbraith 1971). It is thus likely that therefore specialization instead of collaboration is of great importance for development projects. As a consequence, teams focused around one discipline would contribute to performance, while multidisciplinary teams would contribute negatively to the performance of development projects.

Contrary to our expectations, the weight of project-managers appeared to be more important in project-based firms than in non-project-based firms and not less

important. We think that heavyweight project leaders have a different task in project-based firms compared to non-project-based firms. In non-project-based firms heavyweight project leaders are especially needed to coordinate, translate and integrate the demands from the different functional departments (Wheelwright and Clark 1992). Such coordination and translation are not required in project-based firms, as we think that these tasks are facilitated by the organizational structure and the collaborative capabilities. In project-based firms we expect that a project leader is instead needed to translate the new services and products developed by the specialized teams, for use throughout the firm, and to ensure that the new services and products are implemented within future business projects. Project leaders would thus have an important role in facilitating the knowledge transfer from the development project to the outside. This matches the ideas of the ambassadorial and technical scouting roles of project-leaders as described by Ancona and Caldwell (1992).

We did not find confirmation of our expectations that senior management support and expertise would be more important for development projects in project-based firms compared to non-project-based firms. Both factors appeared to be a success factor in both types of firms. With respect to senior management support, we had expected that more senior management support was needed to secure resources and to keep development projects from wandering off, as a result of too much autonomy of project leaders. We verified whether the project leaders had more autonomy within project-based firms. The autonomy of project leaders is equal within both types of firms. Senior management support is thus not needed within project-based firms to compensate for the autonomy project leaders have in business projects (Hobday 2000). Securing resources for development projects by senior management is apparently equally important in project-based firms and non-project-based firms.

Our expectation with respect to the higher importance of expertise was based on the expected lower availability of experts for development projects of project-based firms, because these experts are shared with business projects. Our results show that experts are equally used on development projects of project-based and non-project based firms, and that the availability of experts on development projects is an equally important success factors within both types of firms.

This study has several theoretical and methodological implications. First, our study shows that the management of development projects is different in project-based firms. Planning and multidisciplinary teams appear to have a negative effect on performance in project-based firms. At the same time there is a greater need, instead of the hypothesized reduced need, for heavyweight project leaders. We expect that in project-based firms the experts within one discipline, who work each at separate business projects, need to work together in development projects, since collaboration between disciplines is abound. While in manufacturing firms, where specialization abounds, the experts of the various disciplines need to collaborate in multidisciplinary development teams. In project-based firms the project leader is subsequently needed to translate the specialized new services and products, and to ensure that these are implemented within business projects. This is clearly a different task than for heavyweight project leaders in manufacturing firms, who have to ensure and enable communication between the various disciplines. The negative impact of planning is likely to be due to the capabilities of project-based firms in very efficient project

planning, as explained above, this hampers the quality of the new services and products. The characteristics of project-based firms thereby appear to affect the management of development projects.

Second, It contributes to the literature on project-based firms. As stated in the introduction, some authors claim that the organizational structure of project-based firms make these firms very flexible, and thus more appropriate for innovation, while others have found that project-based-firms have difficulty in renewing themselves. Our results show that, when we discuss innovation in project-based firms, we have to make a clear distinction between the innovations that project-based firms provide to their clients and those that are aimed at the improvement of their own products and services. The fact that project-based firms provide innovative solutions to their customers does not mean that they are innovative themselves. These innovative solutions are often minor for the project-based firms themselves. Our study shows that development projects enable project-based firms to follow innovative strategies. We therefore conclude that project-based firms cannot be considered innovative just because they create innovations for their clients. Our findings suggest that project-based firms are not necessarily better positioned for innovation of their own products and services, compared to other firms, but that the development projects in project-based firms face different challenges.

Third, our findings show that there does not exist a best practice for innovation management that suits all types of firms, as the current innovation literature seems to suggest (Cooper 2001; Eisenhardt and Martin 2000). Each firm has to take its structure, capabilities and routines into account in the management of its development process, as firm characteristics create specific organizational and managerial needs that have to be addressed in the management of the innovation process. More research on the influence of the characteristics of firms on their innovation process would certainly benefit the field of innovation management.

Fourth, since many project-based firms have the character of a service firm, this study is also relevant for the literature on new service development. Authors on new service development argue that differences between product and service firms' output affect the success factors for innovation. They mention in particular the intangibility and perishability of services, and the required user participation in their delivery (De Brentani 2001; Gallouj and Weinstein 1997; Martin Jr. and Horne 1993). Factors that are considered more important for new service development than for new product development are: having a distinct and reliable concept (De Brentani and Ragot 1996; Edvardsson and Haglund 1995), synergy with the firm's current business (De Brentani and Ragot 1996; Martin Jr. and Horne 1993), senior management support (De Brentani 2001), and customer involvement (Bowen and Ford 2002). On the other hand a structured approach would be less important (De Brentani 2001; Edvardsson and Haglund 1995; Griffin 1997).

In spite of the high number of authors that make such claims, the evidence is rather weak, since none of these authors applied a comparative research setting, with product firms as a control group. Henard and Szymanski (2001), who compared new product with new service development projects, found only four differences between service and product firms in their meta-study: a higher importance of price and market synergy and a lower importance of a structured approach and multidisciplinary teams. Moreover, there is no obvious relation between the specific character of services and

the higher or lower importance of the factors mentioned above. Our study contributes by offering alternative explanations for some of the findings of this literature. For instance, our findings suggest that not the character of services versus the character of products is the cause of the lower importance of multidisciplinary teams in new service development projects (Henard and Szymanski 2001), but more likely the capabilities in internal collaboration. Our findings concerning the negative impact of planning can contribute to explain the lower need for a structured approach for development projects of service firms (Keegan and Turner 2002; Nambisan 2001).

A methodological implication of this study is the need for a comparative research setting, using a control group, for the study of the influence of the context on success factors. Comparative research designs are hardly used in research in innovation management (Gerwin and Barrowman 2002). Such a research design makes it possible to investigate differences, and consequently provides more robust findings.

Our findings have important implications for practitioners as well. This study suggests that managers of project-based firms should be careful not to plan their development projects to a too high extent, instead development projects should be planned less strictly and more flexibly (Nambisan 2001). They should also avoid using multidisciplinary teams for development projects. It seems that they need to focus on specialized teams instead. At the same time they should pay more attention to the weight of the project leader. More in general, our research shows that managers of other firms than the manufacturing firms typically addressed in the current innovation management literature, have to take the capabilities and routines of their firm into account when they organize development projects. They have to interpret success factors from the innovation management literature with caution.

This study has several limitations. First, we have studied the impact of only a limited set of success factors. For instance, we included planning as a potential success factor, but it would be interesting to investigate more explicitly the influence of specific types of planning in project-based firms, particularly more mechanistic versus organic ways of planning (Burns and Stalker 1994; De Meyer et al. 2002; Werr and Stjernberg 2003). Also with respect to multidisciplinary teams, we focused on the effects of multidisciplinary teams, not on the benefits of specialized teams. Future research should include more and more specific success factors. Second, we studied the influence of the characteristics of project-based firms on the use of and the need for certain factors. In our model we only indirectly accounted for the impact of organizational structure, capabilities and routines of project-based firms. Future research should investigate in more detail how organizational structure, and specific capabilities and routines affect the use of and the need for each factor.

Third, we compared the usage of the factors in project-based firms and non-project-based firms. Although we used as much as possible objective items, we cannot be sure that respondents in project-based firms and non-project-based firms always had the same reference frame when responding to these items. Respondents in project-based firms may compare usage of a factor in their development projects with the usage on business projects. This would affect our results on differences in the usage, not our results on direct and interaction effects related to the need for these factors. In future studies it will be important to ensure that respondents have the same reference frame (Steenkamp and Baumgartner 1998). Fourth, future research will have to indicate to

which extent our findings are applicable to other types of project-based organizations, such as project-based departments of firms (Bernasco et al. 1999; Hobday 2000; Lindkvist 2004), temporary project organizations (Defillippi and Arthur 1998; Turner and Muller 2003), and professional service firms that do not perform larger projects (Fosstenlokken, Lowendahl and Revang 2003; Greenwood et al. 2005; Robertson et al. 2003; Werr and Stjernberg 2003).

REFERENCES

Ancona, D. G. and D. F. Caldwell 1992. "Bridging the Boundary: External Activity and Performance in Organizational Teams." *Administrative Science Quarterly* 37(4): 634-651.

Ayas, K. 1997. Design for Leaning for Innovation; Project Management for New Product Development. Management. Rotterdam, Erasmus University**:** 242.

Bernasco, W., P. C. De Weerd-Nederhof, et al. 1999. "Balanced Matrix Structure and New Product Development Process at Texas Instruments Materials and Controls Division." *R&D Management* 29(2): 121-131.

Blindenbach-Driessen, F. P. and J. Van den Ende forthcoming. "Innovation in Project-Based Firms; the Context Dependency of Success Factors." *Research Policy*.

Bollen, K. A. 1989. *Structural Equations with Latent Variables*. New York, John Wiley.

Bowen, J. and R. C. Ford 2002. "Managing Service Organizations: Does Having A "Thing" Make a Difference." *Journal of Management* 28(3): 447-469.

Brown, S. L. and K. M. Eisenhardt 1995. "Product Development: Past Research, Present Findings, and Future Directions." *Academy of Management Review* 20(2): 343-378.

Brown, S. L. and K. M. Eisenhardt 1997. "The Art of Continuous Change: Linking Complexity Theory and Time-Paced Evolution in Relentlessly Shifting Organizations." *Administrative Science Quarterly* 42: 1-34.

Burns, T. and G. M. Stalker 1994. *The Management of Innovation*. Oxford, Oxford University Press.

Christensen, C. M. and B. Baird 1997. "Cultivating Capabilities to Innovate; Booz Allen & Hamilton." Harvard Case # 9698027.

Cooper, R. G. 2001. *Winning at New Products, Accelerating the Process from Idea to Launch*. Cambridge, Massachusetts, Perseus.

De Brentani, U. 1989. "Success and Failure in New Industrial Services." *Journal of Product Innovation Management* 6: 239-258.

De Brentani, U. 2001. "Innovative Versus Incremental New Business Services: Different Keys for Achieving Success." *Journal of Product Innovation Management* 18: 169-187.

De Brentani, U. and E. Ragot 1996. "Developing New Business-to Business Professional Services: What Factors Impact Performance." *Industrial Marketing Management* 25: 517-530.

De Meyer, A., C. H. Loch, et al. 2002. "Managing Project Uncertainty: From Variation to Chaos." *MIT Sloan Management Review* 43(2): 60-67.

Defillippi, R. J. and M. B. Arthur 1998. "Paradox in Project-Based Enterprise: The Case of Film Making." *California Management Review* 40(2): 125-139.

Diamantopoulos, A. and H. M. Winklhofer 2001. "Index Construction with Formative Inidators: An Alternative to Scale Development." *Journal of Marketing Research* 38(May): 269-277.

Dougherty, D. 1992. "Interpretive Barriers to Successful Product Innovation in Large Firms." *Organization Science* 3(2): 179-202.

Edvardsson, B. and L. Haglund 1995. "Analysis, Planning, Improvisation and Control in the Development of New Services." *International Journal of Service Industry Management* 6(2): 24-35.

Edwards, J. R. and R. P. Bagozzi 2000. "On the Nature and Direction of Relationships between Constructs and Measures." *Psychological Methods* 5(2): 155-174.

Eisenhardt, K. M. and J. A. Martin 2000. "Dynamic Capabilities: What Are They?" *Strategic Management Journal* 21: 1105-1121.

Eisenhardt, K. M. and B. N. Tabrizi 1995. "Accelerating Adaptive Processes: Product Innovation in the Global Computer Industry." *Administrative Science Quarterly* 40: 84-110.

Ernst, H. 2002. "Success Factors of New Product Development: A Review of the Empirical Literature." *International journal of management reviews* 4(1): 1-40.

Ethiraj, S. K., P. Kale, et al. 2005. "Where Do Capabilities Come from and How Do They Matter? A Study in the Software Service Industry." *Strategic Management Journal* 26: 25-45.

Fosstenlokken, S. M., B. R. Lowendahl, et al. 2003. "Knowledge Development through Client Interaction: A Comparative Study." *Organization Studies* 24(6): 859-879.

Galbraith, J. R. 1971. "Matrix Organization Designs: How to Combine Functional and Project Forms." *Business Horizons* 14(1): 29-40.

Gallouj, F. and O. Weinstein 1997. "Innovation in Services." *Research Policy* 26: 537-556.

Gann, D. M. and A. J. Salter 2000. "Innovation in Project-Based, Service-Enhanced Firms: The Construction of Complex Products and Systems." *Research Policy* 29: 955-972.

Gersick, C. J. G. 1994. "Pacing Strategic Change: The Case of a New Venture." *Academy of Management Journal* 37(1): 9-45.

Gerwin, D. and N. J. Barrowman 2002. "An Evaluation of Research on Integrated Product Development." *Management Science* 48(7): 938-953.

Greenwood, R., S. X. Li, et al. 2005. "Reputation, Diversification, and Organizational Explanations of Performance in Professional Service Firms." *Organization Science* 16(6): 661-673.

Griffin, A. 1997. "PDMA Research on New Product Development Practices: Updating Trends and Benchmarking Best Practices." *Journal of Product Innovation Management* 14: 429-458.

Griffin, A. and A. L. Page 1996. "PDMA Success Measurement Project: Recommended Measures for Product Development Success and Failure." *Journal of Product Innovation Management* 13(4): 478-496.

Henard, D. H. and D. M. Szymanski 2001. "Why Some New Products Are More Successful Than Others." *Journal of Marketing Research* 38(3): 362-375.

Hobday, M. 2000. "The Project-Based Organisation: An Ideal Form for Managing Complex Products and Systems?" *Research Policy* 29: 871-893.

Hoch, D. J., C. R. Roeding, et al. 2000. *Secrets of Software Success: Management Insights from 100 Software Firms around the World*. Boston, Massachusetts, Harvard Business School Press.

Jarvis, C. B., S. B. Mackenzie, et al. 2003. "A Critical Review of Construct Indicators and Measurement Model Misspecification in Marketing and Consumer Research." *Journal of Consumer Research* 30(2): 199-218.

Keegan, A. and J. R. Turner 2002. "The Management of Innovation in Project-Based Firms." *Long Range Planning* 35: 367-388.

Knight Wendling Consulting 2000. Bedrijfstaktoets 2000, Ministerie van economische zaken.

Lewis, M.W., M.A. Welsh, et al. 2002. "Product Development Tensions: Exploring Contrasting Styles of Project Management." *Academy of Management Journal* 45(3): 546-564.

Lindkvist, L. 2004. "Governing Project-Based Firms: Promoting Market-Like Processes within Hierarchies." *Journal of Management and Governance* 8: 3-25.

Lovelace, K., D. L. Shapiro, et al. 2001. "Maximizing Cross-Functional New Product Teams' Innovativeness and Constraint Adherence: A Conflict Communications Perspective." *Academy of Management Journal* 44(4): 779-793.

