Capabilities for Frequent Innovation:
Managing the Early Project Phases in the Pharmaceutical R&D Process

Thomas Biedenbach
Acknowledgements

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Thomas Biedenbach
Abstract

Despite their recognized significance for project success and innovation, the management of the early project phases is still an under-researched area in project management. For organizations to secure a continuous stream of innovation, the utilization of capabilities is crucial for managing the early phases of R&D projects.

The purpose of this dissertation is to advance the understanding of the management of the early project phases in hypercompetitive environments. The thesis addresses the research question of how organizations manage the early project phases of R&D in hypercompetitive environments for frequent innovation by taking a dynamic capabilities perspective.

The first conceptual study reviews the literature covering organizational change in hypercompetitive environments with a focus on projects as the vehicle to create the necessary flexibility. The study found that organizational aspects and capabilities have to go hand in hand as enabler and facilitator for a successful emergent change process.

The second qualitative study investigates how organizations organize the early project phases of R&D in the pharmaceutical industry for an outcome of frequent innovation. The findings show that an optimization of combinative capabilities that balances dynamic, project and multi-project capabilities can be used as a powerful leverage to boost the outcome of frequent innovation.

The third study investigates the philosophical stances and related methodologies used within the last 15 years of project management research at the example of IRNOP conferences. The findings show that ontological subjectivism and epistemological interpretivism are dominating. Moreover, case studies and qualitative methods were the most common methods, whereas mixed method studies were lacking despite their value for developing an increasingly complex research field.

The final mixed method study explores how absorptive, innovative and adaptive capabilities within the early phases of pharmaceutical R&D affect project and portfolio performance. Based on the results of quantitative study, the set of capabilities has an overall effect on the set of performance outcomes and thus confirms the results of the qualitative study that a distinct capability mix is needed in the pharmaceutical R&D process.

To conclude, the dissertation has comprehensively explored the management of the early project phases through four studies and by applying a multitude of methodologies.
Appended papers

Paper #1


Paper #2


Paper #3


Paper #4

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INTRODUCTION

1 Managing the Early Project Phases for Frequent Innovation

Nowadays, organizations are under continuous pressure to maintain their competitiveness due to the complex, highly competitive and dynamic environment in which they operate. D'Aveni (1994, 1995) refers to this extreme setting as hypercompetition, characterized by an intense competition with rapid moves and countermoves, which frequently lead to disequilibrium and disruptions in the market. Consequently, competitive advantages can no longer be sustained based on one single advantage, but instead require a series of temporary advantages (D'Aveni, 1998). In these environments, competitive advantages are eroded rapidly by actions from competitors and the organization itself in response to competitive pressures. As a result, a source for competitive advantage lasts much shorter in time and needs to be replaced by a new basis on which the organization can excel its competitors.

In a hypercompetitive environment, successful organizations apply speed and a high frequency of disruptive actions, continuously challenging themselves by even making their own competencies obsolete before their competitors do (D'Aveni, 1994, 1998). In this context are two themes that are of particular importance: change and innovation. First, organizations are forced to continuously engage in change initiatives to not only secure long-term success, but even to ensure organizational survival (Ilinitch, D'Aveni & Lewin, 1996). Second, innovation is a significant source for a temporary competitive advantage and is intertwined with change (Harvey, Novicevic & Kiessling, 2001). Not surprisingly, R&D initiatives aimed to secure a continuous stream of innovation play a key role in this context. R&D activities are carried out through projects that bring innovation and change to the organization. As a result, new strategic options emerge influencing the competitiveness of an organization.

The pharmaceutical (D'Aveni, 1994, 1998) and biotechnology industries (Liebeskind, Oliver, Zucker & Brewer, 1996) have been characterized as hypercompetitive environments and serve as context in this dissertation. Pharmaceutical and biotechnology organizations are closely intertwined in the pharmaceutical R&D process and collaboratively contribute to the pharmaceutical innovation. Moreover, these two industries are clearly dominated by the R&D pipeline and thus project-based. In the R&D process itself, the early project phases contribute to the largest extent to pharmaceutical innovation, because this is the stage where the invention is
originated. Additionally, the relevance of the early project phases is confirmed by Zhang and Doll (2001) stating that “most projects do not fail at the end; they fail at the beginning.” This quotation highlights the impact and significance of the early project phases. It implies that specific capabilities are required for successfully managing the early project phases.

The pharmaceutical R&D process faces severe challenges in addition to the ones arising from the hypercompetitive environment. First, the pharmaceutical R&D process is characterized by long development times of up to 15 years, high cost, high uncertainty, and high complexity (Cuatrecasas, 2006; Ingelgård, Roth, Shani & Styhre, 2002). Second, the pharmaceutical R&D process requires close collaboration of individuals of diverse backgrounds across different functions within an organization and beyond organizational borders with co-developing organizations, patent offices, and regulatory agencies (Khilji, Mroczkowski & Bernstein, 2006). Failure rates in the pharmaceutical R&D are high, and much money and time can be saved by the timely identification of failures and appropriate project re-prioritizations (Cooper & Kleinschmidt, 1995; Cuatrecasas, 2006). These issues underline the already highlighted importance of the early project phases.

At the same time, the challenges of the pharmaceutical R&D process point out the need to facilitate the management of the early project phases with appropriate capabilities. Therefore, a better understanding of the crucial capabilities for the pharmaceutical R&D process is a primary concern for R&D managers aiming to improve the innovation output. Additionally, the low productivity rate in the pharmaceutical industry indicates the importance of capabilities as key factors for improving the innovation output of the R&D process (Ahn, Meeks, Davenport & Bednarek, 2010; Booth & Zemmel, 2004; Paul et al., 2010). Consequently, the investigation of the capabilities in the early project phases facilitating the pharmaceutical R&D is of high value for practitioners. Moreover, also for academic research a better understanding of the particular capabilities in the early project phases of pharmaceutical R&D is needed, which will be explained subsequently. The literature on strategic management emphasizes the utilization of dynamic capabilities for continuously generating new competitive advantages in hypercompetitive environments (Teece, Pisano & Shuen, 1997; Eisenhardt & Martin, 2000). Moreover, previous research points out the significance of dynamic capabilities for continuous innovation (Verona & Ravasi, 2003). Teece et al. (1997) define dynamic capabilities as “a firm’s ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments” (Teece et al., 1997, p. 516). In this dissertation, the dynamic capabilities framework by Wang & Ahmed (2007) is applied,
highlighting three components namely absorptive, innovative and adaptive capabilities. These particular capabilities are of special relevance for the pharmaceutical R&D process. Absorptive capabilities are crucial for the pharmaceutical R&D enabling that the latest external knowledge can be utilized in learning processes (Lane, Koka & Pathak, 2006). Innovative capabilities are essential for R&D to develop new products, to improve or to replace current products (Subramaniam & Youndt, 2005). Adaptive capabilities are important for the identification and evaluation of emerging market opportunities (Wang & Ahmed, 2007).

The utilization of the three specific capabilities is of special relevance in the hypercompetitive environment, because they can facilitate the creation of a continuous stream of innovation (Ireland & Webb, 2007). Moreover, a capability – firm’s performance relationship has been recognized by previous research. This relationship has been examined in general (Krasnikov & Jayachandran, 2008), or more specifically as the effect of R&D management capabilities on the number of developed products as a measure for R&D performance (Deeds, DeCarolis & Coombs, 1999). Thus on a more detailed level, capabilities are crucial for project performance to create innovation and portfolio performance to achieve a continuous stream of innovation.

Organizations apply projects as vehicle for carrying out change endeavors and for generating innovation. Not surprisingly there is a growing number of project-based and temporary organizations in the evermore turbulent environment (Lundin & Söderholm, 1995; Packendorff, 1995; Turner & Müller, 2003). Although project management has been originated from military development and complex engineering projects, projects are now widely used across different tasks and industries (Blomquist & Söderholm, 2002). Today projects appear in various contexts such as new product development projects, organizational change projects, construction projects, information technology projects, and technology development projects (Söderlund, 2005) and dominate industries such as engineering, consultancy, but also the public and service sectors (Ekstedt, Lundin, Söderholm & Wirdenius, 1999; Blomquist & Söderholm, 2002). These observations show the significant role of project management in modern business practices in general and for innovation in particular.

The majority of research so far has focused on the planning and implementation phases of projects, whereas the early phases have been mostly neglected. However, the early phases have been identified as being crucial for project success (Söderlund, 2005). In this dissertation, the early project phases are understood as comprising pre-project activities that precede the start of a project, as well as the activities for defining and
designing the project during the conceptualization phase. Professional project management associations have established a body of knowledge such as the PMI’s Guide to the Project Management Body of Knowledge (PMBOK) (PMI, 2004) offering guidelines to project managers for successfully managing the different phases of a project. However, in the beginning of a project, the project phases are rather diffuse, the project needs to be prepared, the scope to be clearly defined and the boundaries of the project tend to be blurred. Recent research highlights this ambiguity and inconsistency where the pre-project phases are characterized as being cloudy (Gassmann & Zedtwitz, 2003) or even named as fuzzy front end (Khurana & Rosenthal, 1997; Boedderich, 2004).

The prevailing fuzziness of the pre-project activities makes it hard to clearly address them in the body of knowledge of project management. The early project phases contain a high uncertainty, but also allow a high degree of freedom to maneuver (Olsson & Magnussen, 2007). Therefore, changes and adjustments are common and might be even desired as they help to avoid high costs for late correction in a project. Another reason, which makes it hard to explicitly address pre-project activities, is that these activities happen prior to project start and are thus by definition located outside the project scope. Nevertheless, pre-project and early project activities are interrelated. On the one hand, pre-project activities prepare the project and determine the destiny of a possible project start. On the other hand, the pre-project phase itself often gets projectized, while it is often managed as it would be a precursor project.

The significance of the early project phases for project success has been shown by previous research (Kolltveit & Grønhaug, 2004; Söderlund, 2005; Williams & Samset, 2010). Kolltveit and Grønhaug, (2004) explain their importance with the high uncertainty and the fact that this is the phase, where many influential stakeholders tend to be involved. Moreover, Needleman (2001) stresses that the threat of serious problems often arises from the pre-project phase. Another study points out the advantages involved with making early systematic decisions (Artto, 2001). The most crucial front-end decision can be related to the need to select the right project (Williams & Samset, 2010).

What makes the decisions in the early project phases so difficult is the prevalent lack of information, while being faced with ambiguity and complexity (Williams & Samset, 2010). This context highlights that special capabilities are strongly required in the early project phases. Williams and Samset (2010) note that capabilities are needed at the start of the project to cope with the turbulent environment by integrating flexibility into the
management of a project. The generation of flexibility can be directly linked to the dynamic capability framework demonstrating the importance of such capabilities for the early project phases.

The pharmaceutical R&D process is the empirical context for this dissertation. In the dissertation, the pharmaceutical R&D process refers to the combined process of both biotechnology and pharmaceutical organizations contributing to the development of pharmaceutical products with their R&D efforts. For several reasons, the pharmaceutical R&D has been chosen as suitable context to explore the early project phases and the utilization of dynamic capabilities aimed at frequent innovation.

First, the pharmaceutical R&D is a turbulent environment, where the utilization of dynamic capabilities in the early project phases is crucial (Eisenhardt, 1989a; D'Aveni, 1994, 1998). R&D projects have to get adjusted to the changing market environment with its competitors, competing products and national health care policies. Moreover, for the purpose of innovation, R&D projects need to make use of the latest technologies, knowledge and industry experts. Second, in the pharmaceutical R&D process, it is the early project phases, where the largest extent of an innovation is originated. Thus, the early project phases gain additional importance. Third, it is also the environment, where a continuous stream of innovation is crucial to maintain competitiveness through a series of innovative products (Gassmann & Reepmeyer, 2005; Ireland & Webb, 2007). The significance of frequent innovation becomes obvious due to the prevalent pipeline thinking in the industry. Therefore, project and project portfolio performance are of vital importance.

Despite the recognized significance of the early project phases, it is still an under-researched area in project management, especially regarding the type of capabilities, which are needed to master these phases (Artto, 2001; Kolltveit & Grønhaug, 2004; Söderlund, 2005). Moreover, Williams and Samset, (2010) point out that capabilities providing flexibility are the key for the project start in turbulent environments. Previous research focused on investigating the relationship of capabilities to firm performance (Krasnikov & Jayachandran, 2008). Although flexibility and dynamic capabilities are considered to be able to facilitate a continuous stream of innovation, their different components of absorptive (Lane et al., 2006), innovative (Sher & Yang, 2005) and adaptive capabilities (Bourgeois, 1980; Snow & Hrebiniak, 1980) have only been investigated in relation to overall firm performance. Thus, there is an evident need to investigate the capabilities for managing the early project phases, which can facilitate frequent innovation in general, and affect project and project portfolio performance in particular.
1.1 Research Purpose and Research Questions

The main purpose of the dissertation is to advance the understanding of the management of the early project phases in hypercompetitive environments.

The following main research question is addressed:
*How do organizations manage the early project phases of R&D in hypercompetitive environments for frequent innovation by taking a dynamic capabilities perspective?*

Although not all articles directly answer the research question, they all contribute to its exploration and are important for a comprehensive investigation.

The dissertation makes a theoretical contribution by combining two major themes of strategic and project management. In hypercompetitive environments, dynamic capabilities are seen as critical success factors. Dynamic capabilities concern the ability to change. Change is a theme, which is closely related to projects as a common vehicle for bringing change to an organization. Despite their relevance, the early project phases are still an under-researched area, which is supported by Verganti (1997, p. 377) affirming “...the mechanisms that allow these [early project] phases to be properly managed are still largely unexplored”. This quotation refers directly to the need to gain a better understanding of capabilities that can help to manage the early project phases better. In this respect, the main contribution of the dissertation is to the field of project management by utilizing the dynamic capabilities framework from the field of strategic management to enhance the understanding of the management of the early project phases. In this respect, the investigation of capabilities that facilitate innovation in the early project phases goes beyond the otherwise project-centered capabilities. By considering additional capabilities that are emphasized in the strategic management literature on dynamic environments, new insights can be gained. Consequently, this approach allows a more holistic exploration of the early project phases by combining the research of the interrelated fields of project management and strategic management in the context of pharmaceutical R&D.

The dissertation also contributes to the field of strategic management exemplifying by illustrating how dynamic capabilities appear in the early project phases of the R&D process. Despite being examined in previous empirical studies, the dynamic capabilities concept is often used in more abstract terms. In this respect, the dissertation also contributes to the development of a deeper understanding of what dynamic capabilities actually are in this particular context.
The dissertation consists of four papers, which investigate the main purpose. The first paper “The challenge of organizing change in hypercompetitive industries: A literature review” (Biedenbach & Söderholm, 2008) is a conceptual paper. The purpose of this paper is to review literature covering organizational change in hypercompetitive environments with a focus on projects as the vehicle to create the necessary flexibility.

The second paper “The power of combinative capabilities: Facilitating the outcome of frequent innovation in pharmaceutical R&D projects” (Biedenbach, 2011) is a multiple case study. The purpose of this paper is to investigate how organizations organize the early phases of R&D projects in the pharmaceutical industry to achieve frequent innovation. The concept of dynamic capabilities serves as a starting point in exploring the capabilities required for mastering the crucial activities of R&D projects as pathfinders for frequent innovation. The following four research questions are addressed in the study:

- What capabilities are required to make development choices in the pre-project phase?
- What are the tasks and facilitating actions fostering innovation in the pre-project and early project phases?
- What does the decision-making process look like for the transition of a pre-project into the early project phases, and on what basis are ideas selected for an innovation project?
- What actions and capabilities are required within the R&D process to achieve frequent innovation?

The third paper “Paradigms in project management research: Examples from 15 years of IRNOP conferences” (Biedenbach & Müller, 2011a) explores the current state of project management research. The purpose of this paper is to investigate the philosophical stances and related methodologies used within the last 15 years of project management research. The paper considers the following research question:

- Using the International Research Network on Organizing by Projects (IRNOP) papers as an example, where do we come from, where are we now and where are we heading with our philosophical perspectives towards project management research?

Furthermore, the following sub-questions are addressed:
- Did the philosophical emphasis in project management research change and if yes, how?
• What are the methodological implications of a possible change in research paradigms?

These questions are approached by reviewing and comparing conference papers from the IRNOP conferences of the years 1994 (IRNOP I), 2000 (IRNOP IV) and 2007 (IRNOP VIII).

The fourth paper “Absorptive, innovative and adaptive capabilities and their impact on project and project portfolio performance” (Biedenbach & Müller, 2011b) applies a sequential mixed method starting with a qualitative study, which is followed by a quantitative study. The purpose of this paper is to explore how absorptive, innovative and adaptive capabilities within the early project phases affect project and portfolio performance within the R&D of pharmaceutical and biotechnology organizations. The study examines the following research questions:

• What are the absorptive, innovative and adaptive capabilities within R&D in pharmaceutical and biotechnology organizations?
• How do absorptive, innovative and adaptive capabilities affect project and portfolio performance in these industries?

Table 1 summarizes the characteristics of the different papers included in this dissertation. While exploring the purpose of the dissertation, the unit of analysis is changing through different levels in response to the exploration of the research topic based on the gap of research and new knowledge gained. Throughout the different papers, the level of detail and consequently, the unit of analysis are narrowing down from the organization (paper #1) to the particular capabilities and their relation to the performance outcome (paper #4).

In the first paper, the implications of an external hypercompetitive environment are highlighted around two key challenges. These challenges are the foundation for the particular capabilities needed for the management of the early project phases. In the second paper, the capabilities required in the early project phases are explored in the pharmaceutical industry. The third paper prepares for the final investigation of the early project phases by directing the research in terms of knowledge progression in the field. In this respect, the philosophical stances of project management research are explored to allow conclusions about the state of knowledge and future methodologies, which can advance the research field. The findings from the second paper act as a theoretical foundation for the fourth paper. Furthermore, the methodological implications from the third paper determine the research approach of the fourth paper.
This final paper comprehensively completes the investigation of the early project phases by adding biotechnology organizations into the pharmaceutical R&D context. Moreover, by following a mixed method approach a final investigation explains the impact of particular capabilities on the outcome of project and portfolio performance. This final step is conducted at the most detailed level, where dynamic capabilities are broken down into sub-capabilities and where innovation outcome is divided into more accurately measurable performance outcomes.

The holistic exploration of the early project phases is based on the following logical reasoning. Paper #1 takes organizations in hypercompetitive industries as a unit of analysis by reviewing the literature on organizational change and hypercompetition, and linking it to projects as vehicle for change. It is a conceptual paper, which sets the agenda for the research project and subsequent papers by highlighting challenges faced by organizations while applying projects for continuous change in hypercompetitive environments.

Paper #2 has the pharmaceutical R&D project as a unit of analysis and investigates the capabilities needed in the early project phases to facilitate the outcome of frequent innovation. As a first step, this exploratory multiple case study is needed to gain a better understanding of the capabilities required in the early project phases for generating innovation. The context for this study is the pharmaceutical industry in which the project-based R&D process is crucial.

Paper #3 goes back to a more general level to investigate the current state of project management research by having IRNOP conference papers as unit of analysis. To progress the knowledge in the particular field, it is important to investigate the state of knowledge by looking at philosophical stances and methodologies to identify what type of research is still lacking.

