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Emotions and learning from terminated R&D projects – A multiple-case study research

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Only those who dare to fail greatly can ever achieve greatly.

Robert F. Kennedy (1925-1968)

Important note

This dissertation contains statements and quotes from engineers and managers from a large multinational cooperation. The usage of these statements in quotes serves exclusively to prove cognitive effects in corporate practice in a scientific manner. The used evidence and statements represent in no way a judging or assessing comparison of the subsidiaries themselves, their processes, their methodologies or practices.

Assessments, especially on emotions and level of learning, have been derived by the author and thus include a certain level of subjectivity based on the personal interpretation of the author and a second, independent researcher. The objective of this research is to examine cognitive effects, whose existence and impact is acknowledged by psychology and has been proven in the scientific community, in corporate practice. The author dissociates himself from any judging or valuing conclusions on the quality of any actions or management practices of the respective subsidiaries as this is not the purpose of this dissertation and the interviews have not been evaluated based on this perspective.

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Table of contents

List of figures

List of tables

List of appendices

List of abbreviations

CAIB	Columbia Accident Investigation Board
cf.	Confer (compare)
CTO	Chief Technology Officer
EBIT	Earnings before interest and taxes
e.g.	Exempli gratia (for example)
et al.	Et alii (and others)
i.e.	Id est (that is)
IT	Information technology
KPI	Key performance indicator
n/a	Not available
NPD	New product development
R&D	Research and development
USD	US-Dollar
vs.	Versus

Abstract

Although organization theorists have argued that we learn more from our failures than from our successes, less is known about why some learn more from failure than others. Using a multiple case study method to analyze eight (four of them in greater detail) research and development (R&D) projects, I find that a delayed termination decision has contrasting effects. On the one hand, it enables cognitive preparation, which facilitates team members' learning. On the other hand, it is perceived as a form of 'creeping death' that generates negative emotions. I also find evidence of both an anti-failure bias – redefining the labels of 'project failure' – and a non-participative decision-making and learning process that accelerates project termination but obstructs team members' learning. By investigating how team members learn and feel about project failure, I gain a deeper understanding of a common, yet mysterious, aspect of the R&D process.

In the discussion, I develop a new model based on the four main insights from the analysis that describes the phenomena introduced above and awaits larger empirical research to test and validate the findings and propositions.

Keywords: project failure, R&D organizations, learning from failure, grief, project termination, decision making

Zusammenfassung

Obwohl Organisationstheoretiker argumentieren, dass wir mehr von unseren Fehlern lernen als durch unsere Erfolge, ist weniger bekannt, warum manche mehr aus Fehlern lernen als andere. Mit Hilfe mehrfacher Fallstudien zur Analyse von acht Forschungs- und Entwicklungsprojekten (vier davon detaillierter) habe ich identifiziert, dass eine Verzögerung der Entscheidung eines Projektabbruchs gegenläufige Effekte hat. Einerseits ermöglicht ein verzögerter Abbruch eine kognitive Vorbereitung, die den Lernvorgang der Projektmitglieder unterstützt. Andererseits wird es als eine Art ‚schleichender Tod' wahrgenommen, der negative Emotionen hervorruft. Ebenso finde ich Anzeichen für zwei weitere Phänomene: einen Bias gegenüber Scheitern, durch den die Bezeichnung ‚gescheitertes Projekt' vermieden wird sowie einen nicht-partizipativen Entscheidungs- und Lernprozess. Beide beschleunigen den Projektabbruch, schränken aber gleichzeitig das Lernen der Teammitglieder ein. Durch die Analyse wie Teammitglieder über das Scheitern eines Projektes denken und davon lernen, erziele ich ein tieferes Verständnis eines weit verbreiteten, jedoch immer noch mysteriösen Teils des Forschungs- und Entwicklungsprozesses in Unternehmen.

Im Rahmen der Diskussion entwickle ich ein neues Modell basierend auf diesen vier Kernerkenntnissen der Analyse, das die vorangehend beschriebenen Beobachtungen und Phänomene näher erklärt. Der gewählte explorative Ansatz erfordert jedoch noch größere empirische Untersuchungen, um die Erkenntnisse und Vorschläge zu testen und zu validieren.