MacCormack, A., R. Verganti, et al. 2001. "Developing Products on Internet Time. The Anatomy of a Flexible Development Process " *Management Science* 47(1): 133-150.

Mackenzie, S. B., P. M. Podsakoff, et al. 2005. "The Problem of Measurement Model Misspecification in Behavioral and Organizational Research and Some Recommended Solutions." *Journal of Applied Psychology* 90(4): 710-730.

Martin Jr., C. R. and D. A. Horne 1993. "Service Innovation: Successful Versus Unsuccessful Firms." *International Journal of Service Industry Management* 4(1): 49-65.

Montoya-Weiss, M. M. and R. Calantone 1994. "Determinants of New Product Performance: A Review and Meta-Analysis." *Journal of Product Innovation Management* 11: 397-417.

Nambisan, S. 2001. "Why Service Businesses Are Not Product Businesses." *MIT Sloan Management Review* 42(4): 72-80.

Panne, G. van de 2003. "Success and Failure of Innovation: A Literature Review." *International Journal of Innovation Management* 7(3): 309-338.

Pavitt, K. 1984. "Sectoral Patterns of Technical Change: Towards a Taxonomy and a Theory." *Research Policy* 13: 343-373.

Pinto, J. K. and J. G. Covin 1989. "Critical Factors in Project Implementation: A Comparison of Construction and R&D Projects." *Technovation* 9: 49-62.

Pinto, J. K. and M. B. Pinto 1990. "Project Team Communication and Cross-Functional Cooperation in New Program Development." *Journal of Product Innovation Management* 7: 200-212.

Podsakoff, P. M., S. B. Mackenzie, et al. 2003. "Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies." *Journal of Applied Psychology* 88(5): 879-903.

Prencipe, A., A. Davies, et al., Eds. 2003. *The Business of Systems Integration*. Oxford, Oxford University Press.

Prencipe, A. and F. Tell 2001. "Inter-Project Learning: Processes and Outcomes of Knowledge Codification in Project-Based Firms." *Research Policy* 30: 1373-1394.

Robertson, M., H. Scarbrough, et al. 2003. "Knowledge Creation in Professional Service Firms: Institutional Effects." *Organization Studies* 24(6): 831-857.

Rothwell, R., C. Freeman, et al. 1974. "Sappho Updated." *Research Policy* 3: 258-291.

Salter, A. J. and D. M. Gann 2003. "Source of Ideas for Innovation in Engineering Design." *Research Policy* 32: 1309-1324.

Song, M. and M. M. Montoya-Weiss 2001. "The Effects of Perceived Technological Uncertainty on Japanese New Product Development." *Academy of Management Journal* 44(1): 61-80.

Steenkamp, J.-B. E. M. and H. Baumgartner 1998. "Assessing Measurement Invariance in Cross-National Consumer Research." *Journal of Consumer Research* 25(1): 78-90.

Sundbo, J. and F. Gallouj 2000. "Innovation as a Loosely Coupled System in Services." *International Journal of Services Technology and Management* 1(1): 15-35.

Turner, J. R. 1999. *The Handbook of Project-Based Management*. Berkshire, McGraw Hill.

Turner, J. R. and R. Muller 2003. "On the Nature of the Project as a Temporary Organization." *International Journal of Project Management* 21: 1-8.

Volberda, H. W. 1998. *Building the Flexible Firm, How to Remain Competitive*. Oxford, Oxford University Press.

Werr, A. and T. Stjernberg 2003. "Exploring Management Consulting Firms as Knowledge Systems." *Organization Studies* 24(6): 881-908.

Wheelwright, S. C. and K. B. Clark 1992. *Revolutionizing Product Development*. New York, The Free Press.

Whitley, R. 2006. "Project-Based Firms: New Organizational Form or Variations on a Theme?" *Industrial and Corporate Change* 15(1): 77-99.

APPENDIX 4.A Questionnaire

Construct	Questionnaire items	Factor loadings
Dependent variable		
Performance[R&D]	To what extent do you agree with the following statements (1-7 point Likert scale)?	
	-A a consequence of this project the reputation of our organization in the area related to this project is increased	0.76
	-The new or improved product / service provides us a competitive advantage.	0.88
	-The new or improved product / service fulfils the needs of the clients	0.82
	-The gained profit is …? Very much lower than expected- Very much higher than expected (5 point scale)	0.81
	-The achieved revenue is…? Very much lower than expected- Very much higher than expected (5 point scale)	0.77
Firm characteristics		
Project-based firm[R&D]	Which organizational forms matches best with your organization?	
	-Various departments (production, R&D etc.) have each their own responsibility in the production of our services or products (= functional organization)	0.45
	-A division or department has the responsibility for the production of a product or service (or a group of products or services targeted at one market) (=product/divisional organization)	
	-Within our organizational structure there is an equal division in authority and control between two or more of the following subdivisions: functions, technical disciplines, location, product groups, projects, or other (= matrix organization)	
	-Our products or services are primarily being delivered on project-basis. The entire organization is subsidiary to the projects we execute for our clients (=project organization)	0.65
	Is your organization experienced in the execution of projects?	
	-No, we rarely execute projects	
	-Yes, especially in new product and new service development projects, or R&D projects	
	-Yes, our predominant operational process is the execution of projects	0.45
	Can you indicate the character of the production process for your most important products or services?	
	-production per project (as for example construction projects) (= 1 from the 7 options)	
	Which of the following description matches best the relationship your organization have with customers?	0.16
	-We deliver tailor made product and services (= 1 from the 6	

	options)	
	To what extent do you agree with the following statements (1-7 point Likert scale)?	0.01
	-Our products and services are very complex because they consist of multiple components	0.06
	-Our products and services are very complex because various parties are involved in the production process	
Collaborative[R&D] capabilities	To what extent do you agree with the following statements (1-7 point Likert scale)?	
	-Various functional departments (production, R&D etc) acknowledge each others expertise.	0.85
	-The communication between the various functional departments is frequent and open	0.89
	-Various disciplines (engineering, design etc.) acknowledge each others expertise.	0.87
	-The communication between the various disciplines is frequent and open	0.90
Service firm[R&D]	Does your organization provide (yes / no)?	-
	-Products	
	-Services	
	-A combination of products and services	
Firm size [R&D]	How many employees work for your organization (open question)?	-
Firm strategy[R&D]	To what extent do you agree with the following statements (1-7 point Likert scale)?	
	-New product and service development is very important to sustain our position in the market in which we operate	0.66
	-New product and service development demands very high investment costs	0.47
	-Innovation is very important within our organization	0.84
	To what extent does your organization follow the following strategies (1-7 point Likert scale)?	
	-We try to be the first in the development and application of new products and services	0.79
	-It is not important to be ahead of the competition, we only change to new technologies when it is absolutely necessary	0.57
Project characteristics		
Planning	To what extent did the project plan provide (1-7 point Likert scale)?	
	-Clarity in what should be developed	0.76
	-Clarity in when what should have been finished when (milestone plan)	0.82
	-Clarity on responsibilities	0.87
	To what extent do you agree with the following statements (1-7 point Likert scale)?	
	-A business case formed the foundation of this project	0.72

	-A well considered senior management decision was the basis for project approval	0.73
Senior management support	To what extent do you agree with the following statements (1-7 point Likert scale)?	
	-Senior management provides a culture that stimulates innovation	0.72
	-Senior management involvement has been insufficient during the project[R]	0.51
	-Senior management has from the beginning sufficiently supported the project financially	0.70
	-Senior management has from the beginning been sufficiently committed to the project	0.85
	-Senior management has made available sufficient qualified employees for this project	0.73
Multidisciplinary team	To what extent do you agree with the following statements (1-7 point Likert scale)?	
	-Various functional departments (production, marketing etc) were fully involved in this development project	0.90
	-Various disciplines (engineering, design etc.) were fully involved in this development project	0.74
	-Marketing was closely involved in this project	0.78
Expertise	To what extent do you agree with the following statements (1-7 point Likert scale)?	0.94
	-All required experience was present within the project team	0.94
	-All required expertise was present within the project team	
Heavyweight project leader[R&D]	To what extent do you agree with the following statements (1-7 point Likert scale)?	
	-The project leader had a lot of authority	0.82
	-The project leader had a lot of project management experience	0.66
		0.69
	-The project leader had a lot of knowledge of the target market	0.72
	The project leader was technically very capable.	
Autonomy of project leader	To what extent could the project team take decisions, without needing approval from others, about the following?	
	-Quality of the product or service being developed	0.92
	-Specifications of the end product	0.92
Newness	How new was the new product or service (1-7 point Likert scale)?	
	-For your organization	0.70
	-For the current customers of your organization	0.83
	-For the target customers	0.81
	-For the world	0.72
	-The used technology	0.60

Note: The questions were in Dutch, [R] reversed coded, [R&D] questions from the R&D questionnaire.

Chapter 5

THE INFLUENCE OF OPERATIONAL CAPABILTIES AND ROUTINES

THE EFFECT OF OPERATIONAL COLLABORATIVE CAPABILITIES ON NEW PRODUCT DEVELOPMENT PROJECTS

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Jan van den Ende

We gratefully acknowledge the useful comments and suggestions made during the BPS workshop at the Academy of Management Conference, Hawaii 2005.

Chapter 5

The Effect of Operational Collaborative Capabilities on New Product Development Projects

ABSTRACT

The strategy literature discusses the effect of firm capabilities on innovative performance, at the level of the firm. The innovation management literature focuses on the innovation process within firms. This paper bridges the gap between these literatures by investigating the effect of firm capabilities on the innovation process and the outcome of that process. We focus on collaborative capabilities that reside in the operational processes of a firm, and we investigate their effects on two specific success factors for innovation: the use of multidisciplinary teams and supplier involvement in development projects. We develop and test three alternative models, using a sample of 144 development projects of firms in different industries. Our results show that operational collaborative capabilities increase the use of multidisciplinary teams and supplier involvement. Moreover, the combination of operational collaborative capabilities and executing development projects within the operational environment makes the use of multidisciplinary teams and supplier involvement more effective.

INTRODUCTION

The innovation management literature pays a lot of attention to the creation of new capabilities, the importation of new knowledge, and the use of this knowledge to create new products (Christensen 1997; Danneels 2002; Hamel, Doz and Prahalad 1989; Leonard-Barton 1992; Prahalad and Hamel 1990). This literature dedicates far less attention to the use of existing capabilities and knowledge for the generation of new products. However, a large part of a firm's research and development (R&D) portfolio does not concern exploration, but builds on a firm's existing products, such as platform or incremental innovations (Wheelwright and Clark 1992). This paper investigates the benefits of a firm's operational capabilities for the development of new products and new services. The central question is: do development projects benefit from operational capabilities, and if so, to which extent does the degree of separation between operations and development activities affect these benefits.

By investigating the influence of operational capabilities on the development process, we add both to the organization literature and the strategic management literature. Both types of literatures address the effects of firm characteristics on innovative performance. The organization literature addresses the influence of firm characteristics, e.g. the degree of centralization, functional differentiation, internal and external communication, that contribute positively to the innovativeness of firms (Damanpour 1991). The strategic management literature pays attention to the influence of resources or capabilities on competitive advantage, including innovative performance (Barney 1991; Henderson and Cockburn 1994; Nelson 1991; Peteraf 1993; Prahalad and Hamel 1990; Teece, Pisano and Shuen 1997; Wernerfelt 1984). In both types of literature the innovation process itself remains a black box. We expect that the

effects of firm characteristics or capabilities on a firm's innovative performance are mediated by their effects on the innovation process in the firm. We focus on the operational capabilities of the firm, and we expect that these capabilities affect the innovation process of a firm, and in that way affect a firm's innovative performance.

New product and new service development literature typically considers the management of development projects, as described above, independent of firm characteristics. In the meta-studies of Gerwin and Barrowman (2002) and Montoya-Weiss and Calantone (1994) the impact of organizational characteristics, such as hierarchy and job specialization is addressed. This however concerns the effect of organizational characteristics on the performance on development projects, not the effect of these characteristics on the success factors of these projects. Furthermore operational capabilities are not taken into consideration. The influence of capabilities on the management of development projects, has been illustrated qualitatively (see for instance Iansiti and Clark 1994; Leonard-Barton 1992), but these relationships have not been addressed quantitatively. Our study is thus also a contribution to the innovation management literature.

There are many firms with operational capabilities that can contribute positively to the new product or service development process. Project-based firms are good examples. Project-based firms are firms that are organized around projects (Gann and Salter 2000), that produce integrated complex products and systems for their clients (Hobday 2000), and that usually operate in a business-to-business environment (Prencipe, Davies and Hobday 2003) Their operational capabilities facilitate the execution of development projects in project-based firms (Blindenbach-Driessen and Van den Ende forthcoming). In addition, not only project-based firms but service firms in general, have their development process integrated within the operational environment (Sundbo and Gallouj 2000). We expect that executing development projects in a firm's operational environment will facilitates the use of a firm's operational capabilities in the development process. Our findings will be especially relevant for project-based service firms, but also other firms will have knowledge in their operational process that is relevant for their innovation process.

Operational capabilities are the capabilities used in a firm's operational process, i.e. purchasing, production, sales and after-sales support. We do not include capabilities embedded in other functions in the firm, such as human resources, accounting and marketing. The strategic management literature is not clear about the content of (operational) capabilities (Foss 1997). We use the definition of Grant (1996, p 377), operational capabilities are 'a firm's ability to perform repeatedly a productive task which relates either directly or indirectly to a firm's capacity for creating value thorough effecting the transformation of inputs to outputs'. This definition of operational capabilities is closely related to the component competence of Henderson and Cockburn (1994), and the knowledge and skills, and technical system dimension of capabilities of Leonard-Barton (1992).

We focus at internal and external operational collaborative capabilities. *Internal operational collaborative* capabilities represent the communication and collaboration between disciplines and functions involved in the operational processes of a firm. *External operational collaborative* capabilities represent the communication and collaboration with external parties in the operational process, which are in our case

suppliers. We chose these operational capabilities, as they will be comparable across firms. Furthermore we can relate these capabilities each to a success factor provided by the innovation management literature, the use of a multidisciplinary team and supplier involvement in the development process.

We investigate the indirect effect of operational collaborative capabilities on innovative performance. We hypothesize that operational capabilities affect specific behaviors in innovation activities, particularly the use and effectiveness of multidisciplinary teams and supplier involvement. Multidisciplinary teams include multifunctional teams. From the innovation management literature, it is known that in general multidisciplinary teams or multifunctional teams (Brown and Eisenhardt 1995; Cooper 2001; De Brentani and Ragot 1996; Griffin 1997) and supplier involvement (Brown and Eisenhardt 1995; Clark 1989) contribute to the performance of development projects.

Operational collaborative capabilities can affect the use and effectiveness of a multidisciplinary team and supplier involvement in several ways. We develop and test three alternative models extracted from the innovation, the organization and the strategic management literature. Each of these models represents a different theoretical extreme. Testing hypotheses related to the assumptions underlying these different models provides insight how internal and external operational collaborative capabilities affect the use and effectiveness of multidisciplinary teams and supplier involvement in the development process.

These models take also into consideration the degree of integration in the relationship between operational capabilities and the use and effectiveness of multidisciplinary teams and supplier involvement. Integration refers to the execution of development projects within the operational environment versus execution of these projects within a dedicated R&D department.