Paper #4 follows a mixed method approach, which is generally required to advance the project management field and specifically address the effect of particular capabilities on pharmaceutical innovation in the early project phases. Absorptive, innovative, and adaptive capabilities represent the unit of analysis in the qualitative study. In contrast, the quantitative study has the relation between the different capabilities and project/portfolio performance as unit of analysis. The context of this paper has been expanded to the pharmaceutical and biotechnology industries due to their interdependence in the R&D process of pharmaceutical innovation.
<table>
<thead>
<tr>
<th>Paper</th>
<th>Research purpose</th>
<th>Unit of analysis</th>
<th>Research typology</th>
<th>Methodology</th>
<th>Method</th>
<th>Context</th>
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<tr>
<td><strong>Paper #1</strong></td>
<td>Reviews literature covering organizational change in hypercompetitive environments with a focus on projects as vehicle to create necessary flexibility</td>
<td>Organization</td>
<td>Conceptual</td>
<td>Conceptual paper</td>
<td>Literature review</td>
<td>Hyper-competitive industries</td>
</tr>
<tr>
<td><strong>Paper #2</strong></td>
<td>Investigates how organizations organize the early phases of R&amp;D projects in the pharmaceutical industry to achieve frequent innovation</td>
<td>R&amp;D projects</td>
<td>Exploratory</td>
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</tr>
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<td><strong>Paper #3</strong></td>
<td>Investigates the philosophical stances and related methodologies used within the last 15 years of project management research</td>
<td>Research methods</td>
<td>Descriptive</td>
<td>Content analysis</td>
<td>Literature review</td>
<td>PM research of IRNOP conferences</td>
</tr>
<tr>
<td><strong>Paper #4</strong></td>
<td>Explores how absorptive, innovative and adaptive capabilities within the early project phases affect project and portfolio performance within the R&amp;D of pharmaceutical and biotechnology organizations</td>
<td>Capabilities and their relation to project and portfolio performance</td>
<td>Exploratory and explanatory</td>
<td>Mixed methods</td>
<td>Mixed</td>
<td>Pharmaceutical and biotechnology industries</td>
</tr>
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Table 1: Overview of the research papers
1.2 Thesis Structure

The purpose of the dissertation is explored in four interrelated papers. The first paper (Biedenbach & Söderholm, 2008) reviews the literature of the wider context of the dissertation. This conceptual paper reviews the literature concerning organizational change in hypercompetitive environments by linking it to projects as suitable means for delivering change. In this special context, the emergent change perspective, with projects as structural element and dynamic capabilities as link between the internal processes and hypercompetitive environment, gains significance. The paper highlights that dynamic capabilities are at the core of a capability challenge for generating innovativeness through frequent changes. However, there is also a structural challenge, which can be met with project-based change, where flexibility is appropriately balanced with controllability. The first paper thus shows the relevance of dynamic capabilities and projects for frequent innovation, which will form the theme for the second paper.

The second paper (Biedenbach, 2011) is a qualitative multiple case study, which explores how organizations organize the early project phases of R&D projects in the pharmaceutical industry for frequent innovation. In the pharmaceutical R&D, the largest extent of the innovativeness is generated in the early project phases. Dynamic capabilities, which have been found in the first paper to be of special importance, serve as a starting point for exploring the capabilities needed for continuous innovation. The paper highlights the power of combinative capabilities for frequent innovation when balancing dynamic, project and multi-project capabilities in the early project phases. Despite the recognition and relevance of the different capability concepts, they are often fuzzy and rather abstract terms. In this respect, the second paper also contributes to gaining a deeper understanding of how the different capabilities look like in the pharmaceutical R&D setting. Furthermore, the paper raises implicitly the question in what state the knowledge in the project management field currently is.

The third paper (Biedenbach & Müller, 2011a) investigates how the field of project management has developed, in what state it currently is and in which direction it is moving. An investigation of philosophical stances and methodologies is important for understanding the state of current knowledge and future research directions. One of the findings relates to the lack of mixed methods, despite their value for progressing the field of project management.

The fourth paper (Biedenbach & Müller, 2011b) has been designed as a sequential mixed method study. The paper looks in more detail into the
pharmaceutical R&D process, in which both biotechnology and pharmaceutical organizations are intertwined. First, an initial qualitative study explores the absorptive, innovative and adaptive capabilities in the early project phases. Subsequently, a quantitative study investigates the effects of these particular capabilities on project and portfolio performance.

Project and portfolio performance are requirements for innovativeness in general and achieving frequent innovation in particular. The paper focuses on the effects of capabilities on project and portfolio performance, which can be more accurately measured compared to innovation outcome. This approach especially holds because project and portfolio performance have to concern innovation. Without innovation, a R&D project would not be completed.
2 Capabilities for Frequent Innovation within the Early Project Phases of Pharmaceutical R&D

The dynamic hypercompetitive environment serves as an overarching context of the dissertation. This external context is the beginning of a funnel, which shapes and directs the focus of the research project by determining relevant themes and theory choices. Hypercompetition implies that the ability to change constantly and the utilization of flexible temporal organizational forms such as projects are crucial aspects. In such a setting, the relevance of dynamic capabilities is emphasized, in particular for exploring the pharmaceutical and biotechnology industries as an example for a hypercompetitive environment. These industries are dominated by their R&D pipeline, which is clearly project-based. Concerning innovation, it is the early project phases, which are the main originator for innovation in the R&D process. Despite the importance of these phases they are often neglected and recognized as being fuzzy. Thus, there is an urgent need and benefit for advancing the understanding of capabilities in the early project phases to facilitate the outcome of frequent pharmaceutical innovation.

The literature review starts with the theme of a dynamic business environment. Such an external environment poses special demands and challenges for the therein operating organizations. At the most detailed level, the literature review ends with the theme of the fuzzy innovation front end, which is particularly important for facilitating the outcome of frequent innovation. The early project phases of the pharmaceutical R&D are explored by adopting the concept of dynamic capabilities as a lens. The utilization of dynamic capabilities has several benefits. First, as a construct originated from the field of strategic management, dynamic capabilities can provide new insights to the field of project management and particularly to the early project phases. Second, the dynamic capabilities construct itself can benefit from the utilization in the early project phases of pharmaceutical R&D. This is a context, where dynamic capabilities are needed, commonly applied and visible through a diverse set of examples. In this respect, the early project phases in turn, can help to sharpen the lens of dynamic capabilities with the knowledge on how these capabilities behave and facilitate innovation in this context.

This literature review begins with a description of the implications of an external dynamic environment for an organization by looking at its extreme form, namely hypercompetition (section 2.1). Section 2.2 provides insights to
the pharmaceutical R&D process as context for this study and relates it to hypercompetition. Thereafter, section 2.3 highlights the historical development of the resource-based view until the dynamization of organizational capabilities. The subsequent section 2.4 looks in detail on the construct of dynamic capabilities, its development, key components, and their significance for the pharmaceutical R&D process. Section 2.5 emphasizes the development of the project management field by looking at project and multi-project capabilities, and project and portfolio performance. The significance of the early project phases for pharmaceutical innovation is highlighted in section 2.6. The final section 2.7 concludes the literature review.

2.1 Dynamics of the External Environment

The business environment in which organizations operate became increasingly uncertain, dynamic, complex and thus important due to globalization and the fall of trade barriers (Harvey, Novicevic & Kiessling, 2001). Indicators of relevance of the external environment can be found in several pressures that organizations are faced with such as powerful customers, pressures to decrease times to market in R&D and fast technological advancement (D'Aveni, 1998). The recent financial crisis of the world economy is a contemporary example visualizing the complex interrelatedness between global markets and their implications across national borders and industries.

Dynamics of the external environment have been recognized in previous research, but they have often been termed differently such as turbulent environment (e.g. Raynolds, 1971; Iansiti, 1995; Kraatz & Zajac, 2001; Grant, 2003) or high-velocity environments (Eisenhardt & Bourgeois, 1988; Eisenhardt, 1989a). The extreme form of a fast changing environment with intense, hostile and fierce competition is known as hypercompetition and is defined by D'Aveni (1994, p. 217-218) in the following way:

"Hypercompetition is an environment characterized by intense and rapid competitive moves, in which competitors must move quickly to build advantages and erode the advantages of their rivals. This speeds up the dynamic strategic interactions among competitors."

The notion of hypercompetition appeared in the mid 1990's, where it has led to two subsequent special issues in Organization Science (Vol. 7, No. 3&4, 1996). These thematic issues on hypercompetition pointed out three crucial implications for contemporary organizations such as the need for new flexible organizational forms, for a new language and metaphors, and for
new hypercompetitive strategies, because of the paradigm shift (Ilinitch, D'Aveni & Lewin, 1996). The first implication of flexible organizational forms concerns organizational structures that can provide structural and organizational flexibility while still maintaining high levels of controllability. Second, organizational processes need to rely on new activities that can help to overcome the contradiction of flexibility and stability. Third, new hypercompetitive strategies demand from organizations to be proactive by, for example, launching preemptive strikes (Craig, 1996; Nault & Vandenbosch, 1996) due to the imitative behavior of competitors (Gimeno & Woo, 1996).

In hypercompetitive environments, competitive advantage can no longer be sustained based on one single source. Therefore, a continuous set of temporary advantages is required for sustaining competitive advantage over time (D'Aveni, 1994). In this respect, organizations actively disrupt the market and erode competitive advantages of competitors with new sources of temporary advantages (D'Aveni, 1995). Successful organizations are thus demanded to secure their performance through a sequence of appropriate and timely actions.

D'Aveni (1994, 1998) highlights that organizations tend to move through four arenas of competition in their ambition to achieve a leading market position: the price-quality arena, the know-how/timing arena, the stronghold arena, and the deep pockets arena. In the price-quality arena, organizations compete by product positioning based on certain price-quality combinations. Over time, the competition escalates and price-quality advantages get eroded until a new cycle is started based on a redefined quality definition. In the know-how/timing arena, organizations strive after temporary competitive advantage arising from superior know-how and speed upon which they can apply this knowledge for their products, services or internal processes. The stronghold creation/invasion arena is characterized by organizations competing through building entry barriers around strongholds in product markets, geographic regions or industries. Competition often intensifies with organizations defending their own and entering the stronghold of their attacker. After strongholds have been fallen, the competition moves to the deep pockets arena where organizations try to utilize their financial resources and scale benefits. Small organizations may attempt to counteract advantages of large organizations by enforcing antitrust laws, or try to increase size through diversification, joint ventures or alliances. Underlying the different arenas is the fact that competition escalates both within and across the different arenas due to increasing conflicts. (D'Aveni, 1994, 1998)
In some industries, different arenas might be followed closely in the same sequence, whereas in other industries some arenas might be skipped, entered in a different sequence or multiple arenas could be present simultaneously. In the pharmaceutical and biotechnology industries, competition is characterized by themes of all four different arenas: pricing and product features (price-quality arena), rapid adoption of new know-how and technologies (know-how/timing arena), patenting and licensing (stronghold creation/invasion arena), and product launch pressure (deep pockets arena). Researching the early project phases of pharmaceutical R&D, the price-quality arena and the know-how/timing arena deserve special attention. Price-quality considerations define the scope of the R&D project, whereas rapid utilization of expert knowledge, know-how and novel technologies are the key for the generation of innovation and thus the successful development and product launch. Furthermore, timing is a reappearing theme in activities concerning portfolio management and strategic patenting.

Table 2 summarizes the findings of selected studies on hypercompetition (Biedenbach & Söderholm, 2008). Already from the early special issue on hypercompetition (Organization Science, Vol. 7, No. 3&4, 1996) a possible occurrence of an enduring shift towards hypercompetition has been controversially discussed. In these issues, hypercompetition has been described as occurring in idiosyncratic market circumstances (Nault & Vandenbosch, 1996), in cycles (Gimeno & Woo, 1996), or in limited time and thus being of temporary nature (Thomas, 1996).
<table>
<thead>
<tr>
<th>Authors</th>
<th>Sample &amp; Context</th>
<th>Focus of Study</th>
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<tr>
<td>Bogner &amp; Barr (2000)</td>
<td>Conceptual paper, formulation of propositions</td>
<td>Explores cognitive aspects of cyclical HC</td>
<td>• Adaptive sensemaking processes can get institutionalized perpetuating HC</td>
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<tr>
<td>Craig (1996)</td>
<td>Qualitative multiple case study, 4 Japanese breweries</td>
<td>Explores the nature and causes of HC and the required organizational characteristics in the Japanese beer industry</td>
<td>Defining features of HC: 1. HC leads to frequent change as a result of environmental trends and competitive attacks; 2. HC requires firms to transform to create new and complex organizational capabilities; 3. HC occurs in rounds and periods of state. Crucial capabilities are in the first case specialized capabilities, in the latter case they are more of general nature.</td>
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<tr>
<td>Gimeno &amp; Woo (1996)</td>
<td>Quantitative study, city-pair markets in US airline industry, 1984-1988</td>
<td>Explores the effect of strategic similarity and multimarket contact on competitive rivalry</td>
<td>• Most intense rivalry between similar firms with multimarket contact; • HC may occur in cycles</td>
</tr>
<tr>
<td>Harvey &amp; Novicevic (2001)</td>
<td>Conceptual paper</td>
<td>Explores the dimensions of time in hypercompetitive environments</td>
<td>• In hypercompetitive times decisions need to be made in terms of learned complementarities between flexibility and responsiveness rather than traditional trade-offs</td>
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<td>Harvey, Novicevic &amp; Kiessling (2001)</td>
<td>Conceptual paper, formulation of propositions</td>
<td>Examines drivers of HC; explores the impact of HC on strategy development</td>
<td>• HC shifted focus of organizations to flexible positioning based on effective commitments of their market-orientated assets</td>
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<td>Authors</td>
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<td>Ilinitch, D’Aveni &amp; Lewin (1996)</td>
<td>Introduction to Special Issue on HC</td>
<td>Setting an agenda for discussion about dynamic competition</td>
<td>• New language &amp; metaphors are needed;</td>
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<td></td>
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<td>• Importance of new organizational forms designed for flexibility and knowledge creation;</td>
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<td>• Occurrence of a paradigm shift</td>
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<tr>
<td>Makadok (1998)</td>
<td>Quantitative study, money market mutual fund industry, 1975-91</td>
<td>Examines the sustainability paradigm of first-mover and early-mover advantages</td>
<td>• First-mover and early-mover advantages in price are more sustainable than in market share;</td>
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<td></td>
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<td>• HC might be psychological or perceptual in nature</td>
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<td>McNamara, Vaaler &amp; Devers (2003)</td>
<td>Quantitative study, 114,191 business units, 1978-97</td>
<td>Examines empirical support if markets become increasingly hypercompetitive</td>
<td>• Evidence for temporary HC, late 1970s-late 80s</td>
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<td>Nault &amp; Vandenbosch (1996)</td>
<td>Modeling approach and solution concept from games of timing</td>
<td>Conditions under which an incumbent will use protection-through-preemption strategy</td>
<td>• Preemptive launch of a next generation product can be socially optimal, while firms may bear additional costs</td>
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<td>Rühli (1996)</td>
<td>Case study of Asea Brown Boveri</td>
<td>Applies the HC models by D’Aveni on ABB as case company</td>
<td>• Application of tools and frameworks of HC raises attention on important strategic issues previously uncovered by other frameworks;</td>
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<td>• HC frameworks useful to forecast strategic moves</td>
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<td>Rühli &amp; Sachs (1997)</td>
<td>Conceptual paper</td>
<td>Explores diversification as fundamental problem in today’s hypercompetitive markets</td>
<td>• Dynamic, multi-level, and multi-arena strategic competitive intelligence is required to obtain competitive advantage through diversification to protect firms from threats in hypercompetitive environments</td>
</tr>
<tr>
<td>Thomas (1996)</td>
<td>Quantitative study, 200 industries in the US manufacturing sector, 1958-91</td>
<td>Examines the nature of competition</td>
<td>• Verification of a hypercompetitive shift;</td>
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<td></td>
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<td>• Importance of knowledge base is triggering HC shift</td>
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Table 2: Selected studies on hypercompetition (Biedenbach & Söderholm, 2008)

Mixed support for the presence of hypercompetition has been also reflected by later research. While some studies point out the lacking empirical support for hypercompetition (Makadok, 1998), other studies in contrast find temporary evidence for hypercompetition (McNamara, Vaaler & Devers, 2003). Even stronger empirical evidence for a hypercompetitive shift across different industries has been found by recent research (Wiggins & Rueflí, 2005). However, despite this ambiguity in research, the general perspective on competitive advantages views it as being temporary, and the underlying key factors of the different competitive arenas are assumed to be beneficial for today’s dynamic business environment. Hypercompetition is not only present in the most characteristic settings such as manufacturing (Thomas, 1996) and high-tech industries (Galunic & Eisenhardt, 1996), but also within pharmaceutical (D’Aveni, 1994, 1998), biotechnology (Liebeskind et al., 1996), airline (D’Aveni, 1998), software (Lee, Venkatraman, Tanriverdi & Iyer, 2010), and beverage industries (Craig, 1996).

Later research on hypercompetition has been focusing on characteristics of organizational processes (Rühli & Sachs, 1997; Bogner & Barr, 2000; Harvey
Moreover, hypercompetition has been linked to inter-organizational relationships in supply chain management (Kotzab, Grant, Teller & Halldorsson, 2009), higher education (Sharkey & Beeman, 2008), and emerging economies (Hermelo & Vassolo, 2010). Despite its origin in the 1990’s, hypercompetition is still on the agenda of contemporary research addressed within a Special Issue in the Strategic Management Journal (Vol. 31 No. 13, 2010) on “The age of temporary advantage?”. Furthermore, the California Management Review currently has a call for research on “Achieving strategic agility in hypercompetitive environments”. The themes of structural flexibility and temporality have led to an emergence of new organizational forms such as network structures (Ghosal & Bartlett, 1990), virtual organizations (Mowshowitz, 1994), temporary or project-based organizations (Lundin & Söderholm, 1995; Turner & Müller, 2003; Whitley, 2006), or ambidextrous organizations (O’Reilly & Tushman, 2004; Van Looy, Martens & Debackere, 2005). Volberda (1996) states that appropriate organization structures in hypercompetitive environments need to allow flexibility and a balanced level of change and preservation while controllability has to be preserved.

Hypercompetition leads to an aggressive and dynamic behavior of different actors in the competitive market space, and thus to a condition of constant disequilibrium and change (D’Aveni, 1995). Change will become central for hypercompetitive industries and for each organization involved in this context. While organizations often proactively initiate change, it may also get triggered by attacks from competitors or events in the external environment (Craig, 1996). Innovation and change are closely linked to each other in the context of hypercompetition (Harvey et al., 2001). Within dynamic environments, this interrelationship makes R&D projects a suitable context for this study. The implementation of change requires certain organizational capabilities to not only increase variety and speed, but also for enabling the R&D to direct change in the pharmaceutical industry (Volberda, 1996). The pharmaceutical and biotechnology industries are the chosen hypercompetitive context in this dissertation, which requires idiosyncratic capabilities for constant changes and for mastering the complex R&D process with frequent innovation. These industries are clearly project-dominated due to the significance of their R&D process. The next section will go into more detail on hypercompetition in the pharmaceutical and biotechnology industries and the characteristics of the pharmaceutical R&D process.
2.2 Pharmaceutical R&D and Hypercompetition

The pharmaceutical and biotechnology industries have been described as hypercompetitive (D’Aveni, 1994, 1998; Liebeskind et al., 1996). However, the utilization of patents and compliance with a highly regulated R&D process makes sometimes the outsiders to assume the opposite, by seeing these industries as a stable environment. This fact requires an explanation of why these industries can be termed as hypercompetitive. First, the interviews of this study highlighted that patent protection lasts 15-20 years. However, in practice patents are filed early in the R&D process leaving only a couple of years of patent protection after the commercial approval. When a patent has been expired, pharmaceutical organizations gain severe competition from generic competitors, where brand name sales may drop by 80% (Herper, 2002). Traditional pharmaceutical organizations respond by filing patents on top of existing patents, often resulting in enduring and costly lawsuits with generic pharmaceutical organizations. These hypercompetitive tendencies occur despite an existing or prolonged patent protection, which in practice often is a debatable matter.

Second, although the industry and the R&D process are highly regulated, there exists an intense competition concerning leading scientists with unique competences, being first in filing a patent in a certain area, licensing of latest technologies and techniques, having access to venture capital, having access to leading organizations for partnering, and acquiring market rights. These are examples of crucial elements for the R&D process upon which hypercompetition unfolds. The competition for these factors relates to the know-how/timing arena of hypercompetition, where timely access is crucial. Additionally, the external environment is extremely dynamic with increasing regulations and changing national health care systems.

The pharmaceutical R&D process is a very challenging context for pharmaceutical and biotechnology organizations being a highly uncertain and complex endeavor, which involves high costs and often inefficiencies. Moreover, the pharmaceutical development is a very lengthy process with development times of up to 15 years (Cuatrecasas, 2006; Ingelgård, Roth, Shani & Styhre, 2002). Typically it costs more than $800 million to develop a novel drug (Datamonitor, 2007). The combination of high complexity, costs and uncertainty makes it a high-risk business for the organizations involved. The attrition rate from the initial discovery of compounds until market launch is very high, since only one out of 1000 compounds reaches commercialization (Chesbrough, 2011). From the compounds, which enter the clinical development, 80-90% do not make it until market launch (Cuatrecasas, 2006). The pharmaceutical industry is fragmented, which is
reflected by the fact that four large international players represent only 25% of the market value contributing to a strong global rivalry (Datamonitor, 2010).