Schlagwörter: Projektscheitern, F&E Organisationen, Lernen aus Scheitern, Trauer, Projektabbruch, Entscheidungstheorie

1 Introduction

Anti-failure bias is prevalent in managers, organizations, and amongst scholars (McGrath, 1999). For example, March and Shapira (1987) noted that *"society values risk taking but not gambling, and what is meant by gambling is risk taking that turns out badly"* (p. 1413). Farson and Keyes (2002) proposed that *"while companies are beginning to accept the value of failure in the abstract – at the level of corporate policies, processes, and practices – it is an entirely different matter at the personal level. Everyone hates to fail"* (p.65). Indeed, the *"tendency to view failure negatively introduces a pervasive bias in entrepreneurship theory and research"* (McGrath, 1999, p. 13). Although there has been some recent theorizing and empirical work on how the negative emotions generated by failure impact learning and the motivation to try again (Shepherd, Patzelt, & Wolfe, 2011; Shepherd, Wiklund, & Haynie, 2009), there is still much to learn about how project failure is dealt with in organizations. This represents a substantial gap in the literature, as there remains a great deal of mystery about failure in organizations.

The mystery surrounding failure stands in stark contrast to its prevalence in organizations, especially in entrepreneurial organizations (Burgelman & Välikangas, 2005; Sminia, 2003). For example, it is estimated that 35 to 45% of all new products fail (Boulding, Morgan, & Staelin, 1997), and that almost 90% of corporate venturing projects do to realize their goals (Block & MacMillan, 1993). In some R&D intensive industries, such as biotechnology, more than 95% of projects fail (DiMasi, Hansen, & Grabowski, 2003; Evans & Varaiya, 2003). When talking about project failure, I refer in the following course of my research to *"the termination of an initiative to create organizational value that has fallen short of its goals"* (Shepherd et al., 2011, p. 1229).

The purpose of this dissertation is to deepen the understanding of failure in organizations by exploring the decision to terminate a R&D project and its consequences. To date studies have typically focused on explaining learning after the failure event. For example, work has shown that organizational members' learning from failure events is impacted by individuals' orientation towards learning (Dweck & Leggett, 1988), cognitive biases (Kahneman, Slovic, & Tversky, 1982), coping orientations (Shepherd et al., 2011), and past successful experiences (Ellis & Davidi, 2005) as well as organizational reward systems (Sitkin, 1992) and cultures (Cannon & Edmondson, 2001; Prahalad & Oosterveld, 1999; Shepherd et al., 2011). These studies (because it was not their purpose) have not, however, acknowledged that the process leading up to the actual termination of a project may differ, and how these differences impact learning before the project is actually terminated. This is important because research on escalation of commitment (Staw, Sandelands, & Dutton, 1981) and procrastination (Anderson, 2003; Lazarus & Folkman, 1984) emphasizes that some projects 'fail' over an extended period of time despite managers' beliefs that the project will never reach minimal performance goals. Given that time plays an important part in making sense of failures and learning (Huy, 1999; Kim, 1993; Rudolph, Morrison, & Carroll, 2009), my research aims at complementing recent research and deepening the understanding of the link between the delay of project termination and learning from project failure.

Given the confidentiality of the research subject, I could pursue my research in an exceptional environment and was able to build on unique data. The setting is R&D intensive divisions, within subsidiaries of a large multi-national parent organization. This is an attractive setting for investigating project failure because R&D projects are exploratory vehicles for large, established organizations (March, 1991), which leads to high-variance outcomes including failure, especially in high-technology industries (McGrath, 1999). However, R&D projects, processes, and outcomes are also typically shrouded in secrecy.

Work on these projects represents intellectual property and secrecy is a common method of protecting that property. Due to the contacts of the chair of entrepreneurship and personal networks, I was granted uncommon access to information on substantial R&D projects, including access to team members, project leaders, the top management of subsidiary organizations, and top management of the parent organization. In the current setting, on average, a project receives a 40 million US-Dollar investment, involves 2,000 full time equivalent employee months, and takes 1-2 years to achieve an outcome (including failed projects).

As prior research has not sufficiently explored how failing projects are terminated and what the consequences of that termination are, I use a multiple case study approach in this dissertation to theorize on the topic. As Eisenhardt and Graebner (2007) suggested, building an emerging theory from rich data sources is *"one of the best (if not the best) bridges from rich, qualitative evidence to mainstream deductive research"* (p. 25). It provides the opportunity to generate new insights not available through top down theorizing from past research nor, as others have suggested, through office bound thought experiments (Brown & Eisenhardt, 1997; Glaser & Strauss, 1967).

In the subsequent section, I outline the research questions to be clarified within this dissertation in more detail.

1.2 Research questions

As introduced above, prior research has not yet sufficiently explored how R&D organizations handle failure. Extant literature on failure deals to a great extent with e.g., the financial consequences or deciding upon the right point in time to terminate projects in order to minimize cost related to the failure (McGrath, 1999). Although there has been research on R&D project failure, it covered predominantly the question of analyzing the causes of failure in R&D projects in the innovation process (Kumar, Persaud, & Kumar, 1996; Pinto & Mantel, 1990). Today, still little is known about how it is decided to terminate R&D projects and what the implications of the termination, e.g. on learning from failure, on organizational as well as on employee level, are.