Our research is exploratory, as there is hardly any literature yet about the effect of operational capabilities on the development process. In the next section, we develop the three alternative models. We test these alternative models using a data set of 144 development projects in firms in the IT, Engineering, Construction and related industries. This data set contains information about the execution and performance of the development projects, as well as information on each firm's operational collaborative capabilities. In the discussion and conclusion section we discuss the implications and limitations of our research and make suggestions for future research.

THEORY

Multidisciplinary team and supplier involvement

Several meta reviews mention that multidisciplinary teams and supplier involvement contribute to the performance of development projects (Brown and Eisenhardt 1995; Ernst 2002; Henard and Szymanski 2001; Montoya-Weiss and Calantone 1994; Van de Panne 2003). More detailed studies put theses findings into perspective. They show that in service firms, the use of a multidisciplinary team is less effective. For instance, Henard and Szymanski (2001) find in their meta study that the contribution to performance by multidisciplinary teams is lower in new service development projects than in new product development projects. Lovelace, Shapiro and Weingart (2001)

show that a multidisciplinary team has first to overcome disciplinary differences before such a team is able to collaborate efficiently and effectively and contributes to project performance. Supplier involvement contributes to the performance of development projects, although this evidence is not unequivocal (Brown and Eisenhardt 1995; Primo and Amundson 2002).

Literature shows that multidisciplinary teams and supplier involvement contribute to the performance of development projects. We investigate the influence of firm capabilities on this finding and try to explain the observed differences in contribution of multidisciplinary teams and supplier involvement to the performance of development projects. We do so by investigating the influence of operational collaborative capabilities on the use and effectiveness of multidisciplinary teams and supplier involvement in the development process.

Effect of executing development projects in the operational environment

Contingency theory states that the organization of activities should be adapted to the complexity and uncertainty of the activity at hand. Innovation, due to the uncertainty involved, requires an organic organization (Burton, Lauridsen and Obel 2002; Donaldson 2001; Drazin and Van de Ven 1985; Galbraith 1977). An organic organization enables experimentation and learning, as opposed to a mechanistic organization that is aimed at achieving efficiency (Burns and Stalker 1994). Mechanistic organizations are more frequently applied in operational processes. As a consequence, new research and development projects are in manufacturing firms often executed in a dedicated R&D department, separated from a firm's operational process.

As most innovation management literature still concerns manufacturing firms (Montoya-Weiss and Calantone 1994), it is not surprising that the management of development projects is typically considered to be an isolated process in the innovation management literature. In many service firms, however, boundaries between the operational and the innovation process are absent (Sundbo and Gallouj 2000). In service firms, but also in some production firms (Griffin 1997), development projects are part of a loosely-coupled organizational system within a firm's operational environment (Sundbo and Gallouj 2000), instead of being executed in a dedicated R&D department. Thomke (2003) for example has described how the bank of America has used experiments within the daily operations of a bank, with the aim to create new service concepts for retail banking. Another example would the development of a new mobile service for banks by an IT system integrator firm specialized in mobile services. In the development project the IT firm develops the basic technology, the financial procedures and the knowledge on for instance legal aspects, to be able to customize this technology and service for specific banks. Such a project is neither executed within the projects IT firms execute to customer order for a bank, nor is it executed in a dedicated R&D department. At the same time, it is likely that the IT firm uses the same team that developed the new service, to implement its fist application of this new mobile service as ordered by a bank.

Griffin (1997) found that in manufacturing firms approximately 70 % of new product and new service development activities reside in a dedicated R&D or engineering department. Within service firms only 35 % of the development projects are executed in such a dedicated department. Griffin states that the reason for executing

development projects in the operational environment is the lower degree of organization of new service development process. Thomke (2003) states that new services are difficult to develop isolated from a firm's operational process, because services only exist at the moment they are delivered. Consequently, testing of a new service can only take place within the operational environment.

We seek a different explanation by investigating to which extent development projects executed in the operational environment benefit from, or are hindered by, a firm's operational collaborative capabilities.

Three alternative models

Based on the strategic management literature (Barney 1991; Cohen and Levinthal 1990; Nelson 1991; Peteraf 1993; Prahalad and Hamel 1990; Teece et al. 1997; Wernerfelt 1984), we develop three alternative models how operational capabilities affect the development process. We labeled these models: the Routine model, the Dynamic Capability model and the Absorptive Capacity model.

The Routine Model

The Routine Model is based on the consideration that capabilities require specific routines. *Routines* are the regular and predictable patterns of performing activities within firms (Nelson and Winter 1982; Sholes and Kevan 1999). External collaborative capabilities require routines in contacting employees of other firms in the right stage of a project or of activities, and asking them information on specific issues. Internal collaborative capabilities require equivalent routines in internal communication.

In line with the literature on routines, we assume for the Routine Model that firms use similar routines in their operational and in the development processes. This implies that firms with strong routines in external collaboration in their operational process, will also more often involve suppliers in their development process. And firms with strong routines in internal collaboration in their operational process will more often use multidisciplinary teams in their development process. We therefore hypothesize:

> *Hypothesis 1a*
> *Internal and external operational collaborative capabilities increase respectively the use of multidisciplinary teams and supplier involvement in the development process.*

Execution of development project within the operational environment is likely to enforce the influence of operational routines on the routines which are applied in the development process. We therefore hypothesize:

> *Hypothesis 1b*
> *Executing development projects within the operational environment strengthens the positive relationship between internal and external operational collaborative capabilities and the use of respectively multidisciplinary teams and supplier involvement in the development process.*

As stated above, we expect that firms with strong internal and external collaborative capabilities already use multidisciplinary teams and supplier involvement in the development process to a high extent. Subsequently, we expect, due to diminishing marginal returns, further increasing the use of multidisciplinary teams and supplier involvement will increase the innovative performance only to a minor extent. We therefore hypothesize for the Routine Model that internal and external collaborative capabilities reduce the effectiveness of respectively multidisciplinary teams and supplier involvement in the development process:

> *Hypothesis 1c*
> *Multidisciplinary teams and supplier involvement have a less positive contribution to the performance of development projects if the firm has resp. internal or external operational collaborative capabilities.*

The Dynamic Capability Model

The strategy literature makes a distinction between operational and dynamic capabilities. Operational capabilities represent the capabilities that enable a firm to compete with other firms on the short term (Barney 1991; Grant 1996; Nelson 1991; Peteraf 1993; Prahalad and Hamel 1990; Teece et al. 1997; Wernerfelt 1984). Dynamic capabilities, as for example the capabilities used in the development process, are used to ensure future profits (Teece et al. 1997; Winter 2003). According to the dynamic capability literature, the development process has its own distinct dynamic demands and therefore asks for dynamic capabilities. Furthermore, dynamic capabilities are distinctly different from the capabilities needed within the operational process (Teece et al. 1997). Eisenhardt and Martin (2000) consider dynamic capabilities, such as new product development, not as a capability but as a process. Also in their view, the new product development process is distinctly different from a firm's operational processes.

In line with this approach we assume in the Dynamic Capability Model that operational and dynamic capabilities are distinct capabilities. As a consequence, for this model we hypothesize that there is no relationship between the existence of internal or external collaborative capabilities in the operational process and the use or effects of multidisciplinary teams and supplier involvement in development projects:

> *Hypothesis 2a*
>
> *Internal and external operational collaborative capabilities have no significant effect on the use of respectively multidisciplinary teams and supplier involvement in the development process.*
>
> *Hypothesis 2b*
>
> *Internal and external operational collaborative capabilities have no significant effect on the contribution to performance by respectively multidisciplinary teams and supplier involvement in the development process.*

As stated above, the literature on capabilities claims that dynamic capabilities are clearly different from operational capabilities. Multidisciplinary teams and supplier involvement used on new product development projects are part of these dynamic capabilities (Eisenhardt and Martin 2000), and function as mechanisms to import new knowledge into the development process (Dougherty 1992). We expect that integration will have a negative effect on this knowledge transfer process, since the knowledge existing in the operational environment will hinder the acceptance of the new knowledge needed in the development process (Christensen 1997; Leonard-Barton 1992). This implies that a multidisciplinary team and supplier involvement function are less effectively as transfer mechanisms of new knowledge, when development activities are integrated in the operational environment. We therefore hypothesize:

Hypothesis 2c

Multidisciplinary teams and supplier involvement have a lower positive contribution to the performance of development projects when these projects are executed within the operational environment.

Hypothesis 2d

Multidisciplinary teams and supplier involvement have a lower positive contribution to the performance of development projects when these projects are executed within the operational environment and when the firm has resp. internal or external operational collaborative capabilities.

The Absorptive Capacity Model

Cohen and Levinthal (1990) define absorptive capacity as the ability to identify, assimilate and exploit knowledge from the environment. A firm's prior related knowledge is needed to develop new knowledge (Cohen and Levinthal 1990). Such knowledge can be acquired from outside the firm, or developed within the firm. According to this literature firms need an interface and combinative capabilities (van den Bosch, Volberda and De Boer 1999) to transfer the knowledge from outside into a firm's processes.

For our Absorptive Capacity model we assume that development projects make use of a firm's operational collaborative capabilities as prior related knowledge. Cohen and Levinthal (1990) investigated the absorptive capacity that is created as byproduct of a firm's R&D investment. As a consequence, they associate absorptive capacity with the prior related knowledge residing within a firm's R&D department. In the introduction of their paper, Cohen and Levinthal mention that 'absorptive capacity may also be developed as a byproduct of a firm's manufacturing operations'. In this paper, we refer to prior related knowledge as the knowledge residing within a firm's operational process, not the knowledge residing within a firm's R&D department. We presume for the Absorptive Capacity Model that a firm needs this knowledge to be able to innovate effectively.

The required interface, to enable the use of the prior related knowledge from the operational process in the development process, is assumed to exist only when development projects are executed within a firm's operational environment. A multidisciplinary team and supplier involvement are assumed to work as receiving

mechanisms of the operational knowledge into the development process. As a consequence, development projects, executed in a firm's operational environment, benefit from a firm's operational collaborative capabilities, as these enlarge the absorptive capacity of a development project. We therefore hypothesize:

Hypothesis 3a

Multidisciplinary teams and supplier involvement have a stronger positive effect on the performance of development projects when these projects are executed within the operational environment and when the firm has resp. internal or external operational collaborative capabilities.

The absorptive capacity model implies that the combination of operational collaborative capabilities, an interface, and a receiving mechanism is necessary to make knowledge from the operational process available in the development process. Consequently, integration or operational collaborative capabilities alone should have no effect on the contribution of respectively multidisciplinary teams and supplier involvement to the performance of development projects. These conditions are formulated in hypotheses 3b and 3c (hypothesis 3c is equal to 2c, but for other reasons):

Hypothesis 3b

Execution of development projects within the operational environment only, i.e. without the existence of internal and external operational collaborative capabilities in a firm, has no significant effect on the contribution to performance by respectively multidisciplinary teams and supplier involvement in the development process.

Hypothesis 3c

Internal and external operational collaborative capabilities only, i.e. without executing the development project in a firm's operational environment, have no significant effect on the contribution to performance by respectively multidisciplinary teams and supplier involvement in the development process.

METHODOLOGY

Sample and Data Collection

We explored the existence of each of the three models in firms of the Dutch Information Technology (IT), Engineering, Construction and related industries. We chose these industries because we expected a sufficient number of firms in which development projects were either executed within, or separated from the operational process. We limited the sample to firms larger than 50 employees, because in smaller firms the relevance of separation of R&D activities will be limited. In total approximately 1200 IT, Engineering and Construction firms were randomly selected from the Reach database, and invited by telephone to participate in our internet-based questionnaire. To increase the response rate, several related support groups were asked

to inform their members about our research. This means that our population did not only consist of IT (BIK code 72), Engineering (BIK code 74) and Construction firms (BIK code 45), but also contained a fourth group of firms from related industries. These latter firms were approached via the same procedure.

From the 1200 firms approached by telephone, 720 managers, responsible for development projects, agreed to participate, 205 (22%) of these managers actually responded to this part of the questionnaire.

We developed two questionnaires, one for R&D managers and one for project leaders. Each R&D manager was asked to name two development projects in his firm, a successful and a less successful project. Furthermore we asked the R&D managers questions related to the characteristics of the organization as a whole and the market performance of the two development projects. The project leader of each project answered the questions related to the execution of the development project.

The above mentioned 205 managers provided the e-mail addresses of 213 project leaders for the follow-up questionnaire. 148 of these project leaders responded (69%). We have used the project names and the names of the project leaders to link the two questionnaires. Four projects were deleted, because the project's names provided by the project leaders did not match the projects' names mentioned by the R&D managers.

As a result we used a data set of 144 projects of 96 firms, 23% of the projects were from IT firms, 20% of Engineering firms, 34% were from Construction firms, 23% projects were of the remaining group of related industries.

Measures

The uni-dimensionality of each construct was verified with exploratory factor analyses (principal component, varimax rotation). Cronbach's alpha was used to verify the reliability of each reflective construct. Table 5.1 lists the correlations between the constructs and the Cronbach's alphas of each construct.

Constructs based on senior manager's questionnaire.

Internal operational collaborative capability: The Internal operational collaborative capability of a firm represents the degree to which functional departments and disciplines acknowledged each others expertise, and to which extent open and frequent communication took place ($\alpha = 0.90$) (adapted from Pinto and Pinto 1990).

External operational collaborative capability: Initially external operational collaborative capabilities consisted of collaboration with suppliers and customers. In addition, external collaboration also took into account the complexity of the service or product made in the operational process, since this affects the number of outside parties involved in the production process (Kusunoki, Nonaka and Nagata 1998). During scale purification, the items related to collaboration with customers had to be deleted. It therefore represents the collaboration with other parties in the operational process, excluding collaboration with customers. The reliability for this construct is still limited, as Cronbach's alpa has a value of 0.50, but it is acceptable considering the uni-dimensionality of the construct (Schmitt 1996).

Integration: The degree to which development projects were executed within the operational environment is measured by asking for the degree of separation; the

Table 5.1 Correlations

	Variables	N	μ	Std Dev	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12
1.	Construction Firms	143	0.34	0.48	0.00	1.00	-											
2.	IT Firms	143	0.23	0.42	0.00	1.00	-0.40***	-										
3.	Engineering Firms	143	0.20	0.40	0.00	1.00	-0.36***	-0.27**	-									
4.	Firm size	142	1.81	0.63	1.00	3.00	0.01	0.03	0.12	-								
5.	Service Firms	143	3.28	1.10	1.00	5.00	-0.24**	-0.02	0.47***	-0.10	-							
6.	Fit	141	11.37	2.14	2.00	14.00	0.16†	-0.09	-0.08	-0.02	-0.11	*0.80*						
7.	Integration	143	19.63	7.20	5.33	30.00	0.07	-0.06	0.11	-0.05	0.41***	-0.02	*0.64*					
8.	External operational collaborative capabilities	143	9.51	2.95	2.00	14.00	0.27**	-0.38***	0.21**	0.00	0.06	0.17*	-0.06	*0.50*				
9.	Internal Operational collaborative capabilities	143	20.78	4.81	4.00	28.00	0.09	-0.22**	0.11	-0.07	0.07	0.23**	-0.11	0.17	*0.90*			
10.	Multidisciplinary team	135	13.25	4.48	3.00	21.00	0.02	-0.05	-0.08	-0.01	-0.15†	0.21*	-0.03	0.08	0.27**	*0.74*		
11.	Supplier involvement	143	2.43	2.85	0.00	7.00	0.05	-0.10	-0.08	0.09	-0.25**	-0.11	-0.17	0.17*	-0.09	0.29***	-	
12.	Performance	138	21.38	5.22	7.00	35.00	-0.02	-0.10	-0.07	-0.03	0.05	0.26**	-0.04	0.15†	0.17*	0.24**	0.14†	*0.86*

Note: Pearson Correlations,
Cronbach's alpha is in cursive on the diagonal.
* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$

extent development projects were executed by a dedicated R&D department, and to which extent R&D was formalized and the primary responsibility of the R&D department. Cronbach's alpha for this construct is 0.64.