Figure 1 shows the pharmaceutical R&D process, which is divided into two main stages of a purely research-based drug discovery and a subsequent stage of clinical development. The largest extent of innovation originates in the early stages of drug discovery, which implies that the early project phases in pharmaceutical R&D gain special importance. Regulatory authorities are continuously involved throughout the R&D process, besides being only responsible for the final approval of a drug. The R&D process is a multifaceted endeavor, where people with diverse backgrounds collaborate internally. Moreover, pharmaceutical and biotechnology organizations are closely intertwined in the pharmaceutical R&D process. Traditionally, biotechnology organizations tend to be more involved in the drug discovery, whereas pharmaceutical organizations dominate the clinical development. One reason for it is that most biotechnology organizations lack the resources needed for the access to expertise and markets, funding, and validation, which make them dependent on larger pharmaceutical organizations (Cooper, 2006). Another reason is that pharmaceutical organizations tend to fill possible gaps in their diminishing R&D pipelines by buying pre-developments from biotechnology firms or entering into co-development agreements.

Figure 1: The R&D process in the pharmaceutical industry (Biedenbach, 2011)
Recently, the emergence of fully integrated pharmaceutical organizations and fully integrated biotechnology corporations has considerably changed the power relationships and overall environment (Ahn, Meeks, Davenport & Bednarek, 2010). At the same time, there is a trend of biotechnology organizations moving beyond drug discovery and into drug development (Rothman & Kraft, 2006). These changes stimulate an increasing integration of biotechnology and pharmaceutical organizations along the complete pharmaceutical R&D process.

The pharmaceutical R&D process faces many challenges. First, a pressure to decrease time to market is accompanied by ever-increasing safety requirements from the regulatory authorities. Second, low productivity levels together with high development costs and failure rates have resulted in a strong pressure from shareholders, who expect substantial returns on their investments (Cuatrecasas, 2006). Additionally, there are powerful stakeholders such as medical doctors influencing drug prescription and national health care systems determining reimbursement schemes (Datamonitor, 2007). These stakeholders can significantly change the determinants of the business case of a project. Third, a balanced R&D portfolio is crucial, because sales revenues secure the capital-intensive R&D process and costly clinical development stages. Therefore, pharmaceutical and biotechnology organizations maintain a pronounced pipeline thinking for their portfolio, which addresses the inherent complexity and uncertainty (Gassmann & Reepmeyer, 2005).

Time-related pressures within the R&D process and events in the competitive arena and external environment require organizations to engage in continuous change. In this respect, the organization changes during the R&D process and through its outcomes. Volberda (1996) states that the implementation of change in hypercompetitive environments requires idiosyncratic capabilities that enable the organization to increase speed and variety. The next section will present the theme of organizational capabilities and its foundation in the resource-based view (RBV) of the firm.

2.3 The Resource Based View and Organizational Capabilities

The previous sections have already highlighted the importance of dynamic capabilities for rapid change and flexibility in hypercompetitive environments. Dynamic capabilities and organizational capabilities in general are rooted in the RBV of the firm. The suitability of the RBV for investigating product development performance has been recognized already by previous research (Verona, 1999). Verona (1999) emphasizes that
different organizational capabilities positively affect the R&D outcome by affecting process efficiency and product effectiveness. Taking a capability perspective on the pharmaceutical R&D process is also of special value for practice. Besides contributing to the theoretical refinement of capability research, it is also an area at the core of practitioner’s interest for improving the R&D process by acquiring certain capabilities and capitalizing on them.

2.3.1 Historical Development of the RBV

The RBV matured to one of the prominent theories in strategy research over the last two decades (Lockett, Thompson & Morgenstern, 2009). The perspective provides an explanation for intra-industry performance differences based on competitive heterogeneity, which arises from unique bundles of resources (Hoopes, Madsen & Walker, 2003).

The seminal contributions of three people have paved the way for the RBV. First, Penrose (1959) considers the firm as a bundle of resources. Organizations utilize resources differently while yielding to different services. Thus, they are sources of uniqueness for an organization. Second, Selznick (1957) highlights that during the ongoing institutionalization, an organization develops a distinctive competence in doing a specific work. Third, Chandler (1962) points out the relevance of organizational structure claiming that growth without aligning the structure leads to economic inefficiency. The key result of his empirical research is that structure follows strategy, meaning that a new strategy requires structural changes to maintain efficiency. Another significant precursor to the RBV is Richardson (1972), who developed a theory of inter-firm cooperation based on the concept of capabilities. Furthermore, Nelson and Winter (1982) demonstrate that the characteristics of organizational capabilities are directly affected by the characteristics of individual skills.

The RBV can be divided into two complementary branches: a traditional static approach that examines the conditions for resources to yield rents in equilibrium, and a dynamic approach that considers dynamic factors (Foss, 1997). The traditional approach centers on the building of sustainable competitive advantage (Barney, 1991; Peteraf, 1993; Rumelt, 1984). Competitive advantage arises from different resource allocations and is affecting the performance of an organization (Dierickx & Cool, 1989; Peteraf, 1993). Barney (1991) highlights the so-called VRIN criteria that resources must meet to gain sustainable competitive advantage: they must be valuable, rare, inimitable, and non-substitutable. In line with the VRIN criteria, Peteraf (1993) points out the following four cornerstones resulting in a sustained competitive advantage. First, heterogeneity, which implies that
organizations can compete on the market based on varying superior resources, whereas marginal resources at most lead to breakeven. Second, ex post limits to competition that preserve the condition of heterogeneity over time by, for example, imperfect imitability and imperfect substitutability. Third, ex ante limits to competition, meaning that there must be limited competition for a superior resource position. Fourth, imperfect mobility, which exists when resources are specialized on specific needs of the organization and less valuable to others. Heterogeneity is the most basic criterion, necessary, but solely not sufficient for sustainable advantage.

One of the major contributions to the traditional RBV is from Wernerfelt (1984) clarifying that growth strategy concerns creating a balance between the utilization of existing resources and the development of new resources. Another significant study by Rumelt (1984) introduces an isolating mechanism, which determines stable or defensible competitive positions. One important issue to keep in mind is that within the RBV the term of resources is used in a wider scope including assets, core competencies and capabilities. Organizational capabilities can be understood as a distinct superior way of distributing resources in several complex processes within an organization (Schreyögg & Kliesch-Eberl, 2007).

Core competencies (Prahalad & Hamel, 1990) and dynamic capabilities (Teece et al., 1997) are the key concepts from the dynamic branch of the RBV. Innovation, organizational learning, resource accumulation and the building of competences are examples of important themes of the dynamic RBV (Foss, 1997). The dynamic RBV will be explained in more detail in the subsequent section on dynamic capabilities. Before discussing the dynamic RBV, it is important to consider the following limitations of the RBV.

Priem and Butler (2001) criticize the development of the RBV by stating four major limitations. First, they see the RBV of being tautological and thus difficult to dispute. Second, they identify a problem of equifinality, where many different resource allocations would be of same value, while they would not be sources of competitive advantage. Third, they state that product markets are undervalued. Fourth, they question the practical applicability of the RBV. The article by Priem and Butler (2001) was the starting point of critical debates directing the further development of the RBV. Barney’s (2001) direct response in the same journal issue saw the primary criticism as unfounded, but he recognized its value in identifying aspects that need to be refined and further developed.

Additional critical contributions emerged with the purpose to develop and direct the RBV. Lado et al. (2006) identified paradoxes within the RBV that
are aimed to enhance theorizing and increase the understanding of contradictions and tensions. Another review of the RBV has critically investigated the development of the RBV in a more holistic way by looking at theory, method, empirical evidence and practical insights (Lockett, Thompson & Morgenstern, 2009). Kraaijenbrink, Spender and Groen (2010) suggested integrating space, time and the resolution of uncertainty, and moving the agenda of the RBV into the dynamic framework of Austrian economics. Despite its limitations, the RBV can resist most critiques, continuously develops and turns out to be the dominant perspective in strategic management. Contemporary concepts such as dynamic capabilities and process research highlight the relevance of this theory.

2.3.2 The Dynamization of Organizational Capabilities

In today’s business environment, the organizational capabilities have changed their characteristics in an interplay between the organization and macro-environmental factors. Reasons for this shifting focus originate from both, practical and theoretical perspectives. Firstly, pressures from the turbulent business environment and the resulting implications for organizations have led to a dynamization of organizational capabilities. Change becomes the key for the contemporary organization, either as response to external events or as prevention of attacks from competitors. Thus, it becomes crucial for an organization to have the capability to conduct appropriate changes effectively. Organizations, which can respond timely with fast and flexible product innovations, while still being able to effectively rearrange, coordinate and combine internal and external competences, have been most successful (Teece et al., 1997). The particular abilities needed for these activities have been defined as dynamic capabilities. In contrast to organizational capabilities, dynamic capabilities concern change and are a powerful remedy in rapidly changing environments as an enabler for organizational change.

Secondly, the emergence of the dynamic capabilities concept was also triggered as a reaction to the limitations arising from the static assumptions of the traditional RBV (Foss, 1997). The dynamic capabilities perspective relates to the capacity to renew competences frequently in line with the dynamic business environment (Teece et al., 1997). Therefore, organizational learning and experiences are crucial ingredients for the generation of dynamic capabilities (Teece et al., 1997; Eisenhardt & Martin, 2000; Helfat, 2000). The intangible character of these factors makes the development of dynamic capabilities a rather complex endeavor and is generally difficult to achieve. With an increasing relevance of the dynamic capabilities, the dynamic RBV has emerged (Helfat & Peteraf, 2003; Foss & Ishikawa, 2007).
The dynamic capabilities perspective can be used to understand how changes in the external environment lead to changes in organizations, and how organizations in turn can shape their environment by enhancing their capabilities (Teece & Augier, 2009). Helfat and Peteraf (2003) extend the dynamic RBV arguing that capabilities run through an evolutionary lifecycle of founding, development and maturity stages to explain sources of heterogeneity of organizational capabilities.

Underlying this dynamization of the RBV is the assumption that due to a rapidly changing business environment, sustainability of competitive advantage can be only achieved through a flow of temporary competitive advantages. Eisenhardt and Martin (2000) point out that dynamic capabilities are a necessary tool for the creation of competitive advantage, but they provide only insufficient conditions and cannot be the only source of competitive advantage. Within the pharmaceutical R&D process, the changing health care reimbursement schemes, limited patent protection, rapid development of new technologies and sustainability of revenue streams for expensive development costs require a dynamization of organizational capabilities. Therefore, the utilization of the dynamic capability concept seems to be promising for gaining new insights.

The next section describes how the dynamic capabilities concept has developed over time, presents its constituting elements and outlines three different streams of dynamic capabilities research.

2.4 Characterizing Dynamic Capabilities
2.4.1 The Development of the Dynamic Capabilities Construct

In the seminal work by Teece et al. (1997) the dynamic capabilities construct is described as consisting of three categories: managerial and organizational processes, specific asset position and path dependency (see Figure 2). Thus, competitive advantage is rooted in managerial and organizational processes and is based on their idiosyncratic asset position and available paths, which are shaped by history. The first category, managerial and organizational processes, is based on current practices, routines and learning. The organizational processes have the objectives to coordinate/integrate external technologies and activities, to reconfigure, and to engage in organizational and inter-organizational learning. Kogut and Zander (1992) characterize organizational learning as combinative capability that generates knowledge from internal and external sources.
Figure 2: Dynamic capability framework (adopted from Teece et al., 1997)

The second category, specific asset position, serves as strategic foundation for the competition by determining the competitive advantage of an organization. Rumelt (1984) shows that specialized assets and unique resources are important for the competitive position of an organization being of technological, complementary, financial, reputation-related, structural, institutional or market-related nature, and protected by organizational boundaries. The third category, path dependency, means that historical
routes are important, because asset investments and decisions from the past determine future opportunities and constraints (Kogut & Zander, 1992).

Eisenhardt and Martin (2000) exemplify dynamic capabilities as processes such as product development routines, but also extend the dynamic capabilities concept with the generation of market change and response to exogenous change. Later on, Zollo and Winter (2002) emphasize organizational learning as a source for dynamic capabilities. Building on previous research and directing future research, Helfat et al. (2007, p. 4) define: “A dynamic capability is the capacity of an organization to purposefully create, extend, or modify its resource base”. This definition incorporates decision making concerning search and selection issues of dynamic capabilities.

Along the development of the construct and despite the adjusted definitions, there is a general agreement that dynamic capabilities are organizational processes, which are utilized to change the resource base of the organization (Ambrosini & Bowman, 2009). Ambrosini and Bowman (2009) emphasize four main characteristics of dynamic capabilities. First, in contrast to spontaneous responses or ad-hoc problem solving, they must contain a pattern, and thus must be repeatable. Second, the deployment of dynamic capabilities is intended and based on deliberate actions. Third, dynamic capabilities are not a synonym for change, but instead concern a specific type of change, namely the change of the resource base of an organization. Finally, dynamic capabilities refer to intended activities, which aim to change the organization’s resource base.

While the different characteristics generally describe the dynamic capabilities construct, it is also of multi-dimensional nature. Barreto (2010) distinguish between four different elements of dynamic capabilities, such as propensities to sense opportunities and threats, to make market-oriented decisions, to make timely decisions, and to change the firm’s resource base. Similarly Teece (2007) disaggregates dynamic capabilities into the capacity to sense and shape threats and opportunities, to seize opportunities, and to preserve competitiveness through improving, combining, securing, and if required, reconfiguring the assets of the organization. In this respect, dynamic capabilities facilitate the identification of threats and opportunities, the utilization of opportunities through appropriate decisions, and the maintenance of competitiveness by transforming the resource base of the organization.

Previous research has highlighted that dynamic capabilities occur on different hierarchical levels termed as zero-level, first-order, second-order
and higher order or meta-capabilities, which renew the capability itself (Collis, 1994; Danneels, 2002; Winter, 2003). Ambrosini, Bowman and Collier (2009) distinguish two core levels of dynamic capabilities. They identify a first level of incremental dynamic capabilities that concern adaptive change and continuous improvement of the firm’s resource base, and a second level of renewing dynamic capabilities that refresh and extend the resource base. Moreover, they recognize a third level of regenerative dynamic capabilities as meta-capabilities that impact the way an organization renews its resource base thus directly renewing dynamic capabilities. Ambrosini, Bowman and Collier (2009) link the different levels of dynamic capabilities to the dynamization of the environment relating the incremental level to rather stable environments, the renewing level to dynamic environments and the regenerative capabilities to a hyperenvironment.

Different levels occur not only on a hierarchical level, but also on a more conceptual level. Schreyögg & Kliesch-Eberl (2007) recognize three different perspectives of dynamic capabilities research: (1) the radical dynamization approach, (2) the integrative approach and (3) the innovation routine approach. First, the radical dynamization approach assumes full adaptability of capabilities in dynamic environments. Dynamic capabilities provide abilities to change fast and to master the challenges of an unpredictable environment, and thus can be a potential source for the creation of competitive advantages (Eisenhardt & Martin, 2000). Second, the integrative approach combines static aspects of coordinating and integrating available resources with the process-based aspects underlying organizational learning and resource reconfigurations (Teece et al., 1997).

The third approach is based on additional innovation routines, which can stop organizational capabilities from becoming an organizational rigidity (Zollo & Winter, 2002). Schreyögg and Kliesch-Eberl (2007) question that the three approaches have enough power to overcome the capability paradox, which is based on the following dilemma. On the one hand, capabilities are beneficial as utilization of routines, whereas on the other hand, the organization faces the risk of getting locked to the pattern (Leonard-Barton, 1992; Schreyögg & Kliesch-Eberl, 2007). Therefore, Schreyögg and Kliesch-Eberl (2007) suggest managing capabilities by following a dual model, which comprises two countervailing functions of distinctive organizational capabilities aiming at efficiency and excellence, and simultaneously controlling the dynamization of organizational capabilities.
As every theoretical framework, dynamic capabilities have also some limitations. First, the initial framework of dynamic capabilities by Teece et al. (1997) assumes rapidly changing environments as appropriate context for the application of dynamic capabilities. However, previous research has found that in moderately dynamic environments, dynamic capabilities are still valuable and could differ across these contexts (Eisenhardt & Martin, 2000). Other researchers have highlighted that dynamic capabilities can be beneficial even in stable environments (Zahra et al., 2006; Zollo & Winter, 2002). Although previous research is rather ambiguous concerning this particular limitation, it nevertheless indicates that dynamic capabilities are increasingly valuable or even required in an increasingly dynamic environment. Second, dynamic capabilities are not directly observable and thus need to be explored indirectly by looking at indicators and contributing elements (Easterby-Smith, Lyles & Peteraf, 2009). This limitation highlights a special need for exploratory studies on dynamic capabilities with an appropriate methodology that for example utilizes interviews with rather open questions. This challenging setting has triggered the choice of methodology used in the second paper of this dissertation and is more thoroughly described in the methodology section.

Third, not only regarding qualitative research, but also concerning quantitative studies, it is difficult to measure dynamic capabilities in general, the underlying organizational processes, and the relationship between dynamic capabilities and firm performance (Easterby-Smith, Lyles & Peteraf, 2009). This limitation has shaped the research approach of the fourth paper in this dissertation, which looks at constituting capabilities of the dynamic capabilities construct and relates them to more specific performance measures such as project and portfolio performance. The methodology section will provide more details about these choices, but it is noteworthy already at this point to highlight that the limitations one and two were also the main reason for the sequence of the dissertation research, which firstly includes an exploratory qualitative study and then a final mixed method study.

### 2.4.2 Key Components of Dynamic Capabilities

In their review of the development of the dynamic capabilities construct, Wang and Ahmed (2007) identify three component factors, namely absorptive, innovative and adaptive capabilities. A distinction into sub-capabilities aims to clarify the construct by making it easier to observe and to link related types of capabilities together. All three capability components emerge from an extensive literature review by Wang and Ahmed (2007) and have the advantage of being measured by robust measurement scales.
“Capabilities refer to a firm’s capacity to deploy resources, usually in combination, and encapsulate both explicit processes and those tacit elements (such as know-how and leadership) embedded in the processes” (Wang & Ahmed, 2007, p. 35). Moreover, a combination of different capabilities is supported by Teece at al. (1997), who highlight the combinative purposes of the dynamic capabilities construct.

The specific characteristics of absorptive and adaptive capabilities indicate that the dynamic capabilities construct is closely related to business intelligence. Moreover, innovative capabilities emphasize the importance of skills for dynamic capabilities (Deeds et al., 1999). These three capabilities are embedded in organizational processes that renew, integrate, reconfigure and recreate the resource base of an organization (Wang & Ahmed, 2007).

**Absorptive capabilities**

Research has recognized the relevance of absorptive capabilities for inter-organizational learning and performance (Lane, Salk & Lyles, 2001). Absorptive capability is an organization’s ability to apply external knowledge through three intertwined processes of exploratory, exploitative, and transformative learning (Lane et al., 2006). Learning occurs in a sequence of obtaining external knowledge, applying this knowledge and maintaining the knowledge over time (Garud & Nayyar, 1994; Zahra & George, 2002).

Absorptive capabilities emphasize the importance of taking in external knowledge, combining it with internal knowledge and absorbing it for internal utilization (Wang & Ahmed, 2007). In this respect, the key factors of absorptive capabilities are identification, assimilation, transformation of the organizational context and application of external knowledge (Cohen & Levinthal, 1990; Zahra & George, 2002; Oltra & Flor, 2003). Lane et al. (2006) suggest a model where absorptive capabilities create knowledge and commercial outputs that affect overall firm performance. These themes fit well to the pharmaceutical R&D process concerning the need of utilizing the latest knowledge and indicate that absorptive capabilities relate to project and portfolio performance, which are investigated in the fourth paper.

**Innovative capabilities**

Innovative capabilities concern the development of new products and/or markets combining strategic innovative orientation with innovative behavior and processes (Wang & Ahmed, 2007). Innovative capabilities concern assimilating and storing individual knowledge in the organization in databases, manuals or patents for future utilization, while establishing structures and processes to transform individual inputs into a continuous stream of innovation outcome for the organization (Garud & Nayyar, 1994;
Innovation can be distinguished based on the extent of innovation into incremental innovation and radical innovation (Abernathy & Clark, 1985). There are several innovation typologies that exist in literature with rather ambiguous definitions and demarcations (Garcia & Calantone, 2002). This fact makes it important to highlight the definitions of the innovative capabilities underlying this dissertation.