Thus, the objective of my research is to develop a deeper understanding of R&D project failure, the termination decision and the resulting consequences of discontinued projects. More specifically, the dissertation is intended to make a significant contribution to the research in this field by answering three major questions:

1. How are termination decisions made and what psychological and emotional reactions do they trigger in R&D professionals?
2. How does timing of the termination decision influence the emotional reaction and learning experience?
3. How do team members learn from discontinued R&D projects and how is learning from the experience influenced (on personal and organizational level)?

When defining the research questions, it is crucial to limit the number of questions and at the same time to ensure a focus in order keep data collection streamlined and not to get lost in the vast amount of data (Mintzberg, 1979; Pettigrew, 1990), especially when following a qualitative research approach as introduced in the next chapter.

1.3 Approach and structure

This research is structured into seven chapters. After the introduction to my study in this chapter, chapter 2 is concerned with explaining the theoretical background by providing a literature review and discussing the most important constructs. Moreover, it defines key terms that are of particular importance and form the basis for the research in this dissertation.

Chapter 3 focuses on the exploratory case study design of my empirical research and points out the methodology applied to answer the research questions. Besides explaining why the selected research strategy and design is suitable for this study in chapters 3.1 and 3.2 respectively, I continue to discuss the issues of validity and reliability related to the chosen approach in chapter 3.3. Chapter 3.4 will highlight the data collection approach centered on expert interviews before presenting the methodology applied to prepare and analyze the data in detail in the subsequent chapter 3.5.

Chapter 4 contains the within-case analysis. It starts with a brief introduction into the approach in chapter 4.1 before providing a case outline and the general patterns of the eight cases included in this dissertation. In a sequential approach, for each case a description of the respective content and events is given before conducting a pattern analysis to compose the most remarkable and outstanding patterns throughout chapter 4.2 to 4.9.

The heart of my analysis follows in chapter 5, in which the most important and recognizable aspects across the cases are analyzed and synthesized into the key results. Furthermore, these results are discussed in the light of the respective extant literature. The section starts with the methodological approach in chapter 5.1 before the key insights for the constructs in focus of this study are identified and extracted by a cross-case comparison of the respective events and patterns. The subsequent chapters 5.2 to 5.5 address in detail for each construct the findings and conclusions from the analysis, always relating the results with extant research and literature.

Chapter 6 summarizes the key insights and discusses the implications for research (chapter 6.1) as well as for management (chapter 6.2) based on the results of the case analyses.

Chapter 7 concludes by illustrating and explaining the limitations of this study and identified opportunities for future research in chapter 7.1 before summarizing the key results and insights from this dissertation in the conclusive remarks of chapter 7.2.