Performance: To assess the performance of each development project, we used the items of (Griffin and Page 1996). After the pre-test, market share was omitted as item, as it was a difficult item for some firms to answer (see also Hoch, Roeding, Purkert and Lindner 2000, p. 46). The perceived increase in reputation in the area of the new service was added, to get a better assessment of performance of the new service development projects (De Brentani 1989). Cronbach's alpha of the performance construct is $\alpha = 0.86$. We use the R&D managers perception of success, to avoid common method bias (Podsakoff, Mackenzie, Lee and Podsakoff 2003).

Constructs based on project leader's questionnaire.

Supplier involvement: Supplier involvement on development projects is a composed scale, representing the level of involvement of suppliers (adapted from Brockhoff 2003).

Multidisciplinary team: The use of a multidisciplinary team represents the participation of different disciplines, functional departments and the involvement of marketing ($\alpha = 0.74$) in the development project.

Control variables. We use several control variables. At the project level, we used fit as control variable ($\alpha = 0.80$), i.e the extent to which the new product or service was in line with the firm's current competences and targeted at its current customers. We used fit as a measure for the degree that the project is incremental, as this may affect the usefulness of a firm's existing knowledge. At the firm level, we included firm size as control variable to account for differences in firm size (small 50-100 employees, medium 100-1000, large >1000 employees), as knowledge transfer in very large firms may be limited to certain divisions of the firm only.

Three dummy variables were included to account for the different industries represented by the four different groups, IT, Engineering, Construction and the group of related industries.

Our sample consisted of service and production firms. We expected that most service firms executed development project in the operational environment and most production firms had a dedicated R&D department. To ensure that our findings are due to the integration of development projects in the operational environment, and not due to the differences between production and service firms, we included service firm as a control variable.

RESULTS

Data descriptions of each variable and the correlations between the variables are presented in Table 5.1. From the 144 development projects 127 remained after list wise deletion. We mean-centered our data to decrease the likelihood of multicollinearity in the regression equations with multiple interaction terms. Table 5.2 presents the results for the use of a multidisciplinary team and supplier involvement. Table 5.3 presents the results of the regression analyses on performance. Table 5.4 gives an overview of the

Table 5.2 Use of multidisciplinary teams and supplier involvement[a]

Dependent variable	Multidisciplinary team						Supplier involvement					
	Model 1a MT Model 2a MT			Model 1b MT			Model 1a SI Model 2a SI			Model 1b SI		
N	127			127			127			127		
$F_{\text{for regression}}$	1.63			1.44			3.25**			2.88**		
R^2	0.10			0.10			0.18			0.18		
R^2_{adjusted}	0.04			0.03			0.12			0.12		
F-test for difference				0.02						0.08		
	b	sd	*β*	b	sd	*β*	b	sd	*β*	b	Sd	*β*
Intercept	16.08**			16.09*								
	*	(3.19)		**	(3.21)		9.44***	(2.00)		9.35***	(2.04)	
Construction Firms	-1.55	(1.04)	-0.17	-1.57	(1.05)	-0.17	-0.88	(0.66)	-0.15	-0.90	(0.67)	-0.15
IT Firms	-1.45	(1.19)	-0.14	-1.44	(1.19)	-0.14	-1.47*	(0.74)	-0.21	-1.48*	(0.75)	-0.21
Engineering Firms	-1.67	(1.34)	-0.15	-1.67	(1.34)	-0.15	-1.13	(0.85)	-0.16	-1.17	(0.86)	-0.16
Firm size	-0.18	(0.61)	-0.03	-0.19	(0.62)	-0.03	0.28	(0.38)	0.06	0.28	(0.39)	0.06
Service Firms	-0.60	(0.45)	-0.15	-0.60	(0.45)	-0.15	-0.57*	(0.28)	-0.22	-0.55†	(0.29)	-0.21
Fit							-			-		
	0.07	(0.20)	0.03	0.07	(0.20)	0.03	0.41***	(0.12)	-0.29	0.41***	(0.13)	-0.28
Integration[b]	0.06	(0.06)	0.09	0.06	(0.06)	0.09	-0.01	(0.04)	-0.01	-0.01	(0.04)	-0.01
Internal Operational collaborative capabilities[b]	0.22*	(0.09)	0.22	0.22*	(0.09)	0.23						
Integration x Internal Operational collaborative capabilities[b]				0.00	(0.01)	-0.01						
External operational collaborative capabilities[b]							0.21*	(0.10)	0.21	0.21*	(0.10)	0.20
Integration x External operational collaborative capabilities[b]										0.00	(0.01)	-0.03

[a] Unstandardized coefficients are reported, with standard errors in prarentheses, as well as standardized coefficients

[b] mean centered, † $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

hypothesized relationships for each of the models. The supported hypotheses are indicated in bold.

Model 0 in Table 5.3, is the basis model and it represents the contribution of each factor without interaction effects. The R^2 for model 0 is 0.18. Supplier involvement has a significant positive contribution to the performance of a development project (0.33 (0.18), $p < 0.10$). The contribution of a multidisciplinary team is insignificant. Fit has a positive contribution to performance (0.69 (0.26), $p < 0.01$), which concurs with literature (Brown and Eisenhardt 1995; Henard and Szymanski 2001; Maidique and Zirger 1985; Montoya-Weiss and Calantone 1994). Construction firms (-2.25 (-0.21), $p < 0.10$), and engineering firms (-2.68 (-0.21), $p < 0.10$) have both a significant negative contribution. Integration, internal and external operational collaborative capabilities have no significant effect in model 0

Model 1 – 3 represent respectively the Routine Model, The Dynamic Capability Model and the Absorptive Capacity Model.

Models 1a -1c represent the hypotheses 1a-1c of the Routine Model. For the Routine Model we hypothesize that internal and external operational collaborative capabilities increase the use of respectively multidisciplinary teams and supplier involvement in the development process (hypothesis 1a). Model 1a MT in Table 5.2, shows the result for the use of a multidisciplinary team. This model shows that internal operational collaboration has a significant positive effect on the use of a multidisciplinary team (0.22 (0.22), $p< 0.05$), but the R^2 is low (0.10) and the regression equation insignificant ($F = 1.63$, p = n.s.). The correlation between internal operational collaborative capabilities and multidisciplinary teams is however significant (0.27 $p < 0.01$). Model 1a SI, shows the results for supplier involvement. The R^2 is (0.18) is significant ($F = 3.25$ $p < 0.01$). External operational collaboration capabilities (0.21 (0.21), $p < 0.05$) lead to the use of supplier involvement. Other factors that determine the use of supplier involvement is fit with a firm's current activities (-0.41 (-0.29), $p < 0.001$), service firms (-0.57 (-0.22), $p < 0.05$) and IT firms (-1.47 (-0.21), $p < 0.05$). Since external operational collaborative capabilities increase the use of supplier involvement in the development process, we conclude that for supplier involvement there is support for hypothesis 1a. The regression equation for model 1aMT is insignificant, hence internal operational collaborative capabilities do not lead to the use of a multidisciplinary team. At the same time, the correlation shows that with the increase of a firm's operational collaborative capabilities the use of multidisciplinary teams in the development projects also increases. We therefore conclude that there is support for hypothesis 1a, for both internal and external operational collaborative capabilities.

Hypothesis 1b states that executing development projects in the operational environment strengthens the positive relationship between internal and external operational collaborative capabilities and the use of respectively multidisciplinary teams and supplier involvement in the development process. This hypothesis is tested in the models 1b MT and 1b SI. Model 1b MT of Table 5.2, shows that the combination of integration and internal operational collaborative capabilities does not have an effect on the use of multidisciplinary teams (0.00 (0.01), p = ns, $F_{\text{for difference}} = 0.02$, p = n.s.). The

Table 5.3 The results of the regression analyses on performance[a]

Dependent variable	Performance of the development project											
	Model 0			Model 2c/3b			Model 1c/2b/3c			Model 2d/3a		
N	127			127			127			127		
$F_{for\ regression}$	2.27*			2.47**			1.89*			2.69**		
R^2	0.18			0.22			0.18			0.23		
$R^2_{adjusted}$	0.10			0.13			0.08			0.15		
F-test for difference				3.05†			0.02			4.23*		
	b	sd	*β*	b	sd	*β*	b	sd	*β*	b	sd	*β*
Intercept	12.66 ***	(3.84)		13.67 ***	(3.80)		12.63 ***	(3.93)		11.92 ***	(3.83)	0.00
Construction Firms	-2.25†	(1.22)	-0.21	-2.67*	(1.22)	-0.25	-2.25†	(1.24)	-0.21	-1.85	(1.20)	-0.17
IT Firms	-1.03	(1.41)	-0.08	-1.25	(1.41)	-0.10	-1.01	(1.43)	-0.08	-0.61	(1.38)	-0.05
Engineering Firms	-2.68†	(1.57)	-0.21	-2.70†	(1.54)	-0.21	-2.70†	(1.59)	-0.21	-2.26	(1.53)	-0.18
Firm size	0.04	(0.70)	0.01	0.08	(0.69)	0.01	0.05	(0.71)	0.01	0.16	(0.69)	0.02
Service Firms	0.67	(0.53)	0.14	0.58	(0.52)	0.12	0.67	(0.53)	0.14	0.69	(0.51)	0.15
Fit	0.69***	(0.24)	0.26	0.64**	(0.24)	0.24	0.69**	(0.24)	0.27	0.70***	(0.24)	0.27
Integration[b]	-0.02	(0.07)	-0.03	-0.02	(0.07)	-0.02	-0.02	(0.07)	-0.03	-0.07	(0.07)	-0.10
Internal Operational collaborative capabilities[b]	0.14	(0.11)	0.12	0.14	(0.11)	0.12	0.14	(0.11)	0.12	0.18	(0.11)	0.15

External operational collaborative capabilities[b]	0.09	(0.18)	0.05	0.14	(0.18)	0.07	0.10	(0.19)	0.05	0.14	(0.18)	0.07
Multidisciplinary team[b]	0.16	(0.11)	0.13	0.18†	(0.11)	0.16	0.15	(0.11)	0.13	0.21†	(0.11)	0.18
Supplier involvement[b]	0.33†	(0.18)	0.18	0.27	(0.18)	0.15	0.33†	(0.19)	0.18	0.31†	(0.18)	0.17
Integration x Multidisciplinary team[b]				-0.04**	(0.02)	-0.22						
Integration x Supplier involvement[b]				0.01	(0.02)	0.05						
Internal Operational collaborative capabilities x Multidisciplinary team							0.00	(0.02)	-0.01			
External operational collaborative capabilities x Supplier involvement[b]							0.00	(0.06)	-0.01			
Integration x Internal Operational collaborative capabilities x Multidisciplinary team[b]										0.01*	(0.00)	0.18
Integration x External operational collaborative capabilities x Supplier involvement[b]										0.01†	(0.01)	0.16

[a] Unstandardized coefficients are reported, with standard errors in prarentheses, as well as standardized coefficients,
[b] mean centered,
† $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

combined effect of integration and external operational collaboration capabilities, model 1b SI in table 2, does not have an effect on the use of supplier involvement either (0.00 (-0.03), p = ns, $F_{\text{for difference}} = 0.08$, p = n.s.). Summarized, we do not find support for hypothesis 1b.

Model 1c tests hypothesis 1c, whether multidisciplinary teams and supplier involvement have a less positive contribution to the performance of development projects if the firms has respectively internal or external operational collaborative capabilities. The direct contribution for supplier involvement to performance is positive and significant (0.33 (0.18), $p < 0.10$). The direct contribution of a multidisciplinary team is not significant. The interaction effects of internal and external collaborative capabilities on the effectiveness of respectively a multidisciplinary team and supplier involvement are insignificant. We therefore conclude that neither internal nor external operational collaborative capabilities affect the effectiveness of respectively a multidisciplinary team or supplier involvement. This means that hypothesis 1c is not supported.

In conclusion, we find only partial support for the Routine Model.

Model 2a-2d represent the hypotheses 2a-2d of the Dynamic Capability model. Hypothesis 2a states that there is no significant effect of operational collaborative capabilities on the use of a multidisciplinary team and supplier involvement in the development process. This hypothesis is not supported by the models 2a MT and 2a SI. We explained above, for the Routine Model (1a MT and 1a SI), that there is a positive relationship between internal and external collaborative capabilities and the use of respectively a multidisciplinary team and supplier involvement in the development process.

Hypothesis 2b states that internal and external operational collaborative capabilities have no significant effect on the contribution to performance by respectively multidisciplinary teams and supplier involvement in the development process.. Model 2b, testing hypothesis 2b, is not an improvement over the zero model ($R^2_{\text{adjusted}} = 0.08$ versus $R^2_{\text{adjusted}} = 0.10$, F_{for} difference = 0.02 p = n.s.) As explained above for model 1c, the interaction effect of internal or external collaborative capabilities on the relationship between performance and a multidisciplinary team or supplier involvement is insignificant. Our data provides thereby support for hypothesis 2b.

Model 2c tests whether multidisciplinary teams and supplier involvement have a lower positive contribution to the performance of development projects when these projects are executed within the operational environment (hypothesis 2c). Model 2c is a significant improvement over model 0 ($R^2_{\text{adjusted}} = 0.13$ versus $R^2_{\text{adjusted}} = 0.10$, F_{for} difference = 3.05 $p < 0.10$). In model 2c, the direct contribution to performance is positive and significant for a multidisciplinary team (0.18 (0.16), $p < 0.10$), but not for supplier involvement (0.27 (0.15)). The interaction effect of integration on the effectiveness of a multidisciplinary team is negative and significant (-0.04 (-0.22), $p < 0.01$). The interaction effect on the effectiveness of supplier involvement is insignificant (0.01 (0.05)). This implies that the execution of development projects in the operational environment reduces the contribution of a multidisciplinary team to the performance of development projects. This interaction effect does not exist for supplier involvement. Hypothesis 2c is thereby partially supported.

Model 2d, in the last column of Table 5.3, shows the results for the combined effect of integration and operational collaborative capabilities. Hypothesis 2d states that

multidisciplinary teams and supplier involvement have a lower positive contribution to the performance of development projects when these projects are executed development project within the operational environment and when the firm has respectively internal or external operational collaborative. The results show however a positive interaction effect, respectively (0.01 (0.18), $p < 0.05$) on the effectiveness of a multidisciplinary team and (0.01 (0.16), $p < 0.10$) on the effectiveness of supplier involvement. We have thereby no support for hypothesis 2d.