Incremental innovative capability can be defined as the ability “to generate innovations that refine and reinforce existing products and services”, whereas radical innovative capability describes the ability “to generate innovations that significantly transform existing products and services” (Subramaniam & Youndt, 2005, p. 452). Subramaniam and Youndt (2005) use this differentiator to distinguish between incremental innovative capabilities that require a reinforcement of prevailing knowledge, and radical innovative capabilities that require a transformation of prevailing knowledge. Previous research highlights that innovative capabilities can be also obtained from external organizations and can be created in external inter-organizational collaboration (Hagedoorn & Duysters, 2002). Such complex settings, where organizations are interrelated and gain their innovative capabilities from collaboration, are widespread among the different actors in the pharmaceutical R&D process. Previous research has found that innovative capabilities have an impact on firm performance (Sher & Yang, 2005). Moreover, innovation is playing a key role in all pharmaceutical R&D projects, while innovative capabilities are required for its generation and securing of its potential. In this respect, the context of pharmaceutical R&D indicates that innovative capabilities are also significant for project and portfolio performance. The fourth paper investigates these relationships.

Adaptive capabilities
Adaptive capability can be defined as an organization’s “ability to identify and capitalize on emerging market opportunities” (Chakravarthy, 1982; Hooley, Lynch & Jobber, 1992; Miles & Snow, 1978; Wang & Ahmed, 2007, p. 37). Adaptive capabilities allow reacting fast and in a flexible manner to dynamic market conditions, thinking in new ways supported by rapid decision making, and changing direction (Denton, 1998). Key components of adaptive capabilities are the investment in marketing activities, the speed of response to changing market conditions, and the ability to respond to external product-market opportunities (Chakravarthy, 1982).

Tuominen, Rajala and Möller (2004) divide adaptability into three interrelated aspects such as internal organizational aspects, external market aspects, and technological aspects. Previous research shows that adaptability
leads to an improved performance (Bourgeois, 1980; Snow & Hrebiniak, 1980). Furthermore, Oktemgil and Greenley (1997) highlight adaptability as a key prerequisite for good business performance. Adaptability plays a significant role in the early project phases and can be expected to be of high value for project and portfolio performance. The fourth paper investigates the effects of adaptive capabilities on project and portfolio performance.

The three capabilities (i.e. absorptive, innovative and adaptive capabilities) compose and characterize the dynamic capabilities. There might be other elements and components on other levels of detail. However, these three capabilities allow a more accurate operationalization by utilizing existing robust measures of capabilities that altogether form dynamic capabilities. The three different capabilities themselves contain more detailed elements of dynamic capabilities.

While this section was looking at the different components of dynamic capabilities, the next section links the dynamic capabilities framework to the pharmaceutical R&D process.

2.4.3 Dynamic Capabilities in the Pharmaceutical R&D Process

The dynamic capabilities framework is still in its nascent stage and is still developing, leaving opportunities for research to refine and to detail the construct and its application (Easterby-Smith, Lyles & Peteraf, 2009). The research on dynamic capabilities lacks empirical studies (Pablo et al., 2007), while quantitative studies seem to dominate this research field (Ambrosini & Bowman, 2009). Despite the emergent stage of the dynamic capabilities construct, it has been previously used in the pharmaceutical R&D context (e.g. Deeds et al., 1999; Ingelgård, et al., 2002). Dynamic capabilities have been considered not only as an antidote for dealing with the challenges of a turbulent business environment, but also as an insightful perspective on the complex, uncertain and lengthy pharmaceutical R&D process. Moreover, pharmaceutical and biotechnology organizations are expected to emphasize the application of dynamic capabilities for succeeding within a complex, cross-functional, collaboration-based, skill-based, and knowledge-based R&D process. This particular context is also valuable for progressing the understanding of dynamic capabilities and their application, because this is the setting, where these capabilities are frequently utilized.

Organizational learning and the development of capabilities are key aspects of dynamic capabilities. Ingelgård et al. (2002) emphasize that organizational learning in the pharmaceutical industry is affected by the existing skills and competences, leadership, organizational structure,
organizational culture, the capacity for continuous change, and learning incentives. Additional important elements for organizational learning are information and knowledge. Henderson (1994) finds that integrative capability is crucial for successful pharmaceutical R&D, which refers to the ability to integrate knowledge across firms, but also within intra-organizational disciplinary boundaries. Based on these characteristics, integrative capabilities are closely related and might be an integral element of absorptive capabilities. One example of intra-organizational disciplinary spanning boundaries can be found in the collaboration between marketing and R&D departments. In the pharmaceutical R&D process, the interface between marketing and R&D is highly dynamic and enforcing the capability-building process of the organization (Wang, 1997). Marketing confronts current external events related to the market and competitors with the latest technologies, scientific findings and progress reports from the R&D department. Bruni and Verona (2009) highlight dynamic marketing capabilities, which positively affect R&D performance by utilizing market knowledge to initiate the innovation process and to reconfigure R&D capabilities, and by combining market knowledge with technical knowledge. While being generally important, the marketing – R&D interface becomes even more significant during the early project phases of pharmaceutical R&D. These dynamic marketing capabilities can be understood as adaptive capabilities, because they utilize external influences for shaping the R&D process. The dynamic marketing capabilities and their impact on reconfiguring the R&D capabilities highlight the value of combining different capabilities.

Another research, which explicitly focuses on the combination of capabilities, addresses the context of mergers and acquisitions of pharmaceutical organizations. Coombs and Metcalfe (2002) suggest that it is appropriate to combine two capabilities fully into one single capability, when they are similar, or in contrast, to generate a new capability if there are two complementary capabilities that provide potential for synergies. Furthermore, sequencing of the combination and co-ordination approaches is a suitable way to reduce the risk of capabilities loss (Coombs and Metcalfe, 2002).

In their study of biotechnology organizations, Deeds et al. (1999) find that the concentration of firms, and the quality of the scientific team positively affect product development performance, whereas an overreliance on technical personnel in the organization’s management can undermine R&D performance. The dynamic capabilities construct has been also used to explain the organization of business activity in the biotechnology industry in
relation to international technology flow and organizational form (Madhok & Osegowitsch, 2000).

Dynamic capabilities affect the value creation of organizations by having an impact on their resource base (Ambrosini & Bowman, 2009). Besides affecting value creation, dynamic capabilities emphasize competences and firm performance (Easterby-Smith, Lyles & Peteraf, 2009). While early research suggests a direct relationship between dynamic capabilities and firm performance (Teece et al., 1997), latest research shows less confidence in a direct relationship (Barreto, 2010).

In the pharmaceutical R&D process, long-term firm performance requires innovation for which project management plays a key role (Sicotte et al., 2011). Looking at more detailed performance measures such as project and portfolio performance allows a more direct investigation of the relationship between dynamic capabilities and performance. In the R&D context, innovation is a prerequisite for project performance, while portfolio performance relates to sustaining performance through frequent innovation. The next section will introduce the theme of project management in general, and project performance and portfolio performance in particular.

2.5 The Development of Project Management and its Capabilities

2.5.1 The Field of Project Management

Project management has increasingly gained relevance with organizations getting commonly organized through projects, whole industries such as in construction and consultancy being project-based and even societies being projectized with an increasing amount of people being directly employed on a project basis or hold temporary positions (Ekstedt et al., 1999). The pharmaceutical and biotechnology industries are strongly project-dominated due to their focus on R&D. This section reviews the field of project management regarding the research context and provides the relevant terminology.

Turner and Müller (2003, p. 7) define a project as “temporary organization to which resources are assigned to undertake a unique, novel and transient endeavor managing the inherent uncertainty and need for integration in order to deliver beneficial objectives of change”. Following this definition, the key characteristics are that projects are restricted by time and concern an uncertain, unique, and novel undertaking aimed at a goal-orientated change.
Project management relates to complexity and is beneficial for organizations in this regard. Project management refers to the organization of project activities, which are frequently used to solve complex organizational problems (Söderlund, 2004). Packendorff (1995) highlights that project management provides techniques and models for planning and controlling a complex endeavor.

The field of project management experienced three major leaps, which progressed the field of research by adding new influences. The historical origin of the project management field stems from the 1950’s and 1960’s, when large defense programs utilized project management and developed its techniques (Fondahl, 1987; Snyder, 1987). During that time, project management was heavily dominated by planning techniques and optimization approaches. In the 1990’s, Scandinavian researchers broadened the project management field by linking it to organization theory in the perspective of project as a temporary organization (Lundin & Söderholm, 1995; Packendorff, 1995). The Scandinavian school provided a new stream of research emphasizing qualitative case studies and highlighting the importance of contextual factors for project management (Engwall, 2003). The project management field subsequently opened up to research a diverse array of themes such as human resource management (e.g. Bredin & Söderlund, 2006; Drouin et al., 2009), capabilities (e.g. Brady & Davies, 2004), and marketing (e.g. Cova & Salle, 2005).

The emergence of a critical perspective on project management pushed the development of the field once more by, for example, highlighting the relevance of practice (Hodgson & Cicmil, 2006). Another objective of the critical perspective was to outline research directions by linking project management theory to the needs of practitioners. Theory about practice has the ambition to improve the understanding of practice, theory for practice emphasizes the development of concepts and perspectives that have a practical use, and theory in practice aims to direct practitioners in developing their skills and competences by applying relevant theory (Winter, Smith, Morris & Cicmil, 2006).

Reviewing the field of project management has resulted in the identification of five (Anbari, 1985) or seven (Bredillet, 2004; Söderlund, 2002) major schools of management thought. These reviews laid the foundation for the classification of the nine project management schools of thought by Bredillet, Turner and Anbari (2007a, b, c, 2008a, b, c). They distinguish between nine different but partly interrelated schools of thought, which are described in the order of their appearance. The nine project management schools of thought are more a thematic research categorization rather than a
paradigmatic one that is based on distinct assumptions. Therefore, the same researchers can commonly contribute to different schools of thought.

The *optimization school* emphasizes the definition of project objectives, planning, scheduling, estimating and executing of project activities, while striving for cost and time efficiency to optimize the outcome. The *modeling school* aims to model the total project management system by integrating hard systems and soft systems methodologies. The *governance school* concerns the relationship between contract and project management, and mechanisms of governance of project and project-based organization. The *behavior school* considers the project as being a social system addressing soft issues such as leadership, communication, and human resource management. The *success school* emphasizes success and failure of a project and the identification of critical success factors. The *decision school* focuses on decision-making processes and information processing in projects. The *process school* aims to find structured processes from the conceptual start until the achievement of project objectives. The *contingency school* seeks to adapt project management processes to the particular project context. The *marketing school* tends to focus on the early project phases considering stakeholder needs and stakeholder management (Bredillet, Turner & Anbari, 2007a, b, c, 2008a, b, c).

While the different papers in this dissertation emphasize different project management schools of thought, the process school is the main underlying school of thought in it. Capabilities as the core topic of the dissertation are rooted within organizational processes. The next section will relate capabilities to project management.

### 2.5.2 Project Capabilities and Project Success

During the development of the project management field and in line with the process school, the creation and maintenance of capabilities get increasingly important. Hobday (2000) highlights that project-based organizations use projects to build up knowledge, resources, and capabilities. Therefore, project-related capabilities become a key organizational capability, which needs to be developed. Reviewing research on project and program management, Artto, Martinsuo, Gemünden and Murtoaro (2009) have identified an exponential increase of capability-related research, which thus confirms the increasing significance of capabilities.

Davies and Brady (2000) introduce the term project capabilities in their study of complex product systems (CoPS), which are high-value and high-technology capital goods such as telecommunication systems, air traffic
control systems and high-speed trains. Project capabilities are defined as “the appropriate knowledge, experience and skills necessary to perform pre-bid, bid, project and post-project activities” (Davies & Hobday, 2005, p. 62-63). Although the bid phase is especially important in CoPS and other contractual projects, the bid-related elements of project capabilities might be still valuable and transferable to contexts that are more common. One reason is that also internal projects have to be sold to an internal sponsor and have to be promoted against resistance, organizational politics or competing projects. The general elements of project capabilities concern appropriate procedures and processes, which are required in an organization to complete projects within budget, time and quality constraints (Davies & Brady, 2000). Furthermore, Crawford, Hobbs and Turner (2006) highlight that project capabilities refer to the efficient and effective utilization of available resources. Melkonian and Picq (2011) point out that project capabilities comprise individual, collective and organizational levels of analysis, which generate dynamic loops of interdependencies.

In the context of the dynamic pharmaceutical business environment, the possession of capabilities is not a sufficient condition. Capabilities in general as well as project capabilities have to be continuously maintained, adjusted, and developed. The building of capabilities is therefore crucial for organizations engaging in the pharmaceutical R&D process. Davies and Brady (2000) describe the project capability-building process as four overlapping steps: (1) a new project organization is set up by strategic management leaving the traditional business, (2) lessons learned are prepared and forwarded to current or subsequent projects, (3) a project may lead to a permanent outcome, which demands changes in a new group within the business unit, or the functional organization, and (4) the new group may get separated from the parent organization and sets up a new division maintaining many similar projects (Davies & Brady, 2000).

Brady and Davies (2004) propose a model for project capability-building, which is based on two interacting levels of learning. The first level concerns bottom-up phases of project-led learning, which arises when an organization enters a new technology/market base. The second level relates to top-down phases of business-led learning, which occurs when strategic decisions are directed to create and exploit organizational resources and capabilities required for executing predictable and routine project activities. Organizational project management (OPM) can be seen as a crucial strategic capability supporting innovation performance by integrating technology and marketing strategies (Sicotte et al., 2011). Sicotte et al. (2011) highlight the value of OPM capabilities as vehicle for transforming strategies into successful project outcomes.
Project capabilities are logically linked to project success by facilitating the performance through project specifications. However, the border between success and failure is often blurred depending on the definition and perspective taken. In the pharmaceutical R&D setting, cancelling a struggling and probably failing R&D project in due time helps to save high expenses from the clinical development, and thus can be recognized as success. Moreover, the pharmaceutical R&D process often depends on partnerships and collaboration, where project members work over distance forming virtual project teams across organizational boundaries. Drouin et al. (2010) highlight that project success can be facilitated by organizational support for such virtual project teams. Formal decision-making and autonomy in pursuing project activities are crucial factors for the successful management of distributed project teams (Bourgault et al., 2008). While organizational support relates to the utilization of organizational capabilities, project success is a multidimensional construct. Cooke-Davies (2002) differentiates between (1) project management success, measured against traditional time, cost and quality constraints, and (2) project success, measured against overall project objectives.

Jugdev and Müller (2005) highlight, how the measurement of project success has been continuously evolving throughout the last 50 years in four periods by increasingly incorporating phases from the project life cycle prior to and after the implementation phase. First, during the 1960’s-1980’s the understanding of project success was centered on the implementation phase and the iron triangle of time, cost and quality (Atkinson, 1999). Second, during the 1980’s and 1990’s researchers developed several lists of critical success factors, but these lists were neither grouped nor integrated. Third, during the 1990’s-2000’s integrated project success frameworks emerged. Pinto & Slevin (1988) are the key contributors in this period by identifying the “ten critical success factor” list and classifying it into planning categories (i.e. project mission, top management support, project schedule/plan and client consultation) and tactical categories (i.e. personnel, technology to support the project, client acceptance, monitoring and feedback, channels of communication and troubleshooting expertise) (see also Pinto & Covin, 1989; Pinto & Slevin, 1988, 1989). Shenhar et al. (1997) describe four universal success dimensions, namely project efficiency, impact on customers, business success, and preparing for the future. Fourth, during the 21st century responsibility of the project owner for project success has been emphasized together with the rising understanding of project management as being a strategic asset for the organization. (Jugdev & Müller, 2005)
The project performance construct has been broadened over time. Hoegl and Gemuenden (2001) highlight that effectiveness and efficiency of team performance, and personal success in learning and in work satisfaction as additional elements of project performance. Collins and Baccarini (2004) propose that product success and meeting project owner’s needs are important elements. The importance of supplier and stakeholder satisfaction has further widened the project success construct (Atkinson, 1999; Cicmil & Hodgson, 2006; Shenhar & Dvir, 1996; Turner & Müller, 2006). In their study on new product performance, Pattikawa, Verwaal & Commandeur (2006) have identified 12 crucial factors: the degree of organizational interaction, R&D and marketing interface, general product development proficiency, product advantage, financial/business analysis, technical proficiency, management skill, marketing proficiency, market orientation, technology synergy, project manager competency and launch activities. In hypercompetitive environments, sustaining new product performance and securing organizational survival can only be achieved through a continuous stream of innovative products (Ireland & Webb, 2007). Therefore, the pharmaceutical R&D process is dominated by numerous projects and is clearly a multi-project context. The next section presents the multi-project context and project portfolio performance.

2.5.3 Multi-project Context and Project Portfolio Performance

During the rapid dissemination of project management, the relevance of projects has risen continuously making the utilization of simultaneous or subsequent projects common (Engwall & Jerbrant, 2003; Zika-Viktorsson, Sundström & Engwall, 2006; Blomquist & Wilson, 2007). Multi-project context concerns resource allocation, which is complex and is deeply rooted within political processes, sense making, compromises, and interpretations (Engwall & Jerbrant, 2003). Inter-project learning becomes a crucial and frequent matter for project-based organizations. (Prencipe & Tell, 2001; Tell & Söderlund, 2001).

The widespread use of projects together with a large amount of people working in a project setting has led research to highlight soft issues in management. The project setting of a novel and time-cost-quality restricted endeavor is a challenging work environment for project workers. Not surprisingly, research found that the risk of stress is high for project workers, because of project overload triggered by four factors: large number of simultaneous projects, insufficient routines, lack of time, and lack of opportunities for recuperation (Zika-Viktorsson et al., 2006). Consequently, project overload has to be avoided, which signalizes the need for capabilities to properly manage multiple projects. The studies on multiple projects
emphasize the value of maintaining a considerate, balanced and structured way of managing multiple projects (Engwall & Jerbrant, 2003; Zïka-Viktorsson, Sundström & Engwall, 2006; Blomquist & Wilson, 2007). This insight has contributed to the recent trend of programification in the field of project management, with programs of being a key concern and receiving special attention (Maylor, Brady, Cooke-Davies & Hodgson, 2006). The programification can be seen as an indicator for the development and maturity of the project management field and its increased utilization of multiple interrelated projects.

For the understanding of the management of multiple projects, a distinction between the project portfolio and program of projects becomes important. A project portfolio is defined as a group of projects that need to be managed together coordinating interfaces and prioritizing resources to reduce uncertainty, whereas a program of project goes one step further aiming to deliver strategic objectives of higher order (Turner & Müller, 2003). Resource allocation and portfolio management are central themes for a successful pharmaceutical R&D process. Not surprisingly, organizations involved in the pharmaceutical R&D process show a pronounced pipeline thinking, which basically corresponds with project portfolio management (Gassmann & Reepmeyer, 2005). An enduring challenge for pharmaceutical organizations is to search for more effective ways of managing R&D portfolios, where resource allocation is based on systematic and cost-effective models, while flexibility is preserved to some extent to support development ideas and innovation (Van Arnum, 1998). The potential of portfolio management can be seen from the example of SmithKline Beecham utilizing a new approach, which was able to generate 30% additional value without any additional investment (Sharpe & Keelin, 1998). The portfolio management process of SmithKline Beecham led to a shared understanding between decision makers and scientific personnel concerning the best investment opportunities (Sharpe & Keelin, 1998). Other researchers have identified benefits of pharmaceutical R&D based on a suitable sequence of projects in the R&D pipeline, which balances returns on investment at acceptable risk for the given amount of resources (Blau et al., 2004).

The successful management of multiple projects in an organization demands certain multi-project capabilities, which for example enable organizations to apply knowledge and components across a coordinated stream of new products to reduce development and production costs (Cusumano & Nobeoka, 1998). Research suggests that project capabilities are linked to multi-project capabilities by being the pre-condition (Killen, Hunt & Kleinschmidt, 2008). Although these multi-project capabilities initiate from the automotive development, they are also relevant for managing project
portfolios and programs in the pharmaceutical R&D process. The term multi-project capabilities (Crawford, 2007) was rarely used in research. However, due to the significance of multi-project management for the R&D pipeline, it became necessary to go beyond project capabilities (Biedenbach & Söderholm, 2008). In an investigation of project management offices, Crawford (2007) highlights resource management and inter-project dependencies as components of multi-project capabilities. In this dissertation, multi-project capabilities are defined as the ability to successfully manage the R&D pipeline of multiple projects for the continuous outcome of numerous innovative products.