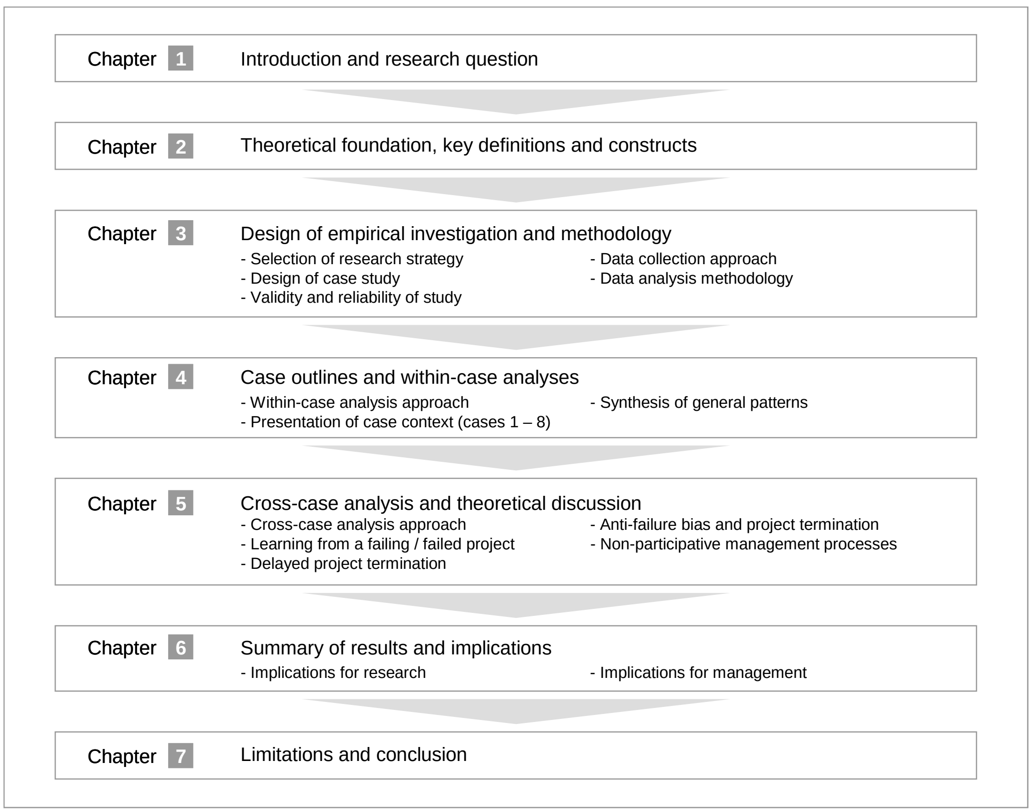

Figure 1: Structure of the study

Source: Own illustration

2 Theoretical foundation, key definitions and constructs

In the context of this dissertation, research and development organizations are the setting for the empirical research on project failure. More specifically, R&D projects in autonomous subsidiary organizations of a large multinational company (see chapter 3.2 for more details on the research setting) will be examined. The following chapters provide the contextual background and introduce the concepts and building blocks of the research in the subsequent sections of this paper.

2.1 Project

As different cases of terminated R&D projects are analyzed and contrasted in this study, I am starting with a brief overview of the concept 'project', representing the main unit of investigation throughout this dissertation.

2.1.1 Terminology

In general, projects can be attributed to almost every field of industry or business and represent a common phenomenon with increasing importance in high technology corporations (Pinto & Kharbanda, 1995). During the last years, the terminology even spread in areas of private life, as it is applied more and more frequently for activities outside the business world (e.g., for do-it-yourself activities at home). The Project Management Institute (2008)[1] provides a very broad and general definition of the term 'project': "*A project is a temporary endeavor undertaken to create a unique product, service, or result*" (p. 5). Accordingly, three characteristics distinguish a project from regular operations in the business context:

[1] The Project Management Institute is a US-based, non-profit organization that aims at advancing project management by e.g., the development of standards and recognized credentials to certify project management expertise. (Project Management Institute, 2012)

(1) *temporary* indicates that a project is intended to be an endeavor with defined beginning and end, which is achieved either when the projects' objectives have been fulfilled or when the project is terminated when these objectives cannot be met (Project Management Institute, 2008). However, the temporary character refers only to the project, not to its result, which is ideally intended to be long-lasting. Moreover, 'temporary' does not necessarily mean 'short' as the duration of a project may comprise a longer period of time (e.g., several years in large development projects).

(2) A project leads to the creation of a *unique product, service, or result* in which the term 'product' represents a quantifiable end product or component; 'service' may constitute, e.g., an ability to execute a specific process in manufacturing; and a 'result' could comprise a scientific document (Project Management Institute, 2008). Nevertheless the characteristic of uniqueness is important – although there might be repetitive outcomes of the project (e.g., several products manufactured after the project to design the specific product) – the project work itself is unique.

(3) The third characteristic, although only implicitly mentioned in the definition, is *ongoing work effort*. That means that the execution of a project is a gradual process, refining broader process steps in the beginning to more specialized specifications and content during the project execution (Project Management Institute, 2008).

2.1.2 Advantages of projects and project organization forms

During the last years, increased competition induced by globalized sales and factor markets had a significant impact on research and development activities. Thus on the one hand, R&D efforts needed to become more efficient in order to meet customer needs better. On the other hand, stronger competition required companies to cut R&D lead times simultaneously (Elmquist & Le Masson, 2009; Hovmark & Nordqvist, 1996). To achieve this, activities in research and development had to be parallelized rather than performed sequentially, leading to a higher number of people working on these tasks. This staff increase in turn intensified coordination requirements of the involved functions and departments, which led to a reorganization need of R&D activities (Hovmark & Nordqvist, 1996). Hayes et. al (1988) as well as Clark & Wheelwright (1992) describe that in particular four types of organizational structures allow to accommodate to and manage the increased complexity of the product development process, one of them being the project organization. Further, Hobday (2000) discusses the extreme form of project-based organizations and its distinct advantages compared to functional organizations. According to his research, pure project-based organizations are able to manage the above mentioned challenges as they are *"ideally suited for managing increasing product complexity, fast changing markets, cross-functional business expertise, customer focused innovation and market, and technological uncertainty"* (Hobday, 2000, p. 871). Therefore, projects are nowadays a widely used form to organize R&D activities in different forms of organizational setups. From the functional matrix organization to the project-based organization, implemented project structures allow coordination and integration of decisions as well as of resources (Hobday, 2000). The major advantages of a project-based organization over a functional organization are flexibility to organize resources, strategies and structures in addition to linking functions according to the need of the respective project (Hobday, 2000). In addition to the ability to meet innovative needs and flexibility, projects provide further distinct advantages when it comes to the organizational setup within a company. They allow to assign experts from different functions, departments, locations or business units and offer a high degree of flexibility to address the peculiarities that are new to the organization which may arise during the execution of a project (e.g., to address local specifics in product design by the assignment of respective experts to the international project team) (Chiesa, 2000; Hobday, 2000).