Although we find support for hypotheses 2b and partially for 2c, we conclude that there is no support for the Dynamic Capability model for two reasons. Firstly, we found a positive, instead of the hypothesized absence of a relationship, between operational collaborative capabilities and the use of multidisciplinary teams and supplier involvement. Secondly, we found a positive, instead of the hypothesized negative relationship, for the combined effect of integration and internal and external collaborative capabilities.

Model 3a-c represent hypotheses 3a-3c of the Absorptive Capacity Model.
Model 3a tests whether multidisciplinary teams and supplier involvement have a stronger positive effect on the performance of development projects when these projects are executed within the operational environment and when the firm has respectively internal or external operational collaborative capabilities. This model is a significant improvement over model 0 ($R^2_{adjusted} = 0.15$ versus $R^2_{adjusted} = 0.10$, F_{for} difference = 4.23 $p < 0.05$). In model 3a, fit is the only significant control variable (0.70 (0.27), $p < 0.001$). Multidisciplinary team (0.21 (0.18), $p < 0.10$) and supplier involvement (0.31 (0.17), $p < 0.10$) both contribute significant to performance. The combined interaction effect of integration and internal or external collaborative capabilities on the use of respectively a multidisciplinary team is also significant, respectively (0.01 (0.18), $p < 0.10$) for the effect on a multidisciplinary team and (0.01 (0.16), $p < 0.10$) for the effect on supplier involvement. Hence, Model 3a shows that internal and external operational collaborative capabilities in combination with executing development project in the operational environment increases the contribution to performance of respectively a multidisciplinary team or supplier involvement, providing support for hypothesis 3a.

Hypothesis 3b, stating that execution of development projects within the operational environment only, without the existence of internal and external collaborative capabilities in a firms, has no significant effect on the contribution to performance by respectively multidisciplinary team or supplier involvement in the development process, is tested by model 3b. As explained above, for model 2c, there is a negative interaction effect of integration on the use of a multidisciplinary team. This interaction effect is insignificant for supplier involvement. It means that Hypothesis 3b is supported for supplier involvement only.

Model 3c shows that there is no significant interaction effect of operational collaborative capabilities on the use of multidisciplinary teams or supplier involvement. It means that Hypothesis 3c, that internal and external operational collaborative capabilities only, without executing the development projects within a firm's

operational environment, have no significant effect on the contribution to performance by respectively multidisciplinary teams and supplier involvement in the development process, is fully supported.

In conclusion, we find full support for the Absorptive Capacity Model for the effectiveness of supplier involvement, and partial support with respect to the effectiveness of a multidisciplinary team. The interpretation of the results is given in the discussion section below.

Table 5.4 Overview results

	Routine Model	**Dynamic Capability Model**	**Absorptive Capacity Model**
	Model 1	**Model 2**	**Model 3**
The use of a multidisciplinary team or supplier involvement			
Effect of collaborative capabilities	**(H1a) positive effect = supported**	(H2a) no effect = not supported	
Combined effect of collaborative capabilities and integration	(H1b) positive effect = not supported		
The effectiveness of a multidisciplinary team or supplier involvement			
Interaction effect of integration		**(H2c) negative effect = partially supported**	**(H3a) no effect = partially supported**
Interaction effect of collaborative capabilities	(H1c) negative effect = not supported	**(H2b) no effect = supported**	**(H3b) no effect = supported**
Combined interaction effect of integration and collaborative capabilities		H2d = negative effect = not supported	**H3c = positive effect = supported**

DISCUSSION AND CONCLUSION

We developed and tested three alternative models for the impact of operational collaborative capabilities on the use and effectiveness of multidisciplinary teams and supplier involvement in the development process.

The Routine Model proposes that operational collaborative capabilities are accompanied by certain routines and that the same routines are copied into the development process. We find that internal and external operational collaborative routines lead to the increased use of respectively multidisciplinary teams and supplier involvement in the development process. We also hypothesized that integration would strengthen the use of these routines. We do not find support for this latter hypothesis. In addition, we predicted that operational collaborative capabilities would reduce the effectiveness of a multidisciplinary team and supplier involvement. We do not find

support for this prediction. This means that the Routine model provides an explanation for the use of multidisciplinary teams and supplier involvement, but not of the effects of these behaviors on performance.

The Dynamic Capability Model hypothesizes that there is no influence of operational collaborative capabilities on the use or effectiveness of multidisciplinary teams or supplier involvement in the development process. The reason is that we presume for this model that "static" operational capabilities are unsuitable to use in the "dynamic" development process. We do not find support for this model. Internal and external operational collaborative capabilities clearly influence the use of respectively multidisciplinary teams and supplier involvement in the development process. The expected negative effect of integration on the use of multidisciplinary teams and supplier involvement is supported for multidisciplinary teams only. However it is unlikely that this negative effect is due to operational capabilities hindering multidisciplinary teams. If integration would hinder a multidisciplinary team, we would not have found a significant positive effect for the combination of integration and operational collaborative capabilities. We have therefore to conclude that the Dynamic Capability model incorrectly depicts the influence of operational capabilities on the use of a multidisciplinary team or supplier involvement in the development process.

The Absorptive Capacity Model makes use of the concept absorptive capacity. The use of a multidisciplinary team and supplier involvement, in combination with executing development projects in the operational environment, and the existence of internal and external collaborative capabilities, seems to contribute to the absorptive capacity of these development projects. As a consequence, a multidisciplinary team and supplier involvement become more effective within these projects. Hypothesis 3a, that integration without operational collaboration has no effect, is not supported for multidisciplinary teams. Integration reduces the effectiveness of a multidisciplinary team, instead of having no effect as hypothesized in the Absorptive Capacity model. Apparently, a multidisciplinary team becomes a superfluous knowledge transfer mechanism when development projects are executed within a firm's operational environment.

Our findings suggest that different models determine the use and effectiveness of multidisciplinary teams and supplier involvement. The Routine Model best describes the use of multidisciplinary teams and supplier involvement in the development process. Operational collaborative routines make it probably more attractive to use multidisciplinary teams and supplier involvement in the development process. The Absorptive Capacity model best describes the effectiveness of multidisciplinary teams and supplier involvement in the development process.

We do not find an increased use of multidisciplinary teams or supplier involvement, as a result of the increased effectiveness of multidisciplinary teams or supplier involvement in combination with integration and operational collaborative capabilities. Nor do we find an increase in effectiveness as a result of the existence of operational collaborative capabilities. Hence the effectiveness of multidisciplinary teams or supplier involvement does currently not seem to determine their use.

Contribution to theory

This paper is relevant for several streams of literature. It adds to the innovation management literature by addressing the influence of firm characteristics on success factors for innovation. Although some authors in innovation management acknowledge that findings and ideas are contingent on contextual factors, the mainstream literature on innovation management reads as recipe books, showing how to best cook innovations (Cooper 2001; Wheelwright and Clark 1992), irrespective of the kitchen environment. Eisenhardt and Martin (2000, p. 1108) even explicitly claim that, "commonalities arise because there are more and less effective ways of dealing with the specific organizational, interpersonal and technical challenges that must be addressed … Just as there are better and worse ways to hit a golf ball or ski a mogul field, there are more and less effective ways to execute new product development projects". We show that executing development project within the operational environment, in combination with operational collaborative capabilities, affects the effectiveness of a multidisciplinary team and supplier involvement. In addition, the operational collaborative capabilities of firms influence the use of multidisciplinary teams and supplier involvement. We expect that the use and effectiveness of other success factors mentioned in the innovation literature are also contingent on a firm's operational capabilities, or on the degree of separation between its innovative activities and operations.

This paper also contributes to the literature on absorptive capacity. This literature addresses the absorptive capacity of the firm as a whole, and considers R&D one of the factors that affect a firm's absorptive capacity. We show that specific processes in the firm also need to import knowledge, and that capabilities residing in other processes affect the ability to import this knowledge. Moreover, we apply this perspective to R&D itself, demonstrating that operational capabilities increase the absorptive capacity of development activities. A prerequisite is the existence of transfer mechanisms and an interface (Cohen and Levinthal 1990; van den Bosch et al. 1999). The necessary interface is created when development projects are executed within the operational environment. The transfer mechanisms for knowledge consist of internal and external operational collaborative capabilities and respectively a multidisciplinary team and supplier involvement within the development project.

In addition, this paper contributes to contingency theory. Contingency theory describes the use of organizational configurations (Donaldson 2001; Schoonhoven 1981; Schoonhoven 1981). Each organization should adapt a configuration, depending on the complexity and uncertainty of the tasks. Our research shows that separation of the development process from the operational process, in order to create the optimal organizational configuration for both these processes, also has negative consequences. This separation hinders the use of operational capabilities in the development process. Current literature suggests that operational knowledge can be inserted by using a multidisciplinary team and supplier involvement in development projects. Our findings suggest that a multidisciplinary team and supplier involvement contribute to the performance of development projects, but this positive relationship was not significant for all models. Multidisciplinary teams and supplier involvement are more effective in combination with operational collaborative capabilities and execution of the development projects in the operational environment. We suggest therefore that within

contingency theory, besides complexity and uncertainty, also a firm's operational capabilities are taken into consideration when determining a firm's optimal organizational configuration.

Practitioners will also benefit from our findings. Managers in the Construction and Engineering industries seem to use multidisciplinary teams and supplier involvement in development projects because they are used to do so in their operational process. For the same reason, managers in the IT industry seem to use multidisciplinary teams in their development projects. Our results show that using a multidisciplinary team or supplier involvement as a consequence of operational collaborative capabilities does not bring additional advantage. Execution of development projects in the operational environment alone makes a multidisciplinary team even superfluous. This integration does not affect supplier involvement in the development process. The combination of operational collaborative capabilities and the execution of development projects in the operational environment make multidisciplinary teams and supplier involvement more effective. This finding suggests that firms that have strong internal and external collaborative capabilities could best perform their development process in close proximity of their operations, and could best use multidisciplinary teams and supplier involvement in their development process to take more advantage of these capabilities.

Limitations

Our research has several limitations. First, we only looked at development projects in a limited amount of industries and our sample consisted of 144 development projects only. Second, our sample was not entirely randomly drawn, as some firms were approached via support groups. This limits the generalizibility of our findings to the Construction and IT industries. Third, we only looked at internal and external operational collaborative capabilities, other operational capabilities were not taken into account. Future research investigating other operational capabilities, as for example customer collaboration capabilities or project management capabilities, may show that also these operational capabilities affect specific behaviors in the development process. Fourth, we investigated the effect of operational collaborative capabilities and integration on the use and effectiveness of multidisciplinary teams and supplier involvement in development projects. We also investigated the effect of integration on this relationship. Our sample, consisting of a more and/or a less successful development projects per firm, did not enable us to simultaneously investigate the direct effect of integration on the performance of the development projects. Future research can supplement this study by investigating the effects of integration on the innovative output of a firm as a whole. Since the variety in the degree of separation is rather low in manufacturing industries, such research could best study similar industries as the ones addressed in this study.

REFERENCES

Barney, J. B. 1991. "Firm Resources and Sustained Competitive Advantage." *Journal of Management* 17(1): 99-120.

Blindenbach-Driessen, F. P. and J. Van den Ende forthcoming. "Innovation in Project-Based Firms; the Context Dependency of Success Factors." *Research Policy*.
Brockhoff, K. 2003. "Customers' Perspectives of Involvement in New Product Development." *International Journal of Technology Management* 26(5/6): 464-480.
Brown, S. L. and K. M. Eisenhardt 1995. "Product Development: Past Research, Present Findings, and Future Directions." *Academy of Management Review* 20(2): 343-378.
Burns, T. and G. M. Stalker 1994. *The Management of Innovation*. Oxford, Oxford University Press.
Burton, R. M., J. Lauridsen, et al. 2002. "Return on Assets Loss from Situational and Contingency Misfits." *Management Science* 48(11): 1461-1485.
Christensen, C. M. 1997. *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*. Boston, Boston business school press.
Clark, K. B. 1989. "Project Scope and Project Performance: The Effect of Parts." *Management Science* 35(10): 1247-1263.
Cohen, W. M. and D. A. Levinthal 1990. "Absorptive Capacity: A New Perspective on Learning and Innovation." *Administrative Science Quarterly*(35): 128-52.
Cooper, R. G. 2001. *Winning at New Products, Accelerating the Process from Idea to Launch*. Cambridge, Massachusetts, Perseus.
Damanpour, F. 1991. "Organizational Innovation: A Meta-Analysis of Effects of Determinants and Moderators." *Academy of Management Journal* 34(3): 555-590.
Danneels, E. 2002. "The Dynamics of Product Innovation and Firm Competences." *Strategic Management Journal* 23: 1095-1121.
De Brentani, U. 1989. "Success and Failure in New Industrial Services." *Journal of Product Innovation Management* 6: 239-258.
De Brentani, U. and E. Ragot 1996. "Developing New Business-to Business Professional Services: What Factors Impact Performance." *Industrial Marketing Management* 25: 517-530.
Donaldson, L. 2001. *The Contingency Theory of Organizations*. Thousand Oaks, Sage.
Dougherty, D. 1992. "Interpretive Barriers to Successful Product Innovation in Large Firms." *Organization Science* 3(2): 179-202.
Drazin, R. and A. H. Van de Ven 1985. "Alternative Forms of Fit in Contingency Theory." *Administrative Science Quarterly* 30: 514-539.
Eisenhardt, K. M. and J. A. Martin 2000. "Dynamic Capabilities: What Are They?" *Strategic Management Journal* 21: 1105-1121.
Ernst, H. 2002. "Success Factors of New Product Development: A Review of the Empirical Literature." *International journal of management reviews* 4(1): 1-40.
Foss, N. J., Ed. 1997. *Resources Firms and Strategies*. Oxford, Oxford University Press.
Galbraith, J. R. 1977. *Organization Design*. Reading MA, Addison-Wesley.
Gann, D. M. and A. J. Salter 2000. "Innovation in Project-Based, Service-Enhanced Firms: The Construction of Complex Products and Systems." *Research Policy* 29: 955-972.

Gerwin, D. and N. J. Barrowman 2002. "An Evaluation of Research on Integrated Product Development." *Management Science* 48(7): 938-953.

Grant, R. M. 1996. "Propsering in Dynamically-Competitive Environements: Organizational Capability as Knowledge Integration." *Organization Science* 7(4): 375-387.

Griffin, A. 1997. "PDMA Research on New Product Development Practices: Updating Trends and Benchmarking Best Practices." *Journal of Product Innovation Management* 14: 429-458.

Griffin, A. and A. L. Page 1996. "PDMA Success Measurement Project: Recommended Measures for Product Development Success and Failure." *Journal of Product Innovation Management* 13(4): 478-496.

Hamel, G., Y. L. Doz, et al. 1989. Collaborate with Your Competitors and Win. *Harvard Business Review***:** 133-139.