Multi-project capabilities are supposed to support and lead to a high project portfolio performance. Like every performance measure, it becomes important to look into more detail what project portfolio performance actually is, and how it differs from project performance. Generally speaking, project performance concerns doing projects right, whereas portfolio performance is doing the right projects (Cooper et al., 2000).

Historically, portfolio management has emerged to a large extent from the new product development context. Cooper et al. (1999) emphasize the significance of portfolio management (1) for selecting the right new R&D projects, (2) for efficient resource allocation, (3) project selection being linked to business strategy, and (4) so that there is a match between the available resources and number of projects. Cooper et al. (1999) find that a more formal approach to portfolio management with well-defined procedures, utilization for all projects, and trust from management can all contribute to portfolio performance excellence. They suggest measuring the performance of portfolio management through six metrics, namely balance of value, balance of resources, balance of time-orientation, reaching time goals, business strategy alignment, and spending linked to business strategy. Their findings suggest that organizations perform better with a more formal approach to portfolio management, which is based on an utilization for all projects management trust, and well-defined procedures (Cooper et al., 1999).

Müller et al. (2008) measure portfolio performance based on the achievement of project and program purpose, and the achievement of desired portfolio results. Moreover, they find that successful organizations measure portfolio performance as the sum of the achievement of planned project purpose and planned project results.

To summarize, organizational capabilities are generally crucial for innovation during all phases of the pharmaceutical development. Dynamic
capabilities direct the organization through the challenges of a rapid changing environment. Project capabilities are required to successfully complete the commercialization of a new innovative pharmaceutical product, thus affecting project performance. Furthermore, multi-project capabilities affecting project portfolio performance are needed to gain a continuous stream of innovation, which is important to secure market success and long-term survival of the organization.

Table 3 presents the different capabilities mentioned in the literature review and categorizes them based on their definition, organizational level where they occur, and the role they play in the different papers of this dissertation.

In the pharmaceutical R&D process, the early project phases are especially significant, because in these stages the majority of innovation is generated, while adjustments to external events might be still possible and less costly. The following section reviews the literature on the early project phases or as it is commonly referred to, the fuzzy front end of innovation.
### Dynamic capabilities

“Firm’s ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments” (Teece et al., 1997, p. 516)

Organizational level: Key capabilities in hypercompetitive environments (paper #1); lens on the R&D process (papers #2 and #4)

### Absorptive capabilities

Firm’s ability to apply external knowledge through three intertwined processes of exploratory, exploitative, and transformative learning (Lane et al., 2006)

Sub-capabilities to dynamic capabilities: Component of combinative capabilities (paper #2); impact on project and portfolio performance (paper #4)

### Innovative capabilities

Ability to develop new products and/or markets through aligning strategic innovative orientation with innovative behavior and processes.

Sub-capabilities to dynamic capabilities: Component of combinative capabilities (paper #2); impact on project and portfolio performance (paper #4)

### Adaptive capabilities


Sub-capabilities to dynamic capabilities: Component of combinative capabilities (paper #2); impact on project and portfolio performance (paper #4)

### Project capabilities

“The appropriate knowledge, experience and skills necessary to perform pre-bid, bid, project and post-project activities” (Davies & Hobday, 2005, p. 62-63)

Project level: Component of combinative capabilities (paper #2)

### Multi-project capabilities

“Ability to successfully manage the R&D pipeline of multiple projects for the continuous outcome of numerous innovative products” (Biedenbach, 2011)

Portfolio level: Component of combinative capabilities (paper #2)

### Combinative capabilities

Ability to balance the utilization of dynamic, project, and multi-project capabilities which has the power to boost the delivery of frequent innovation (Biedenbach, 2011)

Organizational level: Value to combine and balance various capabilities (paper #2)

### Dynamic marketing capabilities

Ability to utilize market knowledge to initiate the innovation process and to reconfigure R&D capabilities (Bruni & Verona, 2009)

Functional level: Underlying and overlapping with adaptive capabilities

### Integrative capabilities

Ability to integrate knowledge across firms, but also within intra-organizational disciplinary boundaries (Henderson, 1994)

(Inter-)organizational level: Overlapping with absorptive capabilities

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**Table 2: Characterization of the different capabilities**
2.6 The Significance of the Early Project Phases for Innovation

Before the investigation of the early project phases can begin, it becomes essential to review the literature on the early project phases or fuzzy front end how it is often termed.

Kolltveit, Karlsen and Grønhaug (2004) divide the early project phases into two general phases. The first phase is often referred to as the front end and the second phase as the planning and decision phase. The front end encompasses activities such as purpose definition, idea analysis, feasibility studies and concept development. The second stage starts when the project proposal is ready. (Kolltveit et al., 2004)

Another way of classifying the early project phases is based on the project life cycle. There are several project life cycle models, which follow the same assumptions, but differ based on the number and specification of the particular phases of the project life cycle. Although the phases can be termed differently, they generally include the same elements and comprise typically of three to five phases. One reason for the differences is the breakdown into a different level of detail, and consequently the number of phases. According to Pinto and Prescott (1988), one of the most recognized project life cycle frameworks goes back to the works by Adams and Barndt (1983) and King and Cleland (1983), which consider the project life cycle as consisting of four different phases.

The first conceptualization phase involves setting up preliminary goals, alternative actions and appropriate means for their achievement. During the second planning phase, plans are formalized to achieve the developed goals. Moreover, the project sponsor’s commitment to provide the required resources needs to be ensured in this phase. The third phase of the life cycle is the execution phase, where the project gets implemented. Termination is the final phase, where the project is handed over, resources are released, and the project team gets dissolved. (Pinto & Prescott, 1988)

Figure 3 presents the project life cycle framework, which was adopted for the purpose of this dissertation by adding a pre-project phase prior to the project life cycle phases. The pre-project phase precedes the conceptualization phase, which includes idea management, selection decisions and preparations concerning the project start. In this dissertation, the early project phases include all activities prior to project execution.
Figure 3: The project life cycle (adopted from Pinto & Prescott, 1988)

The starting phases within new product development are often called the fuzzy front end of innovation. According to Koen et al. (2001, p. 49), the fuzzy front end consists of chaotic, unpredictable and unstructured “activities that come before the formal and well-structured New Product and Process Development (NPPD) or Stage Gate process”. Over time, the new product development process becomes relatively structured based on experiences and following best practices. However, the initiating activities tend to be ambiguous and organization-specific. Another definition of the fuzzy front end describes it as period between the first considerations of an opportunity to the time, when the decision is made that the idea is ready for development (Kim & Wilemon, 2002).

Williams and Samset (2010) point out that front end decision-making requires organizational structures that control, but at the same time allow a sufficient degree of flexibility in turbulent environments. Project flexibility needed in an unpredictable environment versus stability and control directed towards an efficient project management, is the fundamental dilemma of project management (Olsson & Magnussen, 2007). The presence of flexibility in the early project phases leads to the fuzziness despite attempts of pharmaceutical organizations to projectize these phases.
Reasons for the fuzziness of the early project phases are threefold. First, the lack of formality and structure in the beginning of the R&D process is one reason. Second, in the early project phases, a vast amount of complex information gets gathered and combined with different tacit knowledge, conflicting organizational pressures, cross-functional collaboration and uncertainty (Khurana & Rosenthal, 1998). Third, technological advances, dynamic competition and market changes lead to an increased environmental uncertainty. Zhang and Doll (2001) highlight that most activities of the fuzzy front end are interrelated adding to its complexity. Therefore, integration of different front end activities and an increase of formalization play a key role for decreasing the fuzziness and improving the management of the front end (Khurana & Rosenthal, 1997, 1998).

The front end is important for R&D project success (Verworn et al., 2008). Although by nature there has to be fuzziness involved in the front end of innovation, a more balanced approach with some process structuration and formalization might be promising. The new concept development (NCD) model suggested by Koen et al. (2001) attempts to add more structure and formalization to the front end of innovation. The NCD model differentiates five components within the front end of innovation: (1) opportunity identification, (2) opportunity analysis, (3) idea genesis, (4) idea selection, and (5) concept and technology development. The five elements are driven by leadership and organizational culture.

Moreover, the external environment influences the business strategy of the organization, competitive factors, organizational capabilities, and the maturity of enabling sciences and technologies to be utilized. Organizational culture, opportunity identification, top management support, and technology development process have been recognized as key factors for the innovative organization (Koen et al., 2001). The use of the NCD model is valuable for ensuring that the different components for the formalization of the front end processes are addressed. However, this formalization has some limitations, because the establishment of a front end standard across industries is neither feasible nor desirable due to the relevance of the R&D context (Kim & Wilemon, 2002). In the NCD model, the R&D context is considered by the inclusion of environmental influences and the organizational aspects of leadership and culture, which are at the core of the model. Also Nobelius and Trygg (2002) argue for a considerate front end process that incorporates the context of the organization, while leaving room for managerial flexibility in the pre-project phase. The inappropriateness of using one universal front end process and the need for some flexibility stresses the importance of utilizing both, rather formalized (multi-) project capabilities and dynamic capabilities, which provide some flexibility. Moreover, the utilization of these
Kim and Wilemon (2010) have identified five major factors, which can facilitate the fuzzy front end: (1) awareness of the fuzzy front end and its significance, (2) having very creative people, who look for technological and market opportunities, (3) people with interpersonal skills to facilitate teamwork, (4) good knowledge about markets and customers, and (5) learning from other R&D teams. Capabilities can be seen as underlying theme of these facilitating factors, highlighting the importance of the identification of technological and market opportunities (i.e. adaptive capabilities), and utilization of knowledge and learning (i.e. absorptive capabilities). Recent research confirms that the fuzziness based on self-organized innovation activities are very important for the innovation outcome (Koch & Leitner, 2008). These findings emphasize the value of innovative capabilities. Other studies on the fuzzy front end identify three critical success factors, namely the development of a business case prior project approval, the existence of a new product development strategy, and the creation of a culture of innovation (Russell & Tippett, 2008). Thus, intangible assets such as the organizational culture play an important role for innovation and front end success. Organizational culture is also reflected within organizational processes and their underlying capabilities.

This section has highlighted that despite their fuzziness, the early project phases play an important role for innovation (Verworn et al., 2008). Previous research shows that an appropriate management of the early project phases, which considers contextual factors, can facilitate innovation.

2.7 Conclusions from the Literature Review

By reviewing the literature on hypercompetition and dynamic business environments, research clearly shows the need for organizations to utilize dynamic capabilities. The dynamic capability concept has been arising from the RBV of the firm, the dominating perspective in the field of strategic management. The dynamic capabilities are found to be valuable for mastering the challenges of hypercompetitive environments such as the pharmaceutical and biotechnology industries. Although the dynamic capabilities concept has been continuously developed throughout the last decade, empirical studies are still lacking (Pablo et al., 2007).

Project management has continuously increased its significance with the society and industries. Science-based industries such as the pharmaceutical and biotechnology industries are dominated by project management. The
recent trend of programification emphasizes the need to consider the
management of multiple projects (Maylor, Brady, Cooke-Davies & Hodgson,
2006). In the pharmaceutical R&D process, the prevailing pipeline thinking
emphasizes the importance of managing a portfolio of projects and programs
along the different R&D stages. Directing the R&D process towards a
frequent outcome of innovation requires special project and multi-project
capabilities.

Although all stages of the R&D process are relevant, the early project phases
gain an extraordinary importance. The early project phases have generally a
large impact on project success and in particular innovation outcome
(Verworn et al., 2008; Zhang & Doll, 2001). Despite their significance, the
understanding of the early project phases as the fuzzy front end of
innovation is still limited. In order to improve the management of the early
project phases, practitioners and academics alike need to know the
capabilities that can be utilized to facilitate innovation outcome. Underlying
the identified critical success factors are intangible assets that are rooted in
the organizational culture and processes. In this respect, the utilization of
dynamic capabilities and their sub-capabilities (i.e. absorptive, innovative
and adaptive capabilities) can be considered to be a powerful innovation
facilitator for the management of the pharmaceutical R&D process.
Moreover, dynamic capabilities are the source for flexibility, which is of
value in combination with formalization arising from project management.

Although a dynamic capabilities perspective has been used in previous
research on project portfolio management (c.f. Killen et al. 2008; Petit &
Hobbs, 2010), they have not been utilized to explore the management of the
early project phases. It is therefore fruitful to take a holistic capability
perspective by adding dynamic capabilities from the field of strategic
management into the field of project management and the early project
phases. This combination is expected to enrich the exploration of the early
project phases with new influences that lead to new insights. While this
chapter has highlighted the significance of capabilities for managing the
early project phases, the following chapter will present the methodology that
has been used in the studies of this dissertation.
3 Research Design and Methodology

The third chapter describes the research design and methodology. Research design should provide the most suitable way for answering the research questions by considering the research constraints (Ghauri & Grønhaug, 2002). Every researcher is facing unavoidable restrictions arising from time constraints, cost, limited data access and skills. The research design is directed to effectively generate the required results under these limitations (Ghauri & Grønhaug, 2002).

Section 3.1 presents the philosophical background of the study. Section 3.2 explains the research strategy for exploring the early project phases. Thereafter, in section 3.3 the qualitative research is presented by introducing the case study research methodology, describing the choices, data collection, data analysis and quality criteria. Section 3.4 details the quantitative research, research design and measurement, data collection, data analysis and quality criteria.

3.1 Philosophical Foundation and Choice of Study

The paradigm acting as a philosophical foundation is important for every research. It influences the research process, research methods, and analysis techniques. Guba and Lincoln (1994) define paradigms as particular combinations of our worldview as a basic belief system (i.e. ontology) and their associated epistemologies. In this respect, the paradigm guides the research and the researcher's actions ontologically and epistemologically in the choice of an appropriate methodology (Denzin & Lincoln, 2003, Guba & Lincoln, 1994). The ontology describes the nature of reality and human being, whereas the epistemology comprises the nature of knowledge and how the researcher perceives knowledge (Denzin & Lincoln, 2003). The methodology concerns the way knowledge can be gained through research strategies. The research paradigm affects the choices of the researcher related to the methodology, but also to the theory selection and the interpretation of results.

Critical realism serves as underlying paradigm in the dissertation. Critical realism emphasizes the existence of an objective reality independent of researcher's descriptions and ideas (Alvesson & Sköldberg, 2009). Within critical realism, social constructions are recognized, but they are outlined in an objectivist way (Alvesson & Sköldberg, 2009). In critical realism, the social world is transformed and reproduced in daily life rejecting a constructivist or objectivist ontology (Bryman & Bell, 2007). For critical
realists, a phenomenon does not become less real, although they see reality as being socially defined and constructed (Alvesson & Sköldberg, 2009). Social phenomena are produced by real mechanisms, which are not directly observable and only identifiable through their effects (Bryman & Bell, 2007).

Critical realists advocate the move from prediction to explanation, the reliance on interpretative types of investigation, and the use of abstraction (Wikgren, 2005). Critical realism takes a middle ground position between positivism and interpretivism. In positivism, theory aims to predict, whereas in interpretivism, theory describes conditions or context for the production of meaningful experiences (Wikgren, 2005). Critical realism emphasizes the need to critically evaluate objects to be able to understand social phenomena (Sayer, 1992).

The social world can neither be limited to an experiential moment nor to inter-subjective elements for critical realists (Patomäki & Wight, 2000). In this respect, critical realists recognize both, the reality of the natural world and the discourses and events of the social world (Wikgren, 2005). Therefore, structure and the underlying mechanisms play a central role for the understanding of reality. The identification of the structures, which create the discourses and events, is crucial for the understanding of social reality (Bhaskar, 1989). Social phenomena are dependent on human actions, but actions require structure that highlights its importance (Wikgren, 2005).

Objects have power in relation to their structure, whereas the mechanisms, which generate effects, are an outcome of this structure. However, the effect of the mechanisms is not always an observable event on the empirical level. Relations are complex and causality can exist on different levels. Critical realism emphasizes the central role of these mechanisms, which occur in complex compositions and make things happen in the world. Critical realism examines the different mechanisms concerning their effects and events, their characteristics and forces, their linkages to different structural levels. While positivism seeks to identify predictable pattern of exact relations between cause and effect, critical realism emphasizes that causality within social reality is emergent and context-dependent. (Alvesson & Sköldberg, 2009)

A cornerstone of critical realism is that the reality consists of different levels. In this respect, complex social phenomena cannot be explained by solely looking at mechanisms and processes that operate on purely one level (Wikgren, 2005). Entities might be analyzed at different aggregation levels, where some entities also emerge from lower levels (Easton, 2010). The distinction between the different levels arises from generative mechanisms, which run on each level, and not from the entities themselves (Wikgren,
In critical realism, retroduction is the underlying inference, where events are explained by mechanisms that are able to generate them (Sayer, 1992). Thus, retroduction implies moving backwards and asking questions such as “What must be true in order to make this event possible?” (Easton, 2010, p. 123). Therefore, during a scientific endeavor a phenomenon tends to be explained by an ever-deepening level, where the deeper level itself becomes a new phenomenon (Patomäki & Wight, 2000). Patomäki and Wight (2000) characterize this issue as a constant spiral of discovery and understanding, further discovery, modification, and even more accurate understanding.

For critical realists, the research process is about continuously increasing the ontological depth of reality (Alvesson & Sköldberg, 2009). This deepening of the investigation can be also found in this dissertation within the exploration of the early project phases for frequent innovation. While the first paper provides the context and highlights the dominating mechanisms of capability challenges, the second paper specifies the capabilities in the early project phases of the pharmaceutical R&D process. The third paper directs further the epistemological state of knowledge by investigating the development of the research field of project management by looking at the underlying philosophical stances and used methodologies. The fourth paper deepens the exploration of the early project phases on a more detailed level of capabilities and performance outcomes. In this respect, the investigation of the early project phases runs through such a spiral of discovery and understanding at increasing levels of detail.

Overall, the dissertation is directed by the critical realist paradigm influencing to conclude the investigation of the early project phases with a mixed method study. This paradigm combines the view of reality with objective mechanisms, events and people’s subjective interpretations framed by their experiences (Bhaskar, 1975). Realism in general is suitable for the investigation of problems that are more descriptive than prescriptive (Perry, 1998).

The research of the early project phases in this dissertation has been conducted in steps. Such an approach is in line with the assumption of critical realism that things we see are only a part of the bigger picture (Bhaskar, 1975; Saunders et al., 2007). Therefore, research requires a number of complementing perspectives and a multitude of methods. Moreover, the capabilities for the early project phases are under-researched, and thus require an initial deeper investigation through qualitative methods. Ontological subjectivism aimed at gaining deeper insights of the early project phases together with an interpretivism epistemology guide the qualitative
multiple case study methodology from the second paper (Biedenbach, 2011). This exploration requires the researcher to be close to the study subject (i.e. R&D projects) and its actors, which makes an epistemology as objectivist insufficient. The gained knowledge is then utilized in the fourth paper (Biedenbach & Müller, 2011b), which is designed as mixed method. The mixed method study combines in its underlying philosophical foundation ontological subjectivism with epistemological realism.

The following section describes the research strategy applied in this dissertation research and provides justification for its sequence. Furthermore, the section describes the research strategy of the qualitative and quantitative studies.

### 3.2 Research Strategy

The dynamic capabilities framework is utilized in the context of pharmaceutical R&D. The investigation of the early project phases with their underlying organizational processes in this context concerns a complex phenomenon, which demands the utilization of various methods. Due to the lack of research on the capabilities for managing the early project phases, an exploratory study is required to gain a deeper understanding of the early project phases in this setting. For this purpose, an exploratory qualitative study is conducted, which is followed by a subsequent quantitative study.

The investigation of the management of the early project phases has been made through a qualitative study and a subsequent quantitative study. The qualitative study explores the management of the early project phases for frequent innovation by utilizing a dynamic capabilities framework. The qualitative study is based on interviews with rather open-ended questions that allow interviewees to elaborate on the themes. Additionally, the exploratory nature of the qualitative study has been addressed by including a diverse set of pharmaceutical and biotechnology organizations. Across the different organizations, the interviewees had diverse backgrounds, but were commonly involved in the early project phases of pharmaceutical R&D. This approach enables a more thorough exploration of the early project phases through the exploitation of different, but complementary perspectives in a multiple case study.