Pinto and Pinto (1990) describe another advantage of the project organization as cross-functional cooperation benefits both, task outcome (performance of the project) and psychosocial outcomes (how people involved in a project feel about it, e.g., it was worthwhile) of project work, in particular the development of new programs. The collaboration across functions plays an important role as it has been found that group effort on the one hand supports individuals to work more effectively and thus increases overall productivity (cf. Laughlin, Zander, Knievel, & Tan, 2003). On the other hand, collaboration ensures that interdependent functions work together and support the overarching objectives of the organization. Thus, successful cross-functional collaboration in projects is likely to show a higher performance through support of an individual by the group and aligned goals. A successful project implementation in turn is likely to have a positive impact on the attitude towards future projects (cf. Pinto & Pinto, 1990).

Moreover, corporations have become increasingly globalized during the past decades and research and development activities consequently have been internationalized as well in order to capture local expertise and knowledge (Chiesa, 2000). As it is crucial to leverage and exploit this expertise on a worldwide basis, a project organization allows assigning these R&D experts to projects globally according to respective requirements (Bartlett & Ghoshal, 2002; Chiesa, 2000). Furthermore and contrary to large, integrated and hierarchical organizations, neither an anti-innovation bias (which means that innovation is regarded as a threat to existing structures and thus avoided, [cf. Teece, 1996]) nor core rigidities (the fact that in established organizations with e.g. R&D capabilities, it becomes difficult to dismantle the system and develop products in alternative ways, [cf. Leonard-Barton, 1992]) do prevail due to the fact that the project is always a temporary construct (Hobday, 2000; Turner & Müller, 2003). Therefore, research and development departments often use a project organization as it is very effective to accommodate for frequently changing setups that house critical one-time tasks with a defined objective which is new to the organization and shows a high complexity of interdependent singular tasks (Middleton, 1967).

2.1.3 Disadvantages of projects and project organization forms

The advantages of a project-centered organization do as well come at a cost. Main disadvantages are the comparably weak leverage of capabilities and resources across the entire organization as a whole, which becomes apparent through lacking knowledge sharing and learning across projects as well as weak communication or absent integrated systems and processes across the rather isolated project silos (Hobday, 2000). Taking an extreme position, this missing 'mutual fertilization' across teams could endanger the technological leadership position of high-tech companies when not using the full innovative capability of the organization as a whole.

When projects are executed in functional matrix organizations, project managers often do not possess own staff as team members in most cases are direct reports of the respective functional management they belong to (Hobday, 2000). Hence, especially in situations of conflict or scarce resources, challenges arising from contrary interests of project and function might occur due to the divergence of reporting line and project assignment. Ultimately, functional managers could withdraw resources or assign their direct reports to several projects in parallel. Moreover, the project manager in a functional matrix organization often does not have a direct line neither to senior management nor to senior clients, both opposing a stretch to achieve fast decisions as well as accommodating customer requirements (cf. Hobday, 2000). Last but not least, the implementation of projects within a functional matrix organization as well bears the cost of alignment and reporting to several functions, which is time intensive and results in *"a reactive, rather than a proactive stance towards risk, client management, product design, manufacture, and so on"* (Hobday, 2000, p. 881).

In sum, projects are a formidable structure to organize in unstable environments in general. R&D organizations usually consist of multiple nonrecurring development projects with different objectives, accordingly varying, interdisciplinary team and specialist requirements, thus the flexibility of the project organization accommodates these needs in a particular manner (Kutschker & Schmid, 2006). To introduce the concept of research and development, the next chapter gives a basic introduction to the R&D function representing the environment in which the projects under investigation in this dissertation have been executed.

2.2 Research & development as a key function within organizations

To illustrate the area of investigation throughout this thesis, I start with the classification of the R&D function within the operative activities of a company.