Henard, D. H. and D. M. Szymanski 2001. "Why Some New Products Are More Successful Than Others." *Journal of Marketing Research* 38(3): 362-375.

Henderson, R. and I. Cockburn 1994. "Measuring Competence? Exploring Firm Effects in Pharmaceutical Research." *Strategic Management Journal* 15: 63-84.

Hoch, D. J., C. R. Roeding, et al. 2000. *Secrets of Software Success: Management Insights from 100 Software Firms around the World*. Boston, Massachusetts, Harvard Business School Press.

Iansiti, M. and K. B. Clark 1994. "Integration and Dynamic Capability: Evidence from Product Development in Automobiles and Mainframe Computers." *Industrial and Corporate Change* 3(3): 557-605.

Kusunoki, K., I. Nonaka, et al. 1998. "Organizational Capabilities in Product Development of Japanese Firms: A Conceptual Framework and Empirical Findings." *Organization Science* 9(6): 699-718.

Leonard-Barton, D. 1992. "Core Capabilities and Core Rigidities: A Paradox in Managing New Product Development." *Strategic Management Journal* 13.

Lovelace, K., D. L. Shapiro, et al. 2001. "Maximizing Cross-Functional New Product Teams' Innovativeness and Constraint Adherence: A Conflict Communications Perspective." *Academy of Management Journal* 44(4): 779-793.

Maidique, M. A. and B. J. Zirger 1985. "The New Product Learning Cycle." *Research Policy* 14: 299-313.

Montoya-Weiss, M. M. and R. Calantone 1994. "Determinants of New Product Performance: A Review and Meta-Analysis." *Journal of Product Innovation Management* 11: 397-417.

Nelson, R. R. 1991. "Why Do Firms Differ, and How Does It Matter?" *Strategic Management Journal* 12(1): 61-74.

Nelson, R. R. and S. G. Winter 1982. *An Evolutionary Theory of Economic Change*. Cambridge, MA, Harvard University Press.

Panne, G. van de 2003. "Success and Failure of Innovation: A Literature Review." *International Journal of Innovation Management* 7(3): 309-338.

Peteraf, M. A. 1993. "The Cornerstones of Competitive Advantage." *Strategic Management Journal* 14(3): 179-191.

Pinto, J. K. and M. B. Pinto 1990. "Project Team Communication and Cross-Functional Cooperation in New Program Development." *Journal of Product Innovation Management* 7: 200-212.

Podsakoff, P. M., S. B. Mackenzie, et al. 2003. "Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies." *Journal of Applied Psychology* 88(5): 879-903.

Prahalad, C. K. and G. Hamel 1990. "The Core Competence of the Corporation." *Harvard Business Review* 68(3): 79-91.

Prencipe, A., A. Davies, et al., Eds. 2003. *The Business of Systems Integration*. Oxford, Oxford University Press.

Primo, M. A. M. and S. D. Amundson 2002. "An Exploratory Study of the Effects of Supplier Relationships on New Product Development Outcomes." *Journal of Operations Management* 20: 33-52.

Schmitt, N. 1996. "Uses and Abuses of Coefficient Alpha." *Psychological Assessment* 8(4): 350-353.

Schoonhoven, B. C. 1981. "Problems with Contingency Theory: Testing Assumptions Hidden within the Language of Contingency " Theory"." *Administrative Science Quarterly* 26: 349-377.

Schoonhoven, C. B. 1981. "Problems with Contingency Theory: Testing Assumption Hidden within the Language of Contingency "Theory"." *Administrative Science Quarterly* 26: 349-377.

Sholes, G. and S. Kevan 1999. *Exploring Corporate Strategy*. Harlow, Prentice Hall.

Sundbo, J. and F. Gallouj 2000. "Innovation as a Loosely Coupled System in Services." *International Journal of Services Technology and Management* 1(1): 15-35.

Teece, D. J., G. P. Pisano, et al. 1997. "Dynamic Capabilities and Strategic Management." *Strategic Management Journal* 18(7): 509-533.

Thomke, S. 2003. R&D Comes to Services: Bank of America's Pathbreaking Experiment. *Harvard Business Review*. 81**:** 70-79.

van den Bosch, F. A. J., H. W. Volberda, et al. 1999. "Coevolution of Frim Absoptive Capacity and Knowledge Environment: Organizational Forms and Combinative Capabilities." *Organization Science* 10(5): 551-568.

Wernerfelt, B. 1984. "A Resource-Based View of the Firm." *Strategic Management Journal* 5: 171-180.

Wheelwright, S. C. and K. B. Clark 1992. *Revolutionizing Product Development*. New York, The Free Press.

Winter, S. G. 2003. "Understanding Dynamic Capabilities." *Strategic Management Journal* 24: 991-995.

APPENDIX 5.A

Construct	Items	Factor loadings	α
Reach database			
Industry	Used Reach database as source construction industries (bik 45), and information and telecom industries (bik 72), engineering industries (bik 74) and a rest group.	-	
R&D manager's questionnaire			
Firm size	How many employees work for your organization, less than 100, between 100 and 1000, or more than 1000 employees	-	
Service firm	Does your organization provide -Products -Services -A combination of products and services	-	
Integration	-In case development projects are executed within your organization, who is usually responsible		0.64
	-R&D department (yes/no)[R]	0.88	
	-To what extent do you agree with the following statement, regarding the development of new products or services within your organization ((1-7 point Likert scale)		
	-R&D is primarily responsible for innovations within our organization[R]	0.73	
	-The organization of development projects is formalized within our organization[R]	0.76	
Internal operational collaborative capabilities	To what extent do you agree with the following statements (1-7 point Likert scale)		0.90
	-Various functional departments (production, marketing, R&D etc) acknowledge each others expertise.	0.85	
	-The communication between the various functional departments is frequent and open	0.89	
	-Various disciplines (engineering, design etc.) acknowledge each others expertise.	0.87	
	-The communication between the various disciplines is frequent and open	0.90	
External operational collaboration capabilities	To what extent do you agree with the following statements (1-7 point Likert scale)		0.56
	-Our products or services are very complex because they consist of many components	0.69	
	-Our products or services are very complex because many different parties are involved in the production process	0.81	
	-Collaboration with other institutes and firms (disregarding collaboration with your customers) is essential	0.65	

Performance	To what extent do you agree with the following statements (1-7 point Likert scale)		0.86
	-A consequence of this project the reputation of our organization in the area related to this project is increased	0.76	
	-The new or improved product / service has given us a competitive advantage.	0.88	
	-The new or improved product / service fulfils the needs of the clients	0.82	
	-The gained profit is …? Very much lower than expected- Very much higher than expected (5 point scale)	0.81	
	-The achieved revenue is…? Very much lower than expected- Very much higher than expected (5 point scale)	0.77	
Project leader's questionnaire			
Fit	To what extent do you agree with the following statements (1-7 point Likert scale)		0.80
	-This development projects is in line with the current competences of our organization	0.79	
	-This development projects suits the future demands of our current customers	0.79	
Multi-disciplinary team	To what extent do you agree with the following statements (1-7 point Likert scale)		0.74
	-Various functional departments (production, marketing etc) were fully involved in this development project	0.90	
	-Various disciplines (engineering, design etc.) were fully involved in this development project	0.74	
	-Marketing was closely involved in this project	0.78	
Supplier involvement	To what extent were suppliers involved in the development project?	-	
	-Suppliers were not involved		
	-Suppliers		

Note: The questions were in Dutch, R = reversed coded.

Chapter 6

Conclusions

SUMMARY OF THE FINDINGS

Two research questions were addressed in this dissertation. Firstly, we investigated to which extent the management of development projects of project-based firms is similar to the management of development projects described in the innovation management literature. The results of chapter 2 and 4 indicate that the management of development projects differs between project-based firms and non-project-based firms. Executing of development projects within project-based firms is not self evident. Development projects compete for the same resources with the more urgent business projects. Furthermore, we found in the comparative study that planning and multidisciplinary teams contribute negatively, while a heavyweight project leader contributes more to the performance of development projects of project-based firms than of non-project-based firms.

Secondly, we investigated the impact of the specific characteristics of project-based firms, such as the organizational structure, the routines and capabilities, on the success factors for development projects. The results of chapters 2 and 4 illustrate that the characteristics of project-based firms could have an affect on success factors of development projects. In chapter 4, we did not find prove for the hypothesized lower or higher adherence to certain factors in project-based firms compared to non-project-based firms. For example availability of experts was equal on development projects of both types of firms. In chapter 5 we focused on the influence of operational capabilities on success factors for development projects. In this chapter we found that internal and external collaborative capabilities affected the use respectively multidisciplinary teams and supplier involvement in the development process.

By definition the project-based firms had a project-based organizational structure and project-management capabilities. In chapter 4 we found that project-based firms also had a higher level of collaborative capabilities than non-project-based firms. We used these differences in characteristics between project-based and non-project-based firms to explain the differences in success factors between both types of firms. In chapter 5 we developed and tested three alternative models, of how operational capabilities affect success factors for development projects. Executing development projects in the operational environment made multidisciplinary teams redundant for development projects. At the same time, we found that the combination of executing development projects in the operational environment and operational collaborative capabilities increased the effectiveness of multidisciplinary teams and supplier involvement. Our findings thereby support the idea that firm characteristics affect success factors for development projects.

Similarities and discrepancies in the findings

Table 6.1 gives a summary of the research results. Below we discuss the similarities and discrepancies between the findings of each chapter.

Chapter 2 described the exploratory study concerning the management of development projects in project-based firms. In this chapter we illustrated how organizational characteristics could affect the use of and the need for specific factors within the six development process of four project-based firms. Subsequently hypotheses were developed, regarding the contribution of factors to the performance of development projects in project-based firms compared to other firms. Not all these hypotheses were tested in chapter 4, because the survey approach only enabled testing of a few variables. The hypothesis regarding planning was simplified. In the survey, planning referred to the preparation and the availability of a plan, while we distinguished between different types of planning in chapter 2. In chapter 4 the hypothesis reads therefore that planning is less important, instead of more important, see first row Table 6.1.

In chapter 4, we tested differences in success factors between project-based and non-project-based firms. The quantitative data also enabled comparison of specific routines and capabilities of project-based firms with those of non-project-based firms. Project-based firms, by definition, differed in organizational structure and project-management capabilities. The internal collaborative capabilities of project-based firms were significantly higher than those of non-project-based firms, see also Table 6.2. We did not find differences in routines for project planning, the use of cross-disciplinary teams, senior management support, autonomy for the project leader of a development team, or assigning experts to development projects. Some of the hypotheses developed in chapter 2 were based on the assumption that there would be difference in the use of these factors between project-based and non-project-based firms. In project-based firms, the internal collaborative capabilities do not lead to a higher use of multidisciplinary teams, while this would be expected based on the results of chapter 5. There are several explanations for this finding. For instance, it could be that project-based firms apply different routines on their business projects than we assumed, i.e. they do not always use multidisciplinary teams on these projects. Or the routines used for the execution of business projects are not simply copied into the execution of development projects in project-based firms. Or other factors play a role in the decision to use multidisciplinary teams or supplier involvement in development projects. This latter explanation is most likely. The regression results of Table 4.4 showed that besides collaborative capabilities many other factors contributed to the use of multidisciplinary teams and supplier involvement. For multidisciplinary teams the regression equation was even insignificant.

With respect to the effectiveness of multidisciplinary teams, we have several, seemingly contradictory, findings. In chapter 2, we did not expect that multidisciplinary teams would distinguish between successful and unsuccessful development projects in project-based firms. In chapter 4, we found that multidisciplinary teams contributed even negatively to the performance of development projects. In chapter 5, we found that integration makes multidisciplinary teams redundant, while the combination of integration and internal operational collaborative capabilities made multidisciplinary teams more effective. Table 6.2 shows that project-based firms have internal

operational collaborative capabilities and executed their development projects in the operational environment (= integration). Given the results of chapter 5, this combination should result in a higher effectiveness of multidisciplinary teams for project-based firms, instead of the negative contribution we found in chapter 4.

In project-based firms there is apparently another reason why multidisciplinary teams contribute negative instead of positive to the performance of development projects. An explanation for the negative effect could be that project-based firm need specialization within in their development projects, instead of collaboration between disciplines and functions. In functional firms, where each functional department is has its own specialization, integration of specializations is of great importance for development projects. However, specialization is problematic in project-based firms (Galbraith 1971). It is thus likely that specialization instead of collaboration is of great importance for development projects in project-based firms. This could explain why multidisciplinary teams hamper the performance of development projects in project-based firms, as probably instead specialists teams are needed to develop specialized or focused new products or services. In hindsight, we can say that the successful cases of chapter 2, Outsourcing, Water Contest and Soil Cleaning made used of such specialized teams. Then, we thought that these teams were multidisciplinary, since each core member had knowledge of multiple disciplines. Furthermore, when needed, members from other disciplines contributed to each project at an ad hoc basis. At the same time these core members were expert in respectively outsourcing, water management and soil cleaning. With the knowledge we have know, we would reinterpret these teams as specialists teams, or focused teams. The execution of development projects within the operational environment and the internal collaborative capabilities made that these focused team did not operate in isolation, but could draw from other disciplines when needed.

A result of integration of development projects in the operational environment is that each team member is aware of the operational requirements that need to be met. Consequently multidisciplinary teams, used to import this knowledge into the development process, become redundant. Internal operational capabilities alone have no significant effect on multidisciplinary teams. Without taking integration into account, internal operational collaborative capabilities do not affect the effectiveness of success factors for development projects, although internal operational collaborative capabilities lead to a higher use of multidisciplinary teams. In non-project-based firms, the combination of internal operational capabilities and integration, increases the effectiveness of multi-disciplinary teams. This combination enables development projects in these firms to increase their capacity to absorb knowledge from the operational environment.

The findings of chapter 5 support our interpretation of the higher importance of heavyweight project leaders in project-based firms compared to non-project-based firms. In chapter 4 we speculated that the project leader in project-based firms had an important role in translating the specialized new services and products and ensuring that these were used in future business projects. The higher importance of project-managers in project-based firms and this explanation both match with the absorptive capacity model of chapter 5. The absorptive capacity model implies that the combination of operational capabilities, an interface, and a receiving mechanism is necessary to make

Table 6.1 Overview of the results of each chapter

	Findings				
	Chapter 2		Chapter 4		Chapter 5
Factors from innovation management literature	**Observed contribution to success**	**Hypothesized relative contribution to success**	**Hypothesized relative contribution to success**	**Results**	**Results**
Planning of work					
Planning and contingent approach	Straightforward planning approach seemed to hinder especially the more radical development projects	More important	Less important	Supported, contributes even negative to the performance of development projects in project-based firms. We did not find a difference in usage of planning.	-
Senior management involvement					
Project selection	Selection seemed to increase the visibility and status, subsequently more resources were available	More important	-		-
Support	Too much autonomy seem to make the projects wandered off, either in the wrong direction or toward insufficient quality	More important	More important	Not supported, Senior management support is a success factor in both project-based and non-project-based firms.	-
Team					
Multidisciplinary team	Multidisciplinary collaboration did not seem to differentiate the successful from the less successful projects	Less important	Less important	Supported, multidisciplinary teams contribute even negative to the perofmrnace of development project in project-based firms. We did not find a difference in usage of multidisciplinary teams.	Internal operational collaborative capabilities lead to a higher usage multidisciplinary teams. Integration makes cross functional teams as transfer mechanism redundant Combination of internal

					operational capabilities and integration enables leveraging of operational knowledge
Expertise	Absence of experts seem to decrease performance	More important	More important	Not supported. Expertise is a success factor in both project-based and non-project-based firms. We did not find a difference in the availability of experts	-
Heavyweight project leader	Light or medium weight project leaders seemed sufficient to manage the development projects	Less important	Less important	Rejected, instead we found that heavyweight project leaders are more important in project-based firms.	-
Product champion	Product champions seemed to promote their projects effectively	Equally important	-	-	-
External team communication	External promotion seemed to enhanced the visibility of projects (for successful projects only)	Equally important	-	-	-
Involvement of outside parties					
Customer involvement	Customer needs seemed well understood. Clients are not a good source of information for the more radical projects.	Less important	-	-	-
Supplier involvement	Involvement of suppliers did not seem to differentiate the successful from the less successful projects.	Less important	-	-	External operational collaborative capabilities leads to a more frequent involvement of suppliers on development projects. Combination of external operational capabilities and integration enables leveraging of operational knowledge

knowledge from the operational process available in the development process. In the case the heavyweight project leader, his task is not only to enable knowledge to flow from the operational environment to the development projects, but also from the development projects to the operational environment.