The subsequent quantitative study is built on the findings from the qualitative multiple case study by utilizing its resulting theoretical framework. In the quantitative study, an adjusted and further detailed research model is tested. The quantitative study investigates how absorptive, innovative, and adaptive capabilities within the early project phases affect
Mixed method designs enable the generation of a more complete understanding of a phenomenon by including qualitative and quantitative research techniques (Johnson & Onwuegbuzie, 2004; Teddlie & Tashakkori, 2009). The knowledge gained in the qualitative study is used for interpreting the results from the subsequent quantitative study. Despite some skepticism, the mixed method as a combined utilization of quantitative and qualitative methods gained increasingly its legitimacy. Edmondson and McManus (2007) relate the method choice to the state of theory and research, where they propose a methodological fit of the mixed method for research of intermediate maturity. Thus, this method fits well with the choice to conclude the investigation of the early project phases with a mixed method study, when the phenomena is already better understood through the preceding qualitative study. Based on the classification by Johnson and Onwuegbuzie (2004), the mixed method design of this dissertation can be characterized as sequential with a dominant status of an initial qualitative study that is followed by a quantitative study.

The next sections present the methodology of the qualitative research and thereafter the methodology of the quantitative research.

### 3.3 The Qualitative Research

#### 3.3.1 Case Study Research

Yin (2003, p. 13) defines a case study as “an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident”. Another definition of a case highlights its occurrence in a bounded context (Miles and Huberman, 1994). In this respect, case study research contributes to making sense of the complexities of the real world. This sense making occurs in a rich dialogue between evidence and theory (Harrison, 2002). Eisenhardt (1989b) highlights the suitability of case study research for the creation of new knowledge or for a less developed theory base. Harrison (2002) confirms the value of case study research for weak theoretical bases and messy researched phenomena. Therefore, case study research is beneficial for the pharmaceutical R&D process and its investigation of the early project phases, which are a rather ambiguous, complex and intangible matter. Furthermore, the early project phases relate
to the fuzzy front end of innovation and have as an under-researched area a weak theoretical foundation. Therefore, the utilization of case study research is appropriate and promising for the exploration in this research project.

Despite the benefits and advantages for this particular research project, case study research also has its limitations (Eisenhardt, 1989b; Harrison, 2002). First, the utilization of case study research is time consuming and hence costly. Second, the large amount of data is difficult to handle and analyze. Third, the end point of data collection is not clearly defined and ambiguous. Typically the end of data collection is reached, when saturation occurred and information is repeated.

### 3.3.2 Context, Industry and Case Selection

The pharmaceutical R&D was chosen as context for the study due to its complexity and significance of the early project phases for innovation outcome (Cuatrecasas, 2006; Ingelgård et al., 2002). Moreover, the pharmaceutical and biotechnology industries are hypercompetitive and thus, require dynamic capabilities to succeed in this challenging environment (D’Aveni, 1994, 1998; Liebeskind, et al. 1996). Furthermore, these industries are project-dominated with organizations pursuing a R&D pipeline thinking to enable a continuous stream of innovation (Gassmann & Reepmeyer, 2005; Ireland & Webb, 2007). Consequently, project and portfolio management play a key role and require particular capabilities for organizing the early project phases for frequent innovation.

Hypercompetition concerns both, pharmaceutical and biotechnology organizations, but it affects them differently depending on their business model, experience or interrelations with other organizations. Pharmaceutical organizations have a period of patent protection when they can receive monopolistic returns. However, they face hypercompetitive situations in two ways. First, organizations face a severe competition from generic drug manufacturers after patent expiration, which make revenues drop drastically. Second, organizations compete heavily for gaining access to latest technology, leading scientists, patentability and time to market of their R&D.

Case companies were selected by applying a purposeful sampling, which was directed towards having a large variety of pharmaceutical and biotechnology organizations. This selection criterion ensured that the multiple case study provides a complete picture of the pharmaceutical R&D process, where different types of organizations are involved. Therefore, a holistic view can be drawn of the management of the early project phases by including organizations operating in different contexts with varying business models,
age, size, experiences, niche markets, and product categories. This variety clearly supports the exploratory character of the multiple case study. Kim and Wilemon (2002) highlight the relevance of context in managing the innovation front end and the early project phases, which underlines the importance of including a diverse set of case companies. In contrast, a focused exploration of the early project phases would deliver very specific knowledge that can contribute only to a very narrow context.

Twelve different case companies were included in the qualitative study. The diversity among the case companies can be summarized by four different criteria. The first criterion concerns industry affiliation represented by five pharmaceutical, two radiopharmaceutical, four biotechnology, and one life science organization. Second, regarding size and business model, there were two diversified Big Pharma, six focused small and medium sized enterprises, and four niche players. The third criterion concerns industry maturity and experience represented by five pure R&D organizations and seven organizations that have commercialized products on the market already. Fourth, across the twelve organizations, the R&D process was fully portrayed by including drug discovery, drug development and drug enhancement.

3.3.3 Data Collection

Before the main interviews were conducted, an initial background interview was performed on the theme of creativity and innovation projects. The respondent had his own consultancy company focusing on idea management and project management. He had an experience of 20 years in these subjects in the field of packaging design. The interview served as an additional input for the generation of the semi-structured interview guide.

The interview guide was designed to explore the early project phases based on the components and key contributing factors of the dynamic capabilities framework. The questions were carefully phrased, so that practitioners could understand the themes without using abstract terms or theoretical definitions. Through these means, it has been ensured that the interviewees understood the questions without getting irritated or scared off by complicated terms. The semi-structured interviews followed a structure of key questions, which were prepared in advance and asked to every respondent. These key questions were complemented with specific follow-up questions, which were posed to deepen explanations, clarify statements or describe the context of the answers given. Every interview request was complemented with a document describing the research project and its importance. The purpose of the research description was to inform every
interviewee so that he/she could judge if he/she was knowledgeable in the field and willing to contribute.

Before the start of the interview round, general background information about the pharmaceutical and biotechnology industries was collected and utilized for preparation. Upon request from the interviewees, a document was provided a few days prior to the interview describing the interview themes. Before meeting a new case company, background information about the company was collected and studied.

The interviewees held various positions in the different case companies. They were selected based on their knowledge and involvement in the early phases of pharmaceutical R&D. The intention with the interviewee selection was to include a diverse set of roles and backgrounds contributing to multiple perspectives and a holistic picture on the early project phases. One might feel concerned that interviewees holding different positions could make the cases less comparable. However, the interviews explored the process of initiating and managing R&D projects, which always occurs in interaction of different actors from various disciplines. The process was at the core of the exploratory investigation and not a certain managerial role. Therefore, a multidisciplinary group of interviewees contributed to a richer and more comprehensive picture of the early project phases.

The interview guide can be found in Appendix 1. In addition to the interviews, within each organization supplementary material was asked for in order to increase the understanding of the organizational context. The methodological approach resulted in 1-2 interviewees, complemented by secondary data such as annual reports and industry reports, for building the case around each organization. Follow-up interviews were conducted when needed to clarify issues and gather missing information. All interviews were recorded after the agreement of the interviewee was received, then anonymized and fully transcribed. Only once the recording of the interview was perceived negatively. The interviewee mentioned that he would provide less information when being recorded. Therefore, the request was respected and in this interview, hand notes were taken.

For the qualitative study, a total of 18 interviews were conducted across the twelve case companies, whereas four interviews had to be conducted over the telephone. Face-to-face interviews were preferred but due to location, time and cost reasons, few telephone interviews were needed. Due to the advantages of face-to-face conversations for building a trustful and pleasant atmosphere, telephone interviews were only chosen if a personal meeting with the interviewee was not possible. Besides the primary data from the
interviews, additional information was acquired from company websites, magazines, journal articles and annual reports to enlarge the data collection and portray the external context.

3.3.4 Data Analysis

Data was analyzed by conducting a template analysis (King 1998, 2004). A template is a hierarchical list of categories or codes corresponding to the themes, which appeared from the empirical data (Saunders et al., 2007). The interviews already followed certain themes from project management and dynamic capabilities literature. These predetermined themes were modified during the template analysis process, which united a deductive and inductive approach (Saunders et al., 2007).

According to King (1998), the template analysis technique is conducted in seven steps. First, a priori themes are set up in advance. Second, interviews are transcribed and thoroughly read to get to know the content. Third, initial coding attaches a priori themes to the suitable sections and codes are adjusted or new codes are created for relevant issues, which cannot be fully addressed with the initial themes. Fourth, after a subset of coded transcripts, the initial template is generated. Then the template gets structured by grouping several themes into higher-order codes. It should be avoided that the resulting hierarchical structure consists of too many levels, otherwise the template gets unclear and too complex. Fifth, a template is created from the complete data set. Sixth, the findings can be now interpreted by using the template for the analysis and reporting of results. Seventh, a quality check should be conducted at one of the coding stages to decrease the effect of the researcher’s preconceptions and assumptions.

In this dissertation, the template analysis was utilized to explore the early project phases. Initial themes were set up to investigate this context by applying the dynamic capabilities framework and provided some structure to the interviews. The interviews consisted of five major initial themes: (1) idea management and decision making, (2) identification and utilization of business opportunities, (3) application of external information, (4) the role of knowledge and learning, and (5) the R&D environment. By taking relevant aspects from the empirical data into consideration, the initial themes were then adjusted. The themes developed by adding and combining themes. As a consequence, four aggregated major themes emerged: (1) the role of business intelligence, (2) facilitating actions and innovation triggers, (3) transition phase between drug discovery and drug development, and (4) resource (re)allocation in the R&D pipeline. Comparing the a priori themes with the emerged themes it can be seen that the first and second a priori themes were
summarized into the theme of business intelligence. The third and fourth theme emerged due to their relevance. The new aggregated theme of innovation trigger was built from the fourth and fifth a priori themes on the role of knowledge and learning, and R&D environment. The newly developed themes were used for analysis and interpretation. The structure from the template was then used for data analysis by applying word processing software.

Template analysis is a powerful technique, but a critical evaluation should be presented here. The template analysis can be characterized by an underlying tension between the need to have an open attitude to the data and impose a structure during the analytical process. The template analysis has many strengths such as being a flexible technique with only few pre-defined procedures that enables the researcher to adjust the technique to the specific requirements. Moreover, the template analysis is easy to comprehend and apply. The structuration during the procedure improves the clarity and thus prepares the empirical data for analysis. However, the technique has also some weaknesses. One danger is that the resulting templates are too simple for a deep investigation or too complex to overlook. Another weakness is the danger of being over descriptive and loosing individual opinions from interviewees due to the aggregation of themes. (King, 2004)

The template analysis fits well to the investigation of the early project phases and their related capabilities for two reasons. It provides structure for exploring the fuzzy front end of innovation and helps to decrease the abstractness of the capabilities concepts. The resulting template served as guideline for the cross-case analysis of the qualitative study. Individual voices from interviewees were still highlighted while applying the template in the analysis.

3.3.5 Quality Considerations

Following appropriate methodological procedures, while applying suitable methods, contributes to the generation of valid study results. Although the case study methodology is lacking statistical indicators for it, there are principles as suggested by Yin (2003) for the achievement of validity and reliability. First, construct validity was gained by including multiple sources of evidence, such as interview data, reports and other artifacts. Furthermore, it was supported by a high diversity of interviewees’ positions, organizations within each industry and across the industries involved in the R&D process. Second, internal validity was achieved by applying template analysis as a deductive analysis technique in connection with explanation building. Explanations were developed incrementally during the process of refining
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the initial themes (deductively) through observations and examples from the empirical data. Third, external validity was ensured by using replication logic in the form of 12 case studies. The sampling strategy aimed to maximize variance of cases within the particular industry underlying this research. This strategy allowed the identification of common results for all cases, specific results for groups of cases, and particular results for one case only. Replicating the findings from interviewees with different backgrounds further increased the external validity. Fourth, reliability was achieved by using a case study protocol, which outlined the aims, purpose, research question and unit of analysis, as well as the interview questions to be asked in each interview. Furthermore, reliability can be increased by using a case study database (Yin, 2003). In this dissertation, case study documents such as interview guide, interview notes, interview transcriptions and secondary company data were stored in a case study database. The process of conducting interviews continued until theoretical saturation was reached and information started to repeat to a large extent.

Johansson-Lindfors (1993) suggests the consideration of three parallel concepts to evaluate a qualitative study, which are termed as transferability, trustworthiness, and inter-subjectivity. Transferability to other cases corresponds with the above described external validity. Inter-subjectivity contributes to trustworthiness meaning that interpretations should be acceptable from both the researcher and the respondent (Johansson-Lindfors, 1993). Moreover, inter-subjectivity has been included similar to the means of accomplishing construct validity by having discussions of the findings with colleagues, external researchers and professionals at conferences and several other occasions while conducting the study.

3.4 The Quantitative Research

3.4.1 Research Design and Measurement

For the measurement of constructs in the fourth paper, the existing items and scales were used for the questionnaire. Dynamic capabilities were represented in the framework through the constructs of innovative capabilities, adaptive capabilities and absorptive capabilities (Wang and Ahmed, 2007). Absorptive capabilities are defined by Cohen and Levinthal (1990, p. 128) as “the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends … the ability to evaluate and utilize outside knowledge is largely a function of the level of prior knowledge”.

Within the tested conceptual framework, the absorptive capabilities were measured through three dimensions of exploratory learning, transformative
learning and exploitative learning (Lichtenthaler, 2009). First, exploratory learning comprised the recognition and acquisition of external knowledge. Second, transformative learning encompassed the activities for maintaining and reactivating knowledge. Third, exploitative learning referred to the activities of transmuting and applying knowledge. (Lichtenthaler, 2009)

_Innovative capabilities_ were measured by applying the scales suggested by (Subramaniam & Youndt, 2005) and distinguishing the two dimensions of incremental innovative capability and radical innovative capability. _Adaptive capabilities_ were measured by using the adaptability scale by Tuominen et al. (2004). The scale was adjusted by choosing six items from the dimensions of home market and technology sensing, global marketing monitoring, and interfunctional coordination, which fit the R&D context of the study.

The three constituting elements of dynamic capabilities, absorptive, innovative and adaptive capabilities were hypothesized to have a positive effect on project and portfolio performance. The project performance construct included the three dimensions of first, meeting time, budget and other requirements, second, impact on the customer, and third, benefit to the performing organization (Shenhar, Dvir, Levy & Maltz, 2001). Project portfolio performance was represented by maintaining a resource balance within the portfolio, aligning the project portfolio to business’s strategy (Cooper, Edgett & Kleinschmidt, 1999), and achieving its intended results and purpose (Müller, Martinsuo & Blomquist, 2008). Appendix 2 shows the measurement of the constructs by using five-point Likert scales (1 - strongly disagree, 2 - disagree, 3 - neither agree nor disagree, 4 - agree, 5 - strongly agree).

The questionnaire and the measures were pre-tested by using an expert panel. Within the pre-test, the questionnaire was sent to an expert panel consisting of eight industry experts and four professional researchers. Similarly to an experience survey, this pre-test offered new ideas and insights into the phenomena, which were used to refine the final measures, to decide whether or not to include certain items, and finally to edit items concerning appropriate wording (Churchill, 1979).

The industry participants of the expert panel were asked to fill out the survey and comment on the questions’ clarity. The academic representatives of the expert panel were asked to review the questionnaire concerning the formulation of questions, but also the construct measures for the underlying framework. Based on the received comments, adjustments were made to address the idiosyncratic context of pharmaceutical and biotechnology R&D, and to improve the clarity of the questions (Churchill, 1979).
3.4.2 Data Collection

In 2010 the data collection was conducted through a web-based questionnaire. Web-based surveys are a common and well-established data collection method that is increasingly used in academic research (Cobanoglu, Warde & Moreo, 2001; Roster, Rogers, Albaum & Klein, 2004; Shih & Fan, 2008). Advantages of web-based surveys are for example, low costs, short response time, fast response speed within the first days, and automatic recording of the data (Cobanoglu et al., 2001; Ilieva, Baron & Healey, 2002).

On a critical note, Fricker and Schonlau (2002) state that web-based surveys may not be necessarily cheap. Firstly, they emphasize that often there might be direct or indirect data entry costs, since the survey results require manipulation before they can be processed by analytical software. Secondly, they point out the implementation costs of the web-based surveys such as the actual online design. In the current study, these costs were kept at a low level, because the software tool used to conduct the study was free of charge, powerful in exporting data and easy to use.

Another often mentioned weakness of web-based surveys is that they can reach only a subset of the sample, namely the one comprising internet users, who feel reasonably comfortable with internet technology (Schaefer & Dillman, 1998; Shih & Fan, 2008). However, this issue is not critical in this study, because respondents are R&D managers, who regularly use emails as a common communication channel. A recent meta-analysis comparing the response rates between web and mail surveys shows that overall response rates of web-based surveys might be on average 10% lower than of mail surveys (Shih & Fan, 2008). This fact might be seen as a disadvantage, but taking into consideration that R&D managers in these settings are frequently travelling, only email invitations in combination with web-based surveys could allow them to participate in the study independent of their location.

R&D managers were chosen as respondents due to their direct involvement in the R&D process and their knowledge about capabilities needed for a successful innovation management. The specific positions held by the respondents ranged from vice president R&D to chief scientific officer (CSO) and chief executive officer (CEO). Within a new, small biotechnology organization, their CEO's were chosen as respondents, since they occupy many responsibilities within their positions and act as R&D directors. Therefore, the senior management team of each organization was reviewed and if an organization had no R&D director, the CEO was contacted.
Initially presidents of European industry organizations were contacted to request a list of R&D managers of their member organizations. However, these organizations were bound to privacy agreements, which did not allow the forwarding of contact details. As a result, contact data was collected manually to thoroughly identify the contact details of the R&D manager in the particular organization. A sample of 387 pharmaceutical and biotechnology organizations was created by going through the member lists of several industry associations in Europe, although most of them operate globally. When no email address of the R&D manager could be obtained in 58 occasions, another manager was contacted with a request to forward the study invitation to their R&D manager. Otherwise, a personalized email invitation was send to the R&D managers to participate in the study. The email invitation introduced the study topic, its purpose and managerial implications, stated the time required to complete the questionnaire and contained a link to the web-based survey. An anonymous survey was designed, which did not allow tracing back data to individuals. A maximum of two reminders were sent out to the R&D managers, who did not indicate that they had already answered.

### 3.4.3 Data Analysis

The questionnaire was sent to 387 persons, from which 80 responses were received providing a response rate of 21%. Sixteen responses had to be excluded from the analysis, because they were exceeding the minimum level of 30% for missing data (Hair et al., 2006). The resulting data did not show skewness and kurtosis indicating the fulfillment of normality assumptions. Moreover, Cronbach’s alpha coefficients exceeded the minimum of 0.60 for exploratory studies demonstrating reliability of the scales. The correlations between the variables were less than 0.70, which showed that collinearity was not an issue (Hair et al., 2006).

Figure 4 shows the research model of the fourth paper with the hypothesized relationships between the three capabilities and performance outcomes. Multiple regression analyses were conducted with the three capabilities as independent variables and the three performance outcomes as dependent variables. Multiple regression analyses were used to test the correlations between each capability and performance outcome.

Subsequently, a canonical correlation analysis (CCA) was performed according to Sherry and Henson (2005) to evaluate the multivariate relationship between the capabilities and performance outcomes. The CCA is a multivariate technique, which enables the simultaneous comparison among the variables while decreasing the probability of committing Type I
errors, which concerns finding significant results when there should not be any (Sherry & Henson, 2005).

Figure 4: Research model

The CCA resulted in three functions with squared canonical correlations (Rc²) for each successive function. The whole canonical model was controlled for statistical significance by looking at the Wilk’s λ and conducting a dimension reduction analysis. Mutual explanatory power of the full model was assessed based on the variance shared between the variable sets across all functions. The function that explains the largest amount of shared variance and meets a threshold level of 10% practical significance was used for evaluating the canonical solution. Primary and minor contributors to the predictor variate (i.e. capabilities set) and synthetic criterion variable (i.e. set of performance outcomes) in the canonical solution were identified by using a threshold value of 0.45 (Sherry & Henson, 2005) and by looking at the loadings (i.e. structure coefficients).