2.2.1 R&D as a core function in the business model of a firm

Each company consists of a wide array of activities that collectively ensure the delivery of goods or service to the customer. The concept of the business model structures this broad variety of different activities into a flow diagram according to their position in the value creation process (Hungenberg, 2001). The logical order of the activities is determined by their respective position in the value creation process. Although a business model needs to be developed specifically for a company to illustrate all its operations and cluster them correctly to its key activities, a similar structure for businesses within the same industry however still prevails (Hungenberg, 2001).

Research & development represents one of the core functions of a company and in general constitutes the starting point of respective business models across different industries. Successful companies spend a significant portion of their sales on R&D, ranging from a low 1-2% of sales in mature industries up to 20% in high-tech environments (Balachandra, 1996). A simple, generic business model thus starts with research & development and further comprises production, sales and marketing as well as service. Examples of industry specific business models, all starting with R&D as major function, are illustrated in Figure 2.

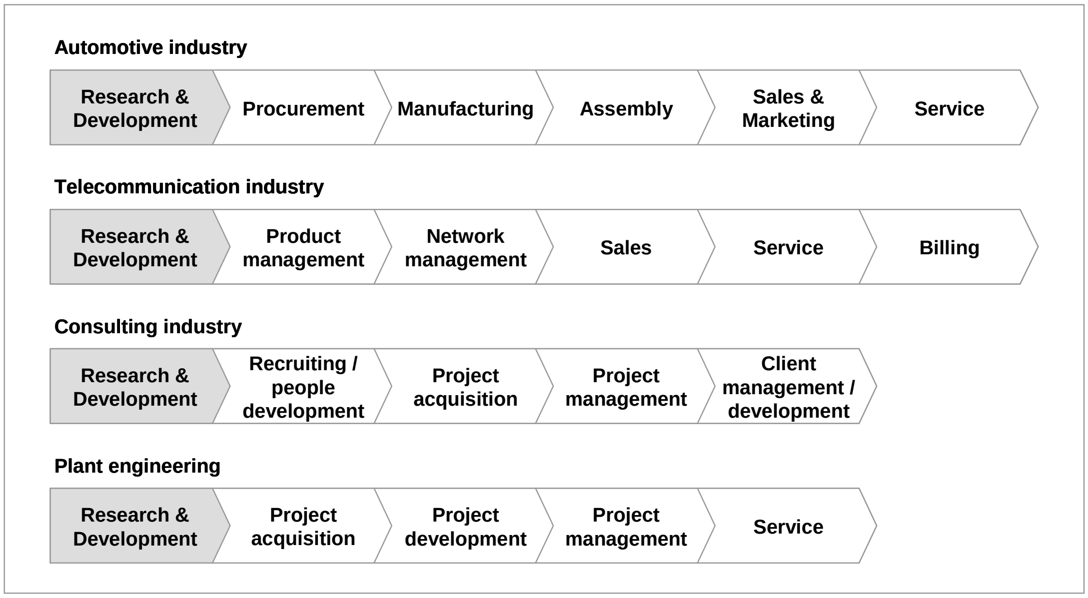

Figure 2: Business models of different industries

Source: Own illustration based on Hungenberg (2001, p. 120)

2.2.2 R&D as an enabling activity in the value chain

A more detailed description of the firm's activities is Porter's value chain, representing one of the most fundamental concepts in general business management (Porter, 1985). It can be used to describe all value-adding activities performed by a firm comprehensively. While its major purpose lies in the evaluation of a firm's relative cost position and degree of differentiation to determine its competitive advantage, it provides a formidable structure to give a more detailed classification of activities within a company, usually constructed on the level of particular industries. Generally, the concept of the value chain differentiates value activities into primary and support activities. Primary activities comprise functions that are directly related to the actual production of the goods or services of the company, e.g., inbound logistics or operations (Porter, 1985). Supporting activities, however, can be regarded as enabler of the primary activities of a company and are not directly involved in the manufacturing of the goods or services. In this concept, the R&D function is considered to be a supporting function, subsumed as part of the category of 'technology development'[2]. As Porter (1985) states: "*The array of technologies employed in most firms is very broad, ranging from those technologies used in preparing documents and transporting goods to those technologies embodied in the products itself*" (p. 42). In this dissertation, however, the term R&D refers to the narrower perspective of research and development related to new products or systems for end-customers performed in the respective departments of the businesses under investigation.

2.2.3 The R&D process

In corporations, R&D projects in general follow a staged process, starting with idea generation to the commercialization of the development (Balachandra, 1996). Thus, the R&D project portfolio of a company usually comprises projects with different maturity levels. Figure 3 depicts the four generic stages R&D projects normally undergo.