In chapter 4 we found no support for the increased contribution to performance by experts or senior management support, as hypothesized in chapter 2. As stated in chapter 4, we found neither a lack of senior management support for the development projects of project based firms, nor that these projects would suffer from too much autonomy. These were both assumptions underlying the hypothesis for the need of more senior management support in project-based firms. The project-based firms that execute development projects have a more innovative strategy. It is likely that in these firms senior management provides a culture for innovation, and has a clear vision on innovation activities. As a consequence, it is likely that development projects in this environment receive more senior management support than in project-based firms that only occasionally or rarely executed development projects. Moreover we think that senior management support and experts are important for any development project in all types of firms.

Table 6.2 Correlations for the total sample of firms (N = 203)

Variable	1	2	3	4	5	6	7
1. Project-based firms							
2. Integration	0.25***						
3. Service firms	0.04	0.31***					
4. Construction firms	0.40***	0.18**	-0.20**				
5. IT firms	-0.38***	-0.14*	0.11	-0.48***			
6. Engineering firms	0.08	0.06	0.33***	-0.31***	-0.22**		
7. Internal operational collabortive capabilties	0.25***	-0.04	-0.09	0.17*	-0.19**	0.04	
8. External operational collabortive capabilties	0.38***	0.01	0.01	0.31***	-0.32***	0.08	0.25***

Pearson correlations
* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$

Performance Measurement of development projects

Chapter three was devoted to performance measurement of development projects. In this chapter we concluded that project and market success are two distinct concepts. We

argued that project success should be defined as a formatively-indicated construct. And market success should be defined as a reflectively-indicated construct.

The main reasons for not assessing both project and market performance in the subsequent chapters were that it added to the complexity of the paper, while it did not lead to additional results. As it appeared, some success factors, i.e. expertise and multidisciplinary teams, behave not exactly the same with respect to project or market performance. The already many hypotheses in chapter 4, or the complex models of chapter 5, had thus to be split to account for both project and market success. That each factors contributes differently to project and market performance, does however underline that project and market performance are two different concepts.

In chapter 3 we also assessed the reliability of each item as perceived by the R&D and the project leader. In chapters 4 and 5, we used the R&D manager's data only, because of the variance between the observations of both respondents and the random error and systematic bias in especially the customer-based performance measures. Averaging the data would not have increased the validity (Van Bruggen, Lilien and Manish 2002). Another option would have been to assess the performance of the development projects only by the financial results. In our option this would however also have reduce the validity of the performance assessment, especially that of the development projects of project-based firms. Especially, since during the exploratory phase, as well as in the survey pre-test, respondents of project-based firms explained to us how hard it was to determine the profitability and revenues resulting from a development project. Hence although the random error and systematic bias of the financial measures is lower than for the other measures, using these items only would still have reduced the validity of the performance construct used in chapters 4 and 5. The independent variables in chapter 4 and 5 are based on the observation of the project leader, this was another reason to use the observations of the R&D managers to assess market success (Podsakoff, Mackenzie, Lee and Podsakoff 2003).

Contribution to innovation management theory

This dissertation contributes to innovation management theory in several ways. Firstly, it provides a better understanding of project-based firms in general, and in particular of the management of development projects in these firms. In general, project-based firms have internal and external collaborative capabilities and execute their development projects within the operational environment. Development projects enable project-based firms to follow more progressive strategies. Furthermore we explored which factors contribute to the performance of these projects in project-based firms.

Secondly, we contribute to the innovation management theory by showing how differences in operational capabilities and differences in organizational structure affect success factors for development projects. Firm characteristics make that some factors should be ignored and other factors should be given more attention. As a consequence, innovation management literature has to pay more attention to the characteristics of the firm in which development projects are executed.

Thirdly, this dissertation provides valuable insights in the ways operational capabilities influence the management of development projects. Taking the capabilities and routines of firms into account, enables generalization of the findings to firms in other industries, with similar routines and capabilities.

Fourthly, the investigation in performance measurement of development project gives suggestions how to improve the performance models for development projects as currently used in the innovation management literature. Researchers should make a clearer distinguish between project and market success and apply formatively indicated constructs to assess project success. Such an approach will make innovation management research outcomes in the future better comparable.

Relevance for managers of project-based firms

The purpose of this dissertation was to increase the innovativeness of project-based firms, more specifically the innovativeness of project-based engineering firms. Business projects of project-based firms provide little room for innovative activity. Customers ask for the development of innovative solutions, and in some cases it is possible to apply an innovative solution of a business projects in a next business project. However the opportunities for the development of new services or products on business projects are limited. Customers of project-based firms often prefer proven technology , furthermore tight budgets and stringent deadlines make that there is only limited room and desire to innovate within these projects (Keegan and Turner 2002). In addition, the innovative solutions are often tailored to one specific customer. It takes additional effort to make a tailored solution suitable for a range of customers (Nambisan 2001).

Our research results show that development projects enable project-based firms to follow more innovative strategies. At the same time, the management of such development projects is not easy, given the characteristics of project-based firms. Christensen and Baird (1997) showed for example that the transformation of ideas into valuable new service offerings for a range of customers is problematic in consultancy firms. This dissertation increases the understanding of the management of new service and new product development project in project-based firms, as our findings showed that the specific structure and the capabilities of project-based firms on the one hand facilitate and on the other hand hinder the execution of development projects.

The capabilities in rigorous and efficient project management, as used on business projects, are unsuitable for development projects (Nambisan 2001). The exploratory study showed that project-based firms apply perhaps a too stringent way of project planning, and that the quality of the new service or product is hampered by this drive for efficiency. In our comparative study, we found that planning contributes negatively to the performance of development projects within project-based firms. We therefore suggest that development projects in project-based firms apply less stringent planning methods. We expect that a less well-defined plan will enable improvisation and allow recycles to occur.

Multidisciplinary development teams contribute negatively to the performance of development projects within project-based firms. In functional firms, where each functional department is highly specialized, integration of specializations is of great importance and contributes to the performance of development projects. However, we expect that in project-based firms, where integration and collaboration abounds, development projects benefit from more specialized activities. At the same time, multidisciplinary teams are especially effective in non-project-based firms, which execute development projects within the operational environment and have internal

collaborative capabilities. This combination enables development projects to absorb more effectively outside knowledge (Cohen and Levinthal 1990).

Development projects within project-based firms benefit more from a heavyweight project leader than development projects of non-project-based firms. We expect that the role of these heavyweight project leaders is different than described in the literature. In literature, their role is primarily to enable communication between the various functions (Wheelwright and Clark 1992). For project-based firms we expect that the role of these project leaders is in getting support from the organization and ensuring that the new services and products developed in specialist teams are actually implemented.

Supplier involvement on development projects contributes to the performance of development projects within project-based firms, especially in case the project-based firm also collaborates with suppliers in the operational process and executed development projects within the operational environment.

The findings of this research will enable project-based firms to execute their development projects more successfully. The outcome of these development projects hopefully enable project-based firms to become more innovative and continue to contribute to the Dutch economy.

Limitations and suggestions for future research.

The data set developed for this research contained development projects of various industries. On the one hand this increased the applicability. However not all firms were part of a randomly drawn sample. As a consequence the generalizibility is limited to the Construction and IT industries only. Table 6.2 shows that project-based firms are positively correlated with Construction firms, and negatively correlated with IT firms. Within the Construction industry, 75% of the firms are project-based. Within the IT industry this is 25%. The difference between project-based firms and non-project-based firms does not reflect the difference between IT and Construction firms, as industry effects are insignificant for the findings of chapter 4. To differentiate between the industries we made use of primary BIK code data of the reach data base only. For most firms up to 4 or sometimes even 7 BIK codes were available. Industry boundaries are thereby less clear than suggested. Especially project-based firms operating in the IT and engineering industries seem to have a whole range of industries they belong to. The value of BIK codes and how to cope with firms that belong to a whole range of industries need to be addressed in future research.

Our sample consisted of a particular type of project-based firms (Whitley 2006). There are also project-based departments in firms in more high tech sectors, such as the defense and aerospace industries. Their innovation efforts fall beyond the scope of this dissertation, and the findings need to be reinvestigated for these type of organization. It is for instance unclear whether a project-based R&D organization can also benefit from internal operational capabilities, since these development activities are not executed within the operational environment. This is clearly an area that needs further research. The findings of chapter 5 should still apply, as in this case the operational capabilities and the integration of the R&D and operational activities are explicitly taken into account. To what extent our findings apply to professional service firms depends on the characteristics of these firms, as not all these firms have a project-

based organizational structure, have project management or internal collaborative capabilities.

Within project-based firms we only looked at development projects, not at the innovative efforts within business projects. We also did not investigate learning effects from business projects to development projects, nor from development projects into business projects. This too could be another interesting area for future research.

Based on our experience with formatively indicated constructs in this dissertation, we would like to make some specific remarks about issues that need to be resolved when using these constructs in future research. We used a formatively defined constructs to define the construct project-based firms. The rules of Jarvis, Mackenzie and Podsakoff (2003) were used as guideline to access the relationship between items and construct. We used two global items to identify the construct. Even for this fully defined construct, it appeared difficult to actually use a formatively defined construct in the regression equations, as there are still many unresolved issues. For instance, how are the global items added to this construct? Are these items added or neglected? And how about formatively defined construct that are identified by means of another construct, as for example project success? Further research is needed to create practical guidelines for the applications of formatively defined constructs.

This research shows how valuable a comparative study can be. In our survey, we tried to use measures that were perceived similarly by the managers of project-based and non-project-based firms. Still, we have the impression that variance in the perception of some measures, especially project planning, may have affected some of the results. In general, the innovation management field needs more objective and reliable measures with a better defined content. This especially holds for performance measures as project and market success. Otherwise it will be impossible to compare development projects executed in different settings.

The final remark relates to the use of multiple respondents to assess performance. This made data collection a very cumbersome process, contributed to the complexity of the survey and thereby limited the response rate of this research. Many publicly available databases can be used to generate a research sample. These databases are however inadequate when investigating new product or new service development projects. For innovation management research, especially at the development project level, information is needed that resides deep within each firm. In addition, this often concerns confidential information. As a consequence, information about the execution of development projects is difficult to obtain. This explain why currently in innovation management literature often subjective data is collected from single informants (Brown and Eisenhardt 1995). This increases the danger of common method variance, and the consequences of this bias were discussed in chapter 3. Instead of using multiple respondents, more reliable performance measures could perhaps enable researchers in the future to use single respondents and to have these respondents assess both the execution and the performance of a development project. This would greatly facilitate the data collection procedure.

LITERATURE

Ancona, D. G. and D. F. Caldwell 1992. "Bridging the Boundary: External Activity and Performance in Organizational Teams." *Administrative Science Quarterly* 37(4): 634-651.

Brown, S. L. and K. M. Eisenhardt 1995. "Product Development: Past Research, Present Findings, and Future Directions." *Academy of Management Review* 20(2): 343-378.

Christensen, C. M. and B. Baird 1997. "Cultivating Capabilities to Innovate; Booz Allen & Hamilton." Harvard Case # 9698027.

Cohen, W. M. and D. A. Levinthal 1990. "Absorptive Capacity: A New Perspective on Learning and Innovation." *Administrative Science Quarterly*(35): 128-52.

Galbraith, J. R. 1971. "Matrix Organization Designs: How to Combine Functional and Project Forms." *Business Horizons* 14(1): 29-40.

Griffin, A. and A. L. Page 1996. "PDMA Success Measurement Project: Recommended Measures for Product Development Success and Failure." *Journal of Product Innovation Management* 13(4): 478-496.

Jarvis, C. B., S. B. Mackenzie, et al. 2003. "A Critical Review of Construct Indicators and Measurement Model Misspecification in Marketing and Consumer Research." *Journal of Consumer Research* 30(2): 199-218.

Keegan, A. and J. R. Turner 2002. "The Management of Innovation in Project-Based Firms." *Long Range Planning* 35: 367-388.

Nambisan, S. 2001. "Why Service Businesses Are Not Product Businesses." *MIT Sloan Management Review* 42(4): 72-80.

Podsakoff, P. M., S. B. Mackenzie, et al. 2003. "Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies." *Journal of Applied Psychology* 88(5): 879-903.

Tatikonda, M. V. and M. M. Montoya-Weiss 2001. "Integrating Operations and Marketing Perspectives of Product Innovation: The Influence of Organizational Process Factors and Capabilities on Development Performance." *Management Science* 47(1): 151-172.

Van Bruggen, G. H., G. L. Lilien, et al. 2002. "Informants in Organizational Marketing Research: Why Use Multiple Informatns and How to Aggregate Responses." *Journal of Marketing Research* 49(November): 469-478.

Wheelwright, S. C. and K. B. Clark 1992. *Revolutionizing Product Development*. New York, The Free Press.

Whitley, R. 2006. "Project-Based Firms: New Organizational Form or Variations on a Theme?" *Industrial and Corporate Change* 15(1): 77-99.

Summary

Innovation enables firms to become and remain profitable. Innovation management research, aimed at improving the innovation process within firms, has traditionally focused on manufacturing firms, such as Philips, Unilever, IBM etc. Such firms are typically functionally organized, with one department dedicated to innovation, usually the research and development (R&D) department.

There are however many firms that have another organizational structure, as they do not produce mass goods. Project-based firms, for example, have a project-based instead of a functional organizational structure, and produce complex integrated systems by order of their clients. Examples are Engineering and Construction companies, Consultancies and System Integrators in the Information Technology industry.

The organizational structure, operational capabilities and routines enable project-based firms to efficiently execute large complex projects. Some have claimed that these characteristics make project-based firms more innovative than manufacturing firms. These firms would be able to adapt quickly and flexibly to changes in their environment. Others have claimed the contrary. According to these authors striving for efficiency in project execution would stifle innovation. The central question in this dissertation is to what extent firm characteristics, i.e. differences in organizational structure, capabilities and routines, affect the innovation process of project-based firms.