3.4.4 Quality considerations

The quality of the quantitative study in this dissertation was evaluated by looking at reliability and validity criteria. Reliability addresses the question whether similar data will be collected if the data collection would be repeated. It is defined as “the similarity of results provided by independent
but comparable measures of the same object, trait or construct” (Churchill & Iacobucci, 2002, p. 413). Internal reliability is commonly assessed through the Cronbach’s alpha coefficients, which calculate the average of all possible split-half reliability coefficients (Bryman & Bell, 2007). As a rule of thumb for the reliability score, Cronbach’s alpha should exceed a threshold of 0.70 but in exploratory research exceeding a 0.60 level is also still acceptable (Hair et al., 2006). In the quantitative study of this dissertation, the Cronbach’s alphas of the scales were mostly above 0.70, except for two scales (i.e. innovative and adaptive capabilities) exceeding the threshold level of 0.60 for exploratory research (see Table 6 in Biedenbach & Müller, 2011b, p. 23). Considering the exploratory nature of this research of the early project phases, it can be concluded that the Cronbach’s alphas of these two variables are within acceptable levels. Based on these reliability coefficients, the study results can be concluded to be reliable.

After reliability is ensured, validity tests serve as final quality assessment. Validity concerns the issue of “whether or not a measure of a concept really measures that concept” (Bryman & Bell, 2007, p. 164). Validity is identical in its meaning to correctness or accuracy and can be distinguished into three main validity categories: predictive validity, concept validity, and content validity (Churchill & Iacobucci, 2002).

Predictive validity describes “how well the measure predicts the criterion, be it another characteristic or a specific behavior” (Churchill & Iacobucci, 2002, p. 407). Concerning this validity type, the researcher would use a future criterion measure by looking at future levels (Bryman & Bell, 2007). Predictive validity would require longitudinal studies and therefore, cannot be assessed within the time constraints of an exploratory study in a doctoral dissertation.

Content validity, also known as face validity, refers to the “adequacy with which the domain of the characteristic is captured by the measure” (Churchill & Iacobucci, 2002, p. 408). Central to content validity is the procedure of variable development (Churchill & Iacobucci, 2002). Content validity was achieved in this research by conducting a thorough literature review for the identification of the variable measurement in the quantitative study (Churchill, 1979). As a result, existing scales from top ranked journals were used. Moreover, feedback from senior researchers in the pre-test contributed to the achievement of content validity and ensuring that the measures were adequate. Some of the measures were refined to match the specific context of pharmaceutical R&D.
Construct validity relates to “the question of what the instrument is, in fact, measuring” (Churchill & Iacobucci, 2002, p. 409). Construct validity was achieved in this research by applying existing scales, which were robust and published in top ranked academic journals. In addition, the questionnaire was pre-tested by an expert panel of practitioners and senior researchers to ensure an accurate measurement. Following Churchill (1979), their feedback was used to slightly adjust the measurement of the items so that it fits the context of pharmaceutical R&D and its questions are easily understood.

Overall, the research strategy has been carefully designed to explore the management of the early project phases comprehensively. Therefore, a multitude of methods has been used. First, a conceptual study has set the agenda for managing the early project phases in hypercompetitive environments. Second, a subsequent exploratory qualitative study deepened the understanding how capabilities are used when managing the early project phases for frequent innovation. The analysis of the qualitative data has been conducted by applying a template analysis resulting in a theoretical framework of combinative capabilities. Third, a review of the philosophical stances and methodologies in the research field of project management has helped to direct the final investigation. Fourth, while moving through ontological depths of reality, a final quantitative study has been conducted to test the theoretical framework on a more detailed level. The last step included a sequential mixed method approach, where the qualitative study has been used to enhance the theoretical framework. Moreover, the qualitative study has been utilized to interpret the findings from the multiple regression and canonical correlation analyses. The findings of the quantitative and qualitative studies were in line with each other showing the coherence of the dissertation.

To summarize, the methodology chapter has highlighted critical realism as a philosophical underpinning of the dissertation. Moreover, this chapter has described the methodological choices that have been made, the means for data collection, techniques for data analysis, and quality considerations for both qualitative and quantitative studies. In the next chapter, extended abstracts of the four papers are presented prior a concluding chapter, which will synthesize and analyze the four papers as a whole.
METHODOLOGY
4 Summary of the Papers

4.1 Extended Abstract Paper #1

Hypercompetitive, that is, dynamic and unpredictable environments require flexible, innovative and creative organizations, which can easily adapt quickly to the changing rules of the competitive arena. Organizations therefore continuously need to change. This paper reviews literature covering organizational change in hypercompetitive environments with a focus on projects as the vehicle to create the necessary flexibility. The challenge is thus to combine the need for long-term sustainability with continuous flexibility in terms of how organizational and technological change efforts are designed and carried out.

Organizational change in hypercompetitive environments implicates tensions between two challenges that are discussed in the paper: (1) the capability challenge and (2) the structural challenge. Meeting the capability challenge is to enable the organization to adapt to frequent changes and making the innovativeness a strategic core competence of the firm that is possible to use to maintain a position in the market. The structural challenge is to create an organizational structure to make the most out of the capabilities and to maintain a strategic focus and direction of the overall operations.

Taken together, the trade-off between controllability and flexibility appear as a main overarching challenge. This paper is meant to highlight and clarify the significance of dynamic capabilities acting as interface between the external dynamics of the environment and the internal tensions within an organizational challenge of change and its specific interrelated change projects.

Organizations are thus well advised to develop a high degree of dynamic capabilities, which are at the core of meeting the tensions of the capability and structural challenge. The authors suggest that organizational aspects and capabilities have to go hand in hand as enabler and at the same time facilitator for a successful emergent change process in hypercompetitive industries.

This article concludes that temporary engagements with high level of local adaptability through network or project-based organizations, and with dynamic capabilities utilized are the main organizational issues to be considered while analyzing continuous and emergent change processes in hypercompetitive environments.
Keywords: hypercompetition, organizational change, organizational design, organizational structure, change capabilities

4.2 Extended Abstract Paper #2

To be successful in today’s hypercompetitive marketplace a continuous flow of innovation is crucial. The purpose of this paper is to investigate how organizations organize the early project phases of R&D in the pharmaceutical industry for an outcome of frequent innovation. The author applies the dynamic capabilities concept as a starting point to explore the capabilities needed to master the crucial activities of R&D projects as pathfinder for frequent innovation.

The study is designed as a qualitative multiple case study employing a template analysis for data interpretation. The investigation of the early project phases is pursued along four themes: (1) the role of business intelligence, (2) facilitating actions and innovation triggers, (3) transition phase between drug discovery and drug development, (4) resource (re-)allocation in the R&D pipeline. The analysis identified a standardized projectification of the pre-project phases, which leads to certain conflicts.

The four research questions led to the following findings:
1. Dynamic capabilities being visible within business intelligence related activities, play a key role for development choices in the pre-project phase.
2. Organizational facilitators and a pre-project projectification demonstrate a tension within activities that should foster innovation.
3. Although there is a transparent idea selection process, project capabilities seem to hold back innovative capabilities in the transition phase.
4. Multi-project capabilities that are crucial for frequent innovation may endanger certain projects and thus can be in conflict with project capabilities.

This study shows a severe tension between the conflicting and interrelated dynamic, project and multi-project capabilities that hampers the frequent outcome of innovation in the pharmaceutical R&D. For this reason, an optimization of combinative capabilities that balance the capabilities triumvirate can be seen as powerful leverage to boost the outcome of frequent innovation.

Keywords: combinative capabilities, dynamic capabilities, project capabilities, multi-project capabilities, innovation, pharmaceutical R&D
4.3 Extended Abstract Paper #3

Previous studies have investigated the development of the project management field concerning underlying assumptions and thematic theoretical debates, methodological issues, or its relationship to allied disciplines in the field of management. What is lacking so far is an evaluation of the research findings based on the “epistemological knowledge assumptions and their related research paradigms”. By reviewing the philosophical stances, a more accurate conclusion of the development stage of the project management field can be given.

The purpose of this paper is to investigate the philosophical stances and related methodologies used within the last 15 years of project management research. This leads to the following main research question:
Using the International Research Network on Organizing by Projects (IRNOP) papers as an example, where do we come from, where are we now and where are we heading with our philosophical perspectives towards project management research?

These questions are addressed through a review and comparison of conference papers from the IRNOP conferences of the years 1994 (IRNOP I), 2000 (IRNOP IV) and 2007 (IRNOP VIII). The papers were examined through content analysis, which investigates documents to systematically quantify content in terms of the following predetermined categories: ontology, epistemology, methodology, method, and project management schools of thought.

The findings showed that the prevailing philosophical stances of the IRNOP conferences 1994, 2000 and 2007 were subjectivism as ontology, interpretivism as epistemology, case studies as methodology and qualitative methods. In terms of schools of project management thought we see a shift in 2007. The governance school was replaced by the process school as the most popular one.

Subjective research paradigms are gradually reduced at the expense of more objective paradigms, whereas the methodology shifts increasingly towards multiple case studies. The trend indicates a steady growth of objective studies among the IRNOP researchers, and a slight decline in the dominance of subjective research paradigms.
This study concludes that the time has come to move beyond the method debate in advancing to management science that is based on constructive debates instead of intolerance against the “odd man”.

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Keywords: project management, research work, epistemology, philosophical concepts

4.4 Extended Abstract Paper #4

The purpose of this paper is to explore how absorptive, innovative and adaptive capabilities within the early project phases affect project and portfolio performance within the R&D of pharmaceutical and biotechnology organizations. The following research questions are addressed:

1. What are the absorptive, innovative and adaptive capabilities within R&D in pharmaceutical and biotechnology organizations? How do absorptive, innovative and adaptive capabilities affect project and portfolio performance in these industries?
2. The study follows a sequential mixed method with an initial qualitative study and a subsequent quantitative study.

Absorptive capabilities involve the application of external information and active networking. Innovative capabilities thrive from a supportive work environment based on clear goals, space for creativity, focused R&D area and proximity to related organizations. Adaptive capabilities relate to the understanding of markets and customers to make adjustments that help to generate incremental innovation or prolong patent protection.

Absorptive capabilities have a positive effect on short- and long-term project success and portfolio performance. Innovative capabilities have a positive effect on long-term project success. Adaptive capabilities have a positive effect on short-term project success and portfolio performance. The set of capabilities has an overall effect on the set of performance outcomes and thus confirms the results of the qualitative study that a distinct capability mix is needed in the pharmaceutical R&D process. Within the set of capabilities, absorptive and adaptive capabilities are the primary contributors to the performance outcome, whereas innovative capabilities are a minor contributor.

The contribution to knowledge lies in achieving a deeper understanding of the rather abstract terms absorptive, innovative and adaptive capabilities and their composition in the pharmaceutical R&D context. Despite the special benefit of these capabilities in the early project phases, the study has additionally shown how project and portfolio managers can utilize particular capabilities to emphasize a certain performance outcome.

Keywords: absorptive capabilities, innovative capabilities, adaptive capabilities, project performance, portfolio performance
5 Discussion and Conclusions

This chapter concludes the dissertation by connecting the four different papers providing an overarching analysis and discussion thereof. All the papers are interrelated and incrementally contribute to increase the understanding of managing the early project phases for frequent innovation. Section 5.1 provides an answer to the research question of the dissertation. Thereafter, section 5.2 synthesizes the different studies and reflects about their implications. Section 5.3 expands the discussion and goes one step beyond by linking the findings from the management of the early project phases to the subsequent phases of the project life cycle and R&D process. A final section 5.4 completes the dissertation by highlighting the theoretical and practical contributions of the research, the strengths and weaknesses of the research, and promising areas for future research.

5.1 Research Findings

The first paper (Biedenbach & Söderholm, 2008) sets the agenda highlighting the implications and challenges for organizations operating in hypercompetitive industries. The paper reviews the literature on hypercompetitive environments and as a result points out the importance of change, project-based organizations and appropriate capabilities. Projects are highlighted as vehicles driving the change endeavors that allow at the same time a certain level of flexibility. The paper discovers a capability challenge and a structural challenge, which are under the tension of controllability versus flexibility. The first challenge is aimed to prepare the organization for frequent changes, whereas the latter challenge concerns the establishment of a suitable organizational structure. The paper concludes that capabilities and organizational aspects are both, enabler and facilitator for coping with the challenge of frequent change in hypercompetitive industries.

The second paper (Biedenbach, 2011) investigates the early phases of pharmaceutical R&D projects in the pharmaceutical industry by looking on how certain capabilities can facilitate the frequent outcome of innovation. One outstanding finding is that a standardized projectification of the pre-project phases tends to hinder innovation. The paper suggests that an optimization of combinative capabilities, which balance the utilization of dynamic, project, and multi-project capabilities, has the power to boost the delivery of frequent innovation.
DISCUSSION AND CONCLUSIONS

The third paper (Biedenbach & Müller, 2011a) investigates the development and current state of project management research by looking at the philosophical stances and methodologies used within the last 15 years of IRNOP conferences. The findings show that ontological subjectivism and epistemological interpretivism are dominating. Moreover, case studies and qualitative methods are the most common, while trends show an increase of positivist and multi-case studies. The paper identifies a lack of mixed method studies, despite their importance for developing such complex and ambiguous issues as capabilities facilitating frequent innovation.

The fourth mixed method paper (Biedenbach & Müller, 2011b) expands the deeper investigation of the pharmaceutical R&D process with a qualitative part that includes also biotechnology organizations. The paper explores how absorptive, innovative and adaptive capabilities within the early phases of pharmaceutical R&D affect project and portfolio performance. The results from the qualitative part show that a distinct capability mix is required in the pharmaceutical R&D process. The subsequent quantitative part of the paper, takes a more detailed look on the specific components of the dynamic capabilities construct and their impact on the crucial project and portfolio performance outcomes for frequent innovation. The results from the quantitative part show that absorptive capabilities have positive effects on short- and long-term project success and portfolio performance. Innovative capabilities have a positive effect on long-term project success. Adaptive capabilities have positive effects on short-term project success and portfolio performance. Another finding identified absorptive and adaptive capabilities as primary performance contributors, whereas innovative capabilities are a minor contributor. This paper finalizes the investigation of the early project phases of pharmaceutical R&D.

Before analyzing and interpreting the four papers of this dissertation as a whole, the dissertation’s research question is repeated below and then answered.

How do organizations manage the early project phases of R&D in hypercompetitive environments for frequent innovation by taking a dynamic capabilities perspective?

The initial conceptual study has highlighted the importance of dynamic, project and multi-project capabilities in hypercompetitive environments for meeting an overarching challenge of controllability versus flexibility. In such a business environment, emergent change processes have to be directed towards frequent innovation through the utilization of appropriate capabilities. While the key to the accomplishment of frequent innovation can
be found in the early project phases, their successful management is
dependent on a diverse set of capabilities.

On a more detailed level, the qualitative study has emphasized the
management of the early project phases through different efforts that are
rooted in certain capabilities. Organizations in the pharmaceutical R&D
process utilize business intelligence efforts for the identification of emerging
market opportunities by looking at medical needs, competitors, filed patents,
available products and current developments. These efforts are captured by
adaptive capabilities. Other important elements of adaptive capabilities in
the early project phases include making adjustments based on market and
customer knowledge.

R&D activities in the early project phases, which aim to prolong product life
cycles, to shorten development times and to make use of windows of
opportunities are represented by innovative capabilities. Furthermore, the
consideration of factors such as having a supportive work environment, a
focused R&D area and proximity to similar organizations contribute to
innovative capabilities during the management of the early project phases.

The utilization of research networks and external information from
conferences, patent databases, and research findings are highlighted by
absorptive capabilities in the management of the early project phases. In
addition to these three dimensions of dynamic capabilities, project
capabilities and multi-project capabilities are emphasized when managing
the early project phases. Even before project status has been given to a
project, R&D activities are often managed already through procedures
similar to the ones during a project. This finding points towards an existing
projectification of the pre-project phase and consequently, an early
utilization of project capabilities.

A holistic pipeline thinking, which already includes considerations to balance
the portfolio within the early drug discovery stages, brings up the early
involvement of multi-project capabilities. The underlying activities of the
five mentioned capabilities show how frequent innovation can be facilitated
by the way, in which the early project phases are managed.
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Table 4: Synthesis of the research
5.2 Synthesis of the Research

This section interprets the different studies and their interrelation. New knowledge is generated incrementally, which improves our understanding of innovation facilitating capabilities in the early project phases. Table 4 provides an overview of the research synthesis of the different papers, their findings, interpretation, project management schools of thought, and emerging research gap in the logical sequence employed.

The first paper (Biedenbach & Söderholm, 2008) provides the justification and argumentation for linking the themes of change, dynamic capabilities and project-based organizations in hypercompetitive environments. Dynamic capabilities are deliberately chosen as a lens to explore the early project phases. As it is highlighted in the conceptual study, dynamic capabilities are at the core of a capability challenge that addresses the demands of generating frequent changes and innovation. A structural challenge can be met by using a project-based organizational structure for implementing change and creating innovation. The need to balance the opposing forces of flexibility and controllability emerges as an overarching challenge.

While dynamic capabilities may support flexibility to be developed to its extremes, project management may hold it back by posing structure and guidelines. In this respect, a balance occurs to some extent already naturally due to the opposing directions of a flexibility push and a structure push. Noteworthy is the fact that although project-based organizations may gain some rigidity by following certain project management steps, as an organizational form they provide flexibility. Therefore, the paper concludes that capabilities and organizational features have to go hand in hand as an enabler and a facilitator for emergent change and frequent innovation. Additionally, the paper suggests that dynamic capabilities should be complemented with project and multi-project capabilities in order to frequently change and innovate. These findings raise the interest for new areas of research such as the exploration of the power of dynamic, project and multi-project capabilities as innovation facilitators, which is chosen as a theme of the qualitative study.

The qualitative study investigates how organizations manage the early phases of R&D projects in the pharmaceutical industry to achieve frequent innovation (Biedenbach, 2011; Biedenbach & Müller, 2011b). The qualitative study shows that organizations recognize the starting time of a project at different stages of the R&D process. This fact indicates the fuzziness and
ambiguosness of the early project phases. The second paper identifies four significant themes for the investigation of the early project phases. The first theme, business intelligence, matches the features of absorptive and adaptive capabilities and determines the scope of multi-project capabilities. Innovation trigger are the second theme in congruence with absorptive, innovative, project and multi-project capabilities. Solely adaptive capabilities do not have the power to strongly contribute to innovation. This statement is confirmed by the quantitative study in the fourth paper, which shows adaptive capabilities contributing to short-term project success, and thus rather incremental innovation (Biedenbach & Müller, 2011b). The third theme is the transition phase from pre-project activities to the project phase. The transition phase explicitly concerns project capabilities, whereas absorptive, innovative and adaptive capabilities affect how the transition is managed. The fourth theme focuses on resource (re)allocation, which is in fact the theme of multi-project capabilities. Resource (re)allocation can support or constrain project capabilities, whereas adaptive and absorptive capabilities determine the resource (re)allocation.

![Figure 5: Combinative capability mix (developed from Biedenbach, 2011)](image)

The second paper concludes with a theoretical framework (see Figure 5) highlighting project capabilities, multi-project capabilities and dynamic capabilities with their absorptive, innovative and adaptive sub-capabilities, as facilitators for frequent innovation. The paper identifies three tensions
between the three main capabilities. First, project capabilities may affect creativity and freedom to innovate, and thus hinder absorptive and adaptive capabilities. Second, there is a tension between striving after highly flexible resources based on dynamic capabilities and a specific resource prioritization arising from multi-project capabilities. Third, project capabilities that focus on the successful delivery of a single project can be in conflict with the holistic view associated with multi-project capabilities.

The implication of the tensions between the different capabilities is that an optimization, which appropriately balances the utilization of the capabilities triumvirate, seems to be the most powerful way to facilitate frequent innovation. The optimization of these capabilities corresponds to the overarching challenge that balances the opposing forces of flexibility and controllability (Biedenbach & Söderholm, 2008). The finding that different capabilities need to be optimized to boost innovation, directly asks for a way to measure their contribution. Moreover, the intertwined nature of the pharmaceutical R&D process implies that for a holistic investigation of the early project phases both pharmaceutical and biotechnology organizations need to be included.