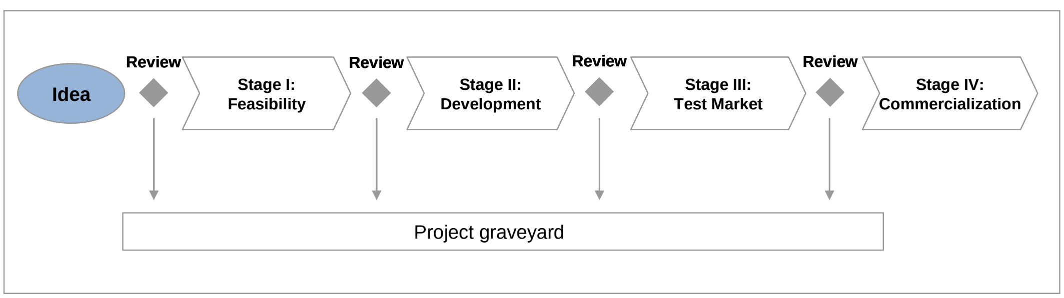

Figure 3: R&D project life stages

Source: Own illustration based on Balachandra (1996, p. 89)

From a pool of project ideas a first review determines the interesting ideas to be included in the project portfolio. After having received a budget and schedule, the assessment

[2] Porter (1985) considers the technology development category to be broader than just research and development as it as well covers the aspect of process development, supporting the entire value chain and not the end product only.

of feasibility represents the core of this first phase. During the second phase, projects ideas receive major resources and are developed into first prototypes. Afterwards, the developed products are tested on the market (phase three) before entering the final stage of commercialization (phase four), constituting the transfer of the product into the marketable product portfolio. R&D projects in general have a high failure rate (cf. Boulding et al., 1997; Stevens & Burley, 2003 or DiMasi et al., 2003). The termination of a project is decided in the project reviews, in which a negative assessment would take the project to the project graveyard as depicted in Figure 3. Most of the projects are terminated during the second stage of 'development', representing the phase where large amounts of money need to be invested and terminating projects with low success probabilities saves the firm significant amounts of resources (Balachandra, 1996; Ming Ding & Eliashberg, 2002).

2.2.4 The importance of the R&D function as setting for this dissertation

The corporate R&D context is a particularly meaningful setting to explore project failure and its consequences for three main reasons. First, research and development is one of the *core processes* of every venture, especially in the high technology environment of the subsidiaries analyzed in this thesis, representing a *key factor to competitive advantage* (Porter, 1985). Whereas other operational processes, e.g., manufacturing, ensure the functioning of current activities, the major impact of R&D is to ensure the continued existence and success of the venture in the marketplace (cf. Balachandra, 1996; Briscoe, 1973 or Brown & Eisenhardt, 1995). Thus, a high observability should prevail as R&D projects due to their nature and their importance to the company's future success possess a high visibility and are monitored closely by management and employees (Briscoe, 1973; Corbett, Neck, & DeTienne, 2007). Second, in the case of R&D projects within a company, *key resources* allocated to the failed project *are more likely to stay within the corporation after the failure* and therefore permit a better opportunity to learn from failure as opposed to startup ventures which may disappear after failure (Rerup, 2005; Shepherd, Covin, & Kuratko, 2009). Third, in high-technology companies *a high number of failed projects prevails*, as described below. Constant innovation and development effort, materialized by working on a large number of new research projects, is a crucial factor to maintain a competitive advantage, especially in the very dynamic and uncertain environment that companies are facing today. Under conditions of high uncertainty, scholars suggest a real options approach as a strategy to ensure competitiveness (Chatterjee, Lubatkin, & Schulze, 1999; McGrath, 1999). This approach attaches value to a large number of options, often called projects, proposed investments or ventures, in uncertain situations (Dixit & Pindyck, 1994; McGrath, 1999). Pursuing these options, especially in the R&D context, companies are provided with a mechanism to adapt and develop new products (Marsh & Stock, 2003) and to gain competitive advantages (Brown & Eisenhardt, 1995). Moreover, not only the inherent risk of uncertainty requires high R&D efforts but strong competition from aggressive ventures of emerging countries as well imposes the need for intense R&D activities (cf. von Zedtwitz, 2005). In short cycles, these low-cost competitors are often trying to imitate products and goods that have been innovated and developed with major efforts during long periods of time by the established companies (cf. Yiu, Lau, & Bruton, 2007). Therefore, especially companies in high-cost countries need to compensate imitations through innovativeness.

Overall, an inherent need for constant innovation and new product development prevails in technology driven industries to ensure long-term success, growth and profitability, especially for high technology companies (Briscoe, 1973; O'Meara, Jr., 1961). Under these conditions, not all projects can achieve their planned objectives and project termination is a regular phenomenon for researchers and R&D organizations. The next chapter gives an introduction into R&D project failure and provides an overview how failure can be defined.