When discussing innovation in project-based firms, we have to make a distinction between the projects in which project-based firms provide innovative solutions to their clients, the business projects, and the projects that are aimed at the renewal and improvement of their own products and services. We focused on the latter type of projects and labeled these development projects.

The innovation management literature has provided ample success factors for development projects. In our theoretical model we assume that firm characteristics affect the use of and the need for these factors, e.g. affect the use of and need for multidisciplinary teams, planning or customer involvement in development projects. We used an exploratory study of 6 development projects to investigate the impact of firm characteristics on success factors for development projects in project-based firms. The organizational structure of these firms and collaborative capabilities of the employees seem to facilitate the execution of development projects, especially the coordination of these projects. We therefore hypothesize that multidisciplinary teams, heavyweight project leaders, and customer and supplier involvement are less needed for development projects of project-based firms compared to development projects in manufacturing firms. The capabilities and routines in rigorous and efficient project management seem to be a hindrance. Development projects have to cope with recycles due to the uncertainty involved. Striving for efficiency seems to have a negative impact on the quality of the developed new services and products. In addition, some capabilities needed to successfully commercialize a new product or service seem to be absent in project-based firms, as these are not needed for the successful execution of business projects. We therefore hypothesize that there is a greater need for senior

management involvement, involvement of experts, contingent planning approaches, pre-development, testing and launch activities on the development projects of project-based firms compared to the development projects of manufacturing firms. This exploratory study is described in chapter 2.

A comparative study of 144 development projects of project-based and non-project-based firms in the Dutch Information Technology, Construction, Engineering and related industries was used to confirm the hypotheses developed in the exploratory study.

Chapter 3 focuses on the definition of performance of development projects. The consistency in the performance models currently used in the innovation management literature is limited, due to the applied construct validation theory. We develop a theoretical performance model for the assessment of development projects. We test the model with the traditional and an alternative method for construct validation, using the performance assessment of R&D managers of 257 development projects and dual performance assessment by the R&D managers and the project leaders of 144 development projects.

The comparative study, chapter 4, confirms that the characteristics of project-based firms affect the execution of development projects. Planning and multidisciplinary teams appear to have a negative effect on performance in project-based firms. At the same time there is a greater need, instead of the hypothesized reduced need, for heavyweight project leaders. We expect that in project-based firms the experts within one discipline, who each work at separate business projects, need to work together in development projects, since collaboration between disciplines abounds. While in manufacturing firms, where specialization abounds, the experts of the various disciplines need to collaborate in multidisciplinary development teams. In project-based firms the project leader is subsequently needed to translate the specialized new services and products, and to ensure that these are implemented within business projects. This is clearly a different task than for heavyweight project leaders in manufacturing firms, who have to ensure and enable communication between the various disciplines. The negative impact of planning is likely to be due to the capabilities of project-based firms in very efficient project planning. As explained above, this is likely to hamper the quality of the new services and products. In addition, we found that the project-based firms which executed development projects had a significantly more progressive strategy than the project-based firms which did not execute development projects.

The comparative study illustrates that firm characteristics affect the management of development projects. In chapter 5 we develop a more elaborate theory of how organizational capabilities affect the use of and need for factors that contribute to the successful execution of development projects. Three alternate models are developed and tested to determine how operational collaborative capabilities affect the use and effectiveness of multidisciplinary teams and supplier involvement in the development process. We find that operational collaborative capabilities determine the use of multidisciplinary teams and supplier involvement, but not necessarily their effectiveness.

This dissertation contributes to the innovation management literature. We investigate the management of development projects in project-based firms instead of

those in manufacturing firms, and show that firm characteristics are a contingency factor for the management of development projects.

With products and services becoming more and more integrated, the need for the services of project-based firms is also growing. Increasing competition from low cost countries as for example in former Eastern Europe and India, requires Western project-based firms to be more innovative in the services and solutions they provide. The innovative solutions that project-based firms provide for their customers do not necessarily make these firms innovative. Our data shows that development projects enable project-based firms to follow more innovative strategies. Furthermore we provide recommendations for the execution of these projects. This dissertation hopes thereby to contribute to the innovativeness of an important sector in the Dutch economy that is formed by project-based firms.

Nederlandse samenvatting

Innovatie stelt bedrijven in staat om winst te maken, en te blijven maken. Innovatiemanagement onderzoek, gericht op de verbetering van het innovatieproces binnen bedrijven, heeft zich met name georiënteerd op productie bedrijven zoals Philips, Unilever, IBM etc. Deze bedrijven zijn meestal functioneel georganiseerd, waarbij één van de afdelingen, meestal de research en development (R&D) afdeling. verantwoordelijk is voor innovatie.

Er zijn echter ook bedrijven met een geheel andere organisatiestructuur, aangezien ze geen massagoederen produceren. Projectmatig werkende bedrijven hebben bijvoorbeeld een project -, in plaats van een functionele organisatie. Deze bedrijven produceren complexe geïntegreerde systemen in opdracht van klanten. Voorbeelden zijn ingenieursbureaus, bouwbedrijven, adviesbureaus en systeem integrators in de informatie technologie sector.

Projectmatig werkende bedrijven hebben een organisatiestructuur, operationele vaardigheden en routines die deze bedrijven in staat stellen om effectief grote complexe projecten uit te voeren. Sommige onderzoekers stellen dat deze eigenschappen projectmatig werkende bedrijven innovatiever maken dan productie bedrijven. Ze zouden in staat zijn om snel en flexibel in te springen op veranderingen in de omgeving. Anderen beweren het tegenovergestelde. Deze onderzoekers stellen dat het streven naar efficiency in de projectuitvoering weinig ruimte over laat voor innovatie.

Als we spreken over innovatie in projectmatig werkende bedrijven moeten we een onderscheid maken tussen de projecten die voor klanten worden uitgevoerd, de business projecten, en de projecten die gericht zijn op het ontwikkelen en verbeteren van de eigen producten en diensten. Dit proefschrift heeft betrekking op het laatste type projecten, die we ontwikkelingsprojecten zullen noemen.

De innovatiemanagement literatuur heeft een veelvoud aan succes factoren opgeleverd voor ontwikkelingsprojecten. In ons theoretisch model gaan we ervan uit dat de eigenschappen van een bedrijf het gebruik van, en de noodzaak voor deze factoren beïnvloeden, e.g. dat het gebruik van, en de noodzaak voor multidisciplinaire teams, planning en de betrokkenheid van klanten op ontwikkelingsprojecten wordt beïnvloed.

We verrichten een exploratieve studie van 6 ontwikkelingsprojecten om de invloed van bedrijfskarakteristieken op de uitvoering van ontwikkelingsprojecten te onderzoeken. De organisatiestructuur van de onderneming en de samenwerkingsvaardigheden van de medewerkers lijken de uitvoering van ontwikkelingsprojecten te vergemakkelijken, met name in de coördinatie van deze projecten. We stellen vervolgens dat ontwikkelingsprojecten in projectmatig werkende bedrijven minder baat hebben bij multidisciplinaire teams, ervaren projectleiders, de betrokkenheid van klanten en toeleveranciers, dan ontwikkelingsprojecten uitgevoerd in productiebedrijven. De operationele vaardigheden en routines in degelijk en efficiënt project management lijken een belemmering te vormen. Ontwikkelingsprojecten hebben te maken met recycles, gezien de onzekerheden die er bestaan tijdens de uitvoering. Streven naar efficiency lijkt daarom negatieve gevolgen te hebben voor de

kwaliteit van de op te leveren nieuwe producten en diensten. Daarnaast lijken enkele vaardigheden te ontbreken, die noodzakelijk zijn voor het succesvol op de markt brengen van nieuwe producten en diensten, die niet nodig zijn voor de uitvoering van business projecten. We stellen daarom dat ontwikkelingsprojecten van projectmatig werkende bedrijven meer profijt hebben van steun van het management team, de betrokkenheid van experts, een contingente planning, voorstudies, testen en afzet activiteiten, dan ontwikkelingsprojecten in productie bedrijven. De exploratieve studie is beschreven in hoofdstuk 2.

Een vergelijkende studie, bestaande uit 144 ontwikkelingprojecten in projectmatig- en niet projectmatig werkende bedrijven in de Nederlandse informatietechnologie, bouw, ingenieursbureaus en aanverwante sectoren, werd gebruikt om bovenstaande stellingen te toetsen.

In hoofdstuk 3 wordt nader ingegaan op de definitie van het 'succes' van ontwikkelingsprojecten. In de literatuur is weinig consistentie in de modellen die hiervoor worden gebruikt. Wij tonen aan dat dit komt door de manier waarop constructen momenteel worden gevalideerd. We ontwikkelen vervolgens een theoretisch model om het succes van ontwikkelingsprojecten te bepalen. Dit model wordt getest door gebruik te maken van de traditionele en een alternatieve manier van model validatie. Hiervoor worden 257 project evaluaties van R&D managers gebruikt, evenals de beoordeling door zowel de R&D- als de projectleiders van 144 ontwikkelingsprojecten.

De vergelijkende studie, beschreven in hoofdstuk 4, bevestigt dat de eigenschappen van projectmatig werkende bedrijven de uitvoering van ontwikkelingsprojecten beïnvloed. Planning en multidisciplinaire teams blijken een negatief effect op het succes te hebben. Aan de andere kant hebben ontwikkelingsprojecten meer -, in plaats van minder profijt zoals verondersteld, van ervaren projectleiders. Wij vermoeden dat in projectmatig werkende bedrijven de experts uit één discipline, die werken op de verschillende business projecten, samen moeten werken in ontwikkelingsprojecten. Aangezien samenwerking tussen disciplines reeds overvloedig aanwezig is, terwijl in productiebedrijven, waar specialisatie de boventoon voert, de samenwerking van een multidisciplinaire team in ontwikkelingsproject juist noodzakelijk is. In projectmatig werkende bedrijven is vervolgens een ervaren project leider nodig om de ontwikkelde specialistische nieuwe producten en diensten te vertalen, en te verzekeren dat deze worden toegepast op de business projecten. Dit is een beduidend andere taak dan die van ervaren project leiders in productiebedrijven, die ervoor moeten zorgen dat er gecommuniceerd en samengewerkt kan worden tussen de verschillende disciplines. De negatieve invloed van planning is waarschijnlijk te wijten aan de vaardigheden in het zeer efficiënt plannen van projecten wat, zoals hierboven is uitgelegd, een nadelig effect heeft op de kwaliteit van de nieuwe diensten en producten die worden ontwikkeld. Verder hebben we gevonden dat projectmatig werkende bedrijven die ontwikkelingsprojecten uitvoeren een veel innovatiever strategie volgen dan de projectmatig werkende bedrijven die dit soort projecten niet uitvoeren.

In hoofdstuk 5 ontwikkelen wij een uitgebreidere theorie over hoe operationele vaardigheden succes factoren voor ontwikkelingsprojecten beïnvloeden. We ontwikkelen drie alternatieve modellen en testen vervolgens hoe operationele

samenwerkingsvaardigheden het gebruik en de effectiviteit van multidisciplinaire teams en de betrokkenheid van toeleveranciers op ontwikkelingsprojecten beïnvloeden. We vinden dat operationele samenwerkingsvaardigheden wel het gebruik, maar niet de effectiviteit van multidisciplinaire teams of de betrokkenheid van toeleveranciers bepalen.

Deze dissertatie draagt bij aan de verdere ontwikkeling van de innovatiemanagement literatuur, doordat we niet de ontwikkelingsprojecten van productiebedrijven maar van projectmatig werkende bedrijven hebben onderzocht. Verder tonen we aan dat succesfactoren voor ontwikkelingsprojecten afhankelijk zijn van bedrijfseigenschappen.

Producten en diensten bestaan steeds vaker uit geïntegreerde elementen, waardoor de vraag naar de diensten van projectmatig werkende bedrijven toeneemt. Toenemende concurrentie met bedrijven uit lage lonen landen, zoals bijvoorbeeld landen uit het voormalig Oostblok of India, maken dat projectmatig werkende bedrijven in het Westen meer innovatieve diensten en producten zullen moeten aanbieden. De diensten die projectmatig werkende bedrijven aanbieden aan klanten, maken deze bedrijven niet noodzakelijkerwijs innovatief. Ons onderzoek toont aan dat ontwikkelingsprojecten projectmatig werkende bedrijven in staat stelt om innovatiever strategieën te volgen. Daarnaast doen we aanbevelingen voor het uitvoeren van innovatieprojecten. Dit proefschrift hoopt daarmee bij te dragen aan de innovativiteit van een belangrijke sector in de Nederlandse economie, die gevormd wordt door projectmatig werkende bedrijven.

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Floortje Blindenbach-Driessen was born in 1969 in Middelstum, The Netherlands. She finished her secondary education in Holten in 1989, after having lived a year in the United States as Rotary Exchange Student. In 1995, she received her Master's degree in Chemical Engineering at the Delft University of Technology. She started in 1995 as process engineer at Fluor Daniel. Later she became performance consultant for the same company and assisted project managers in their efforts to enhance project performance. In 2001 she resigned to start as a PhD candidate at the RSM Erasmus University. Her research focus is on innovation management in project-based firms. Floortje Blindenbach-Driessen has given presentations on this subject at conferences in both Europe and the United States. In 2005 she won the runner-up best paper award at the International Product Development Conference in Copenhagen. Her work has appeared in conference proceedings and the second chapter of this dissertation has been accepted for publication in Research Policy. She teaches a Master's course on innovation project management at the Erasmus University.

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Innovation Management in Project-Based Firms

Project-based firms have an organizational structure, capabilities and routines that clearly distinguish them from firms that manufacture mass products. Some have claimed that these characteristics make project-based firms more innovative than for instance manufacturing firms, others argue the contrary. The central question in this research is to what extent the specific characteristics of project-based firms affect innovation management. We focus on new product or service development projects in project-based firms and investigate the influence of firm characteristics on the management practices for these projects. We performed exploratory case studies to generate hypotheses and subsequently tested these hypotheses using a large scale comparative survey of project-based and non-project-based firms in the Dutch Information and Technology, Construction, Engineering and related industries. We find that development projects enable project-based firms to follow more innovative strategies. To execute these development projects successfully, they are to be managed differently than is currently described in the innovation management literature. Multidisciplinary teams and planning, for example, hamper development projects of project-based firms. In firms that manufacture mass products, where specialization abounds, the experts of the various disciplines need to collaborate in multidisciplinary development teams. On the contrary, in project-based firms it seems that the experts within one discipline, who usually work each at separate projects, need to work together in development projects, since collaboration between disciplines abounds. Subsequently, the project leader's task seems to be the translation of the specialized new services and products and to ensure that these are implemented within projects executed to customer order. This is a different task than for heavyweight project leaders in manufacturing firms, who have to enable communication and collaboration between disciplines. Furthermore, it seems that project-based firms should apply a more emergent style of project management on their development projects, as their capabilities in efficient project planning hamper the quality of the services and products that are developed.

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ISBN 90-5892-110-7

Design: B&T Ontwerp en advies www.b-en-t.nl Print: Haveka www.haveka.nl