In line with the philosophical underpinning of critical realism, science means continuously digging into the depths of reality (Alvesson & Sköldberg, 2009) where science develops in a constant spiral of discovery, understanding and revision (Patomäki & Wight, 2000). In this respect, it is necessary to go back to a higher aggregation level in order to better guide the revision and continuous exploration before entering the investigation at a more detailed level. Thus, to be able to direct effectively the further investigation of the early project phases it is important to understand in what state the field of project management research has developed. Consequently, the third paper has been examined the foundation of the knowledge generation in project management research by looking into philosophical stances and methodologies.

One of the findings is a growing multiplicity in the applied methodologies (Biedenbach & Müller, 2011b). This conclusion indicates the progress and broadening of the field of project management, where increasingly complex issues are addressed by researchers. This complexity can be explained with the rise of the process school from 10% until the most prominent project management school of thought in 2007. Table 4 shows the two most emphasized project management schools of thought (Bredillet et al., 2007a, b, c; 2008a, b, c), which underline the four papers of this dissertation.
It needs to be emphasized that the project management schools of thought are rather a thematic categorization instead of being a paradigm with strict assumptions. Therefore, it is possible to combine different schools of thought within a single study. However, this fact does not necessarily mean that all different schools are equally emphasized. It is more likely that there is one dominating project management school of thought underlying the research. One example for such a combination can be found in the second paper (Biedenbach, 2011). While capability research by nature belongs to the process school, the contingent optimization is at the core of the second paper. In this respect, the contingency school is dominating this study, while the necessity of balancing combinative capabilities points towards an optimization within contextual parameters. Since the actual optimization is not explicitly investigated, the optimization school is only touched upon as a resulting theme for further investigation.

Throughout the exploration of the early project phases for frequent innovation, the research moves through different levels of detail and for this reason it contributes to different schools of thought. The first paper elaborates on capabilities and structural forms at a broad level of hypercompetitive industries. These themes correspond to the process and governance schools of thought. In the second paper, different capabilities are explored concerning their combined contribution to innovation corresponding with the contingency and optimization schools of thought. Since the third paper is used to redirect the exploration focus, the level of detail is very broad. The last paper completes the investigation of the early project phases at a detailed level by looking at specific capabilities and their impact on more specific performance outcomes that lead to frequent innovation. With its focus on the impact of capabilities on performance outcomes, the last paper combines the process and success schools of thought.

The third paper finds that subjective research paradigm is currently dominating at IRNOP conferences, whereas objective studies are increasing. Another conclusion is that mixed method papers are lacking despite their potential to progress the field through their methodological variety and complementing perspectives. In line with this reasoning, the fourth paper is utilizing a sequential mixed method approach to effectively progress the investigation of the early project phases in the pharmaceutical R&D process.

The fourth paper (Biedenbach & Müller, 2011b) complements the qualitative research of the early project phases with a subsequent quantitative study. The quantitative study examines a more detailed research framework compared to Figure 5. The quantitative study examines how absorptive,
innovative and adaptive capabilities within the early project phases affect project and project portfolio performance within the R&D of pharmaceutical and biotechnology organizations. Figure 6 shows the resulting model and the significant relationships between the constructs.

Easterby-Smith et al. (2009) highlight that dynamic capabilities are not directly observable. As a response to this statement, the adjusted framework measures dynamic capabilities through the contributing components of absorptive, innovative and adaptive capabilities. Another problem is the accurate measurement of frequent innovation outcome, which depends on the context of the specific organization. The detailed consideration of the performance elements improves the measurement of innovation. Innovation is underlying the success of project performance, whereas the measure of project portfolio performance implies the frequency of innovation in the portfolio. Therefore, the particular capabilities can be assumed that have a similar positive effect on project and portfolio performance outcomes as on frequent innovation.

![Figure 6: Resulting model](image-url)
The findings from the canonical correlation analysis show that absorptive capabilities as a primary contributor have positive effects on all performance outcomes, and thus frequent innovation. Innovative capabilities positively affect long-term project success. Therefore, innovative capabilities facilitate innovation, but seem to be solely not sufficient for frequent innovation, because they lack portfolio considerations. The lack of a significant effect of innovative capabilities on short-term project success could be explained by the fact that short-term innovation is a basic requirement within the R&D. In contrast, adaptive capabilities do not significantly affect long-term project success. A possible explanation arises from the qualitative study, which indicates that adaptive capabilities are important for the generation of incremental innovation, and thus rather short-term success. However, adaptive capabilities do positively affect as another primary contributor short-term project success and portfolio performance, and hence should have the power to facilitate frequent innovation directly. As a result, the different capabilities can be utilized to boost project and portfolio performance, and consequently frequent innovation. The consideration of combinative capabilities (Biedenbach, 2011) that keep project, multi-project, dynamic capabilities and their contributing sub-capabilities in balance deserve additional attention.

To summarize, all three sub-capabilities have at least a positive effect on one outcome of project and portfolio performance. In this respect, absorptive, innovative and adaptive capabilities have their particular contribution to the performance outcomes. This finding implies that dynamic capabilities positively affect project and portfolio performance, and also frequent innovation. The next section characterizes and further elaborates on the early project phases by relating them to the R&D process.

5.3 The Early Project Phases in the Pharmaceutical R&D Process

While in the previous section, the different papers of the dissertation were linked together and findings were interpreted, this section analyzes the early project phases across the different papers. In the first step, the different challenges (Biedenbach & Söderholm, 2008) are linked to the early project phases. The next step will portray the capability utilization across the early project phases. Moreover, the analysis will be taken one step further by showing the tendencies of these different challenges and the capability utilization in continuation of the project life cycle.

Figure 7 combines the three challenges highlighted in the first paper (Biedenbach & Söderholm, 2008) and places them into the project life cycle.
The shapes of the different curves are more an approximation than the result of a precise measurement. However, they are summarizing the themes of the challenges, which were to some extent also touched upon during the interviews of the qualitative study. The arrow on top of Figure 7 shows how the pharmaceutical R&D process relates to the challenges within the project life cycle. Within the R&D process, the exact timing of the transition phase, from pre-project phases to the conceptualization phase of a project, is rather fuzzy depending on the organizational context (Biedenbach, 2011). However, as indicated by the broken line in the arrow, this transition occurs approximately between drug discovery and drug development. The transition reflects the different characteristics of the drug discovery and drug development stages. The drug discovery corresponds with the research stage of pharmaceutical R&D, whereas drug development corresponds with the clinical testing. Thus, the essential challenges also change. The capability challenge (Biedenbach & Söderholm, 2008) to enable frequent change is emphasized during the drug discovery and transition phases, whereas structure becomes later increasingly important when executing the project in the clinical development.

Figure 7: Challenges within the R&D process
First, the capability challenge is most significant during the pre-project and conceptualization phases when the project is still flexible and open for changes. The flexibility may start to decrease already when the drug candidate is selected, but at the latest at project start. Second, the structural challenge (Biedenbach & Söderholm, 2008) is the reverse to the capability challenge. However, it starts at a minimum level arising from a basic level of organizational structure requirement, and then tends to increase continuously through the emergence of project structure. The flexibility versus controllability challenge (Biedenbach & Söderholm, 2008) might be represented by a straight line, which decreases continuously. This challenge emphasizes the tendency that flexibility is steadily utilized to a minor extent, while the probability for changes tends to be at its maximum in the beginning of the project life cycle.

Figure 8: Importance of capabilities within the project life cycle (developed from Olsson & Magnussen, 2007)

Figure 8 utilizes the summary of the main attributes of the project life cycle from Olsson and Magnussen (2007) and adds the curves of the different capabilities based on their characteristics from this study. The analyses have identified that absorptive capabilities have been used to apply external
DISCUSSION AND CONCLUSIONS

information and for networking at many occasions throughout the entire project life cycle. Therefore, the absorptive capabilities maintain at a high level of importance.

Adaptive capabilities relate to the understanding of markets and customers for making adjustments. They are determined by the degree of freedom to maneuver (Olsson & Magnussen, 2007). Thus, it can be concluded that these capabilities tend to match the same curve. The interviewees highlighted that the largest extent of innovation is originated in the discovery stages and early project phases. Therefore, innovative capabilities are the most important in the pre-project and conceptualization phase and their importance decreases thereafter. As a reminder that capabilities can be also beneficially utilized for stopping a struggling project in due time, the accumulated cost curve is also displayed. The costs grow exponentially, when progressing through the different clinical development phases. In this respect, absorptive capabilities are not only essential for facilitating frequent innovation, but also for the timely identification of a failing project that has to be stopped.

Since the largest extent of innovation arises within the early project phases, the importance of innovative capabilities is decreasing in the clinical development. This conclusion does not mean that innovation is not relevant any longer, but rather that the innovation needs to be secured and applicable through a thorough clinical development. Adaptive capabilities are emphasized during drug discovery and pre-clinical development, whereas adjustments during the clinical development are limited. Absorptive capabilities are continuously important during the entire R&D process for applying new knowledge and technologies to support the successful clinical development.

The dissertation emphasizes the early project phases. However, the findings from this research and its four papers can be placed into a larger context. There are three reasons why reflecting upon the whole project life cycle and the complete R&D process is valuable. First, the time when a project starts is ambiguous and differs across organizations. Second, the early project phases have implications for the subsequent project phases and the complete R&D process. Moreover, the exploration of the management of the early project phases is directed by the way, in which innovation can be facilitated as R&D outcome. Third, the utilization of the different capabilities continues also after the early project phases. Therefore, knowing their subsequent importance is beneficial when balancing capabilities for facilitating the innovation outcome.
The following section concludes the dissertation by looking at its theoretical and practical contribution. Furthermore, the limitations and possibilities for future research are outlined. The section ends by looking at the generation of knowledge and the strengths of the dissertation.

5.4 Implications and Further Research

This dissertation has several theoretical contributions. First, the main contribution is to the field of project management by increasing the understanding of the management of the early phases of R&D projects and their value for the generation of innovation outcome. In particular, activities that provide and allow a certain level of flexibility are a fruitful combination with the structure arising from project management procedures. Moreover, the study of the early project phases at different levels of detail and through the utilization of diverse methods, has led to a holistic and comprehensive exploration. In this respect, the increasing projectification of the early project phases should be met with balanced influences arising from dynamic capabilities and their sub-capabilities.

Another contribution of the dissertation is to the field of strategic management and the research on dynamic capabilities in particular. The context of pharmaceutical R&D is beneficial for investigating the sub-capabilities of absorptive, innovative and adaptive capabilities. It is a context, in which these capabilities can be explored more clearly and possible exemplifications contribute to their clarification. The exploratory nature of the research in this dissertation and the use of different methods help to overcome the shortcomings of research on dynamic capabilities, which are often considered to be hard to observe. Furthermore, the research in this dissertation indicates that a more considerate utilization of dynamic capabilities is advantageous.

The dissertation shows the special value of combining the rather practical field of project management with the quite abstract field of dynamic capabilities. A theoretical implication is that the causal effects between dynamic capabilities and project performance outcomes prove that the two research fields are complementary to each other. Thus, project management with its closer integration to practitioners and strategic management with its solid foundation as a more established field, mutually providing new insights and legitimacy. In this respect, the two research fields can learn from each other and progress jointly.

The findings from synthesizing the papers have also several practical implications. First, practitioners gain knowledge about challenges that
concern the balancing of capabilities for frequent changes, flexible structure versus stability, and an overarching flexibility versus controllability challenge. An overemphasis of certain features should be avoided and be rather well adjusted. By looking at the project life cycle, practitioners can identify, which challenge is the most relevant one to consider at a certain time. Second, project and portfolio managers learn to emphasize the crucial capabilities within the different project phases. Moreover, they can emphasize certain capabilities depending on the performance outcome they want to achieve. Third, the exemplifications within the early project phases and their link to innovation should generally help to promote the significance of the early project phases to project sponsors, and in particular to highlight the importance of allowing some flexibility, so that innovation can flourish.

Although the research of the early project phases in this dissertation contains an extensive exploration of the research topic by applying various methods and analysis techniques, some limitations need to be recognized. First, the investigation is limited to the context of R&D projects in pharmaceutical and biotechnology industries. However, it can be assumed that many aspects of the findings also hold in other industries and other project contexts. Therefore, it can be valuable to expand the exploration of the early project phases into other industries and project contexts such as organizational change. Second, the mixed method paper was constrained by a limited amount of responses, which excluded the utilization of many other analysis techniques for the quantitative data. Therefore, the sample of future studies could be expanded to gain a larger amount of responses. During the quantitative study, the data collection can be seen as a shortcoming that can be improved in future research. The data collection was certainly not efficient considering the efforts spent for reaching suitable respondents, and the amount of responses received. As a conclusion, the combined use of web-based and paper-based questionnaires might be helpful.

As a third limitation, the dissertation has investigated the early project phases at one occasion. Future research could include a longitudinal investigation to identify how the utilization of dynamic capabilities changes over time with an increasing experience of the different organizations. This approach could further enable the identification of higher-order or meta-capabilities that renew the concept of dynamic capabilities as such.

The dissertation contributes to the generation of knowledge by integrating the themes of hypercompetition, change, strategic management with project management. Thus, the dissertation contributes to a broadening of the project management field by enriching it with new influences. The findings
also help to recognize the importance of a distinct set of capabilities for the management of the early project phases and innovation outcome. The harmonization of these capabilities and the features from the highlighted challenges emphasizes the value of a contingent optimization rather than an overemphasis of one single factor. Moreover, the papers in this dissertation help to decrease the abstractness of the concept of dynamic capabilities, by providing an exemplification of how their components are used in the R&D process. The project life cycle shows further that the importance of particular capabilities shifts over time and that they can be purposefully used to direct certain performance outcomes.

In addition to the knowledge creation, the dissertation has the following strengths. First, the research provides a coherent and holistic exploration of the management of the early project phases for frequent innovation. By focusing on capabilities, the pharmaceutical R&D process has been investigated comprehensively. The study embraces different levels of detail in theoretical terms from the challenges arising in hypercompetitive environments to the exploration of the management of the early project phases based on certain capabilities facilitating innovation, and finally to the impact of dynamic capabilities on project performance outcomes. Second, the dissertation is very comprehensive based on a variety of constituting studies: a conceptual study, a philosophical study, a qualitative study and a quantitative study. A contemporary topic and a research context of high complexity have been encountered by utilizing various theoretical perspectives and by applying a sequential mixed method in a methodological multiplicity.
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REFERENCES


Appendix 1: Interview Guide

THANK YOU
INTRODUCTION
PERMISSION TO USE RECORDER

I.) Company/industry/respondent background

1. What is your position in the company and what are your responsibilities?

2. Please tell me about your company and the type of projects, which run in its R&D department.
   • How are you involved in it?

II.) Innovation and Project Management

3. Please describe how a R&D project develops based on initial ideas and early decisions made.
   • Where do ideas for R&D projects tend to originate?
   • How are decisions made on which idea will proceed to a R&D project?
   • What are the decision points in the R&D process a project has to pass?
   • How is resource allocation handled in the portfolio of R&D projects?
   • What _________ do you consider as most crucial for frequent innovation?
     o competences (of the scientific personnel)
     o skills (of the scientific personnel)
     o aspects
     o other

III.) Components of dynamic capability related questions

4. Please tell me, how do you discover emerging business opportunities in your company?
   • product-wise
   • research results
   • latest technology
   • other
5. How do you identify and handle valuable external information in your company? e.g. research results?

After the acquisition of valuable information -

- How do you internally distribute it and assure its application in your company?
- How is innovation encouraged and facilitated...
  - for researchers?
  - in development processes?

IV.) Role of knowledge and learning

6. Could you please describe the role and practices of knowledge management in your company.

- How is learning facilitated in the R&D process?
- How is the process of knowledge creation organized? – make-or-buy, internal/external info
- Please describe collaboration in the R&D department...
  - with external scientists.
  - across functions.
  - across disciplines.
  - across projects.
- Are there means through which __________ are integrated to each other to facilitate knowledge development and knowledge management?
  - functions
  - disciplines
  - projects
- Are there any routines or guidelines for the translation of knowledge into useful actions?

V.) R&D environment

7. Please describe how you can facilitate the development of innovative products in your position.

How would you describe the work atmosphere...

- in research teams?
- related to senior management?

8. What are the future challenges for the biotechnology industry?

9. What are the challenges for your company and the R&D projects?

THANK YOU VERY MUCH FOR YOUR CONTRIBUTION!
Appendix 2: Construct Measurement

**ABSORPTIVE CAPABILITIES**

*Knowledge recognition*
- ABC1. We frequently scan the environment for new technologies.
- ABC2. We thoroughly observe technological trends.
- ABC3. We observe in detail external sources of new technologies.
- ABC4. We thoroughly collect industry information.
- ABC5. We have information on the state-of-the-art of external technologies.

*Knowledge assimilation*
- ABC6. We frequently acquire technologies from external sources.
- ABC7. We periodically organize special meetings with external partners to acquire new technologies.
- ABC8. Our employees regularly approach external institutions to acquire technological knowledge.
- ABC9. We often transfer technological knowledge to our firm in response to technology acquisition opportunities.

*Knowledge maintenance*
- ABC10. We thoroughly maintain relevant knowledge over time.
- ABC12. We communicate relevant knowledge across the units of our firm.
- ABC13. Knowledge management is functioning well in our company.

*Knowledge reactivation*
- ABC14. When recognizing a business opportunity, we can quickly rely on our existing knowledge.
- ABC15. We are proficient in reactivating existing knowledge for new uses.
- ABC16. We quickly analyze and interpret changing market demands for our technologies.
- ABC17. New opportunities to serve our customers with existing technologies are quickly understood.
Knowledge transformation
ABC18. We are proficient in transforming technological knowledge into new products.
ABC19. We regularly match new technologies with ideas for new products.
ABC20. We quickly recognize the usefulness of new technological knowledge for existing knowledge.
ABC21. Our employees are capable of sharing their experience to develop new products.

Knowledge application
ABC22. We regularly apply technologies in new products.
ABC23. We constantly consider how to better exploit technologies.
ABC24. We easily implement technologies in new products.
ABC25. It is well known who can best exploit new technologies inside our firm.

INNOVATIVE CAPABILITY
INC1. Our innovations reinforce our prevailing product lines.
INC2. Our innovations reinforce our existing expertise in prevailing products.
INC3. Our innovations reinforce how our company currently competes.
INC4. Our innovations make our prevailing product lines obsolete.
INC5. Our innovations fundamentally change our prevailing products.
INC6. Our innovations make our existing expertise in prevailing products obsolete.

ADAPTIVE CAPABILITY
ADC1. We know the R&D activities of our competitors well.
ADC2. We know the strategic moves of our competitors well.
ADC3. We know the product needs of our customers well.
ADC4. Our current product is based on established solutions.
ADC5. Our marketing management and personnel collaborate closely with R&D.
ADC6. The dissemination of market information increases cooperation between marketing and R&D.
SHORT-TERM PROJECT SUCCESS
SPS1. Our R&D projects meet their operational performance goals.
SPS2. Our R&D projects meet their technical performance goals.
SPS3. Our R&D projects meet their time goals.
SPS4. Our R&D projects stay within budget limits.
SPS5. Our R&D projects address a recognized customer need.
SPS6. Our R&D projects solve a serious problem of the customer.
SPS7. Our developed product is used by the customer.
SPS8. Our customer is satisfied with the developed product.

LONG-TERM PROJECT SUCCESS
LPS1. Our R&D projects have a high potential for commercial success.
LPS2. Our R&D projects have a high potential for creating a large market share.
LPS3. Our R&D projects will create a new market.
LPS4. Our R&D projects will create a new product line.
LPS5. Our R&D projects are developing a new technology.

PROJECT PORTFOLIO PERFORMANCE
Characteristics of R&D project portfolio performance
PPP1. We have the right number of projects for the resources available.
PPP2. Our portfolio contains high-value projects.
PPP3. Our portfolio has an excellent balance of projects (long term vs. short term, risk, etc.).
PPP4. Our projects are aligned with the business’s strategy.
PPP5. The spending breakdown of our projects in the portfolio reflects the business’s strategy.

R&D project portfolio achievement
PPP6. Our portfolio leads to a high customer satisfaction.
PPP7. Our portfolio achieves time, cost and quality objectives.
PPP8. Our portfolio achieves financial objectives.
PPP9. Our portfolio fulfills the customer requirements.
PPP10. Our projects’ purpose is achieved.
PPP11. Our programs’ purpose is achieved.