2.3 Uncertainty and R&D project failure

Before defining the term ‘failure’ for this dissertation, a brief overview on extant literature and analyses of R&D project failure rates is provided in the next section.

2.3.1 R&D project failure in extant literature

Working on diverse, highly volatile and uncertain R&D projects in parallel, e.g., investigating new materials or cutting-edge technologies, it is immanent that not all of these endeavors will turn out to be successful and achieve their objectives. For example, DiMasi, Hansen and Grabowski (2003) and Garnier (2008) found for the biotechnology and pharmaceutical industry that research projects frequently fail due to diverse technological, market and research uncertainties. This holds true for other industries in the high technology sector as well. For instance McGrath, Keil, and Tukiainen (2006) found for new product development at Nokia that during a four year period from 1998 to 2002 about 70% of corporate venturing investments had to be either discontinued or fully divested.

Companies are aware of the risk and uncertainty associated with research and development activities, thus they deliberately maintain an extensive pipeline for new projects to remain competitive (Colvin & Maravelias, 2011; Ming Ding & Eliashberg, 2002). According to Amram and Kulatilaka (1999), they need to be *“more flexible, take more risks, start a lot more projects, and kill a lot of projects”* (p. 210) and consequently companies rely on parallelizing “*to increase the likelihood of having at least one successful product, multiple approaches may be simultaneously funded at the various NPD stages*” (Ming Ding & Eliashberg, 2002, p. 343).

This inherent uncertainty of R&D projects leads inevitably to project failures since *“failure is an essential part of high-risk projects, especially in the case of R&D projects”* (Ahonen & Savolainen, 2010, p. 2176). As a consequence, this uncertainty often results in cost overruns, missed timelines or ultimately in project terminations (Colvin & Maravelias, 2011; de Reyck & Leus, 2008). The reasons for failure are diverse and manifold, in some cases market prospects change during the lifetime of the project, objectives are technically simply not feasible or in other cases mistakes before or during the execution lead to the cancellation of the project (Ahonen & Savolainen, 2010; de Reyck & Leus, 2008). Since at first sight failure often has a negative connotation and is regarded as a bad thing by embarrassed managers and project team members, a high reluctance to reveal information about then failure predominates (Ahonen & Savolainen, 2010; Briscoe, 1973; Lyytinen & Robey, 1999). This results in the fact that many R&D project failures remain shrouded in secrecy; only very few are communicated in the media – instead successes are emphasized (Briscoe, 1973; Sitkin, 1992).

Scholars have investigated project failures within the R&D- and new product development (NPD) environment. In fact, one of the first extensive research articles on success rates of new product development showed that around 33% of NPD projects fail (Booz, 1968). In the same decade, O’Meara (1961) even mentions significantly higher rates of around 75%-95%, referring to a rate of 80% derived from a study of new products placed on the market by 200 leading packaged-goods manufacturers. Subsequent authors confirm high failure rates of new product developments and arrive at similar results. Table 1 provides an overview of frequently cited papers in this respect.

Table 1: Overview of studies providing new product development failure rates

Author	Year	Industry	Business type	Failure rate	Comments / rate based on (external) source
O'Meara	1961	Packaged goods	Consumer	80%	Ross Federal Research Corporation
Booz, Allen and Hamilton	1968	Diverse	Diverse	33%	
Booz, Allen and Hamilton	1982	Diverse	Diverse	35%	
Block and MacMillan	1993	Diverse – new corporate ventures	Diverse	50-80%	
The Standish Group	1994	IT	Diverse	31%	
Griffin	1997	Diverse	Diverse	41%	PDMA survey
Boulding, Morgan and Staelin	1997	Diverse	Diverse	35-45%	(Power & Kerwin, 1993) (based on Booz, Allen and Hamilton); (Wind, 1982) (based on AC Nielsen)
Evans and Varaiya	2003	Biotechnology	Consumer	>90%	Related to market readiness, research of Pharmaprojects and R&D Time-Lines (PR Newswire UK, 2002).
DiMasi, Hansen and Grabowski	2003	Pharmaceuticals	Consumer	31,5%	Related to marketing approval
Stevens and Burley	2003	Industrial products	Diverse	40%	
Clancy and Stone	2005	Consumer products	Consumer	95%	AC Nielsen BASES and Ernst & Young
McGrath, Keil, and Tukiainen	2006	Telecommunications	Consumer / business	70%	Internal project data
Garnier	2008	Pharmaceuticals	Consumer	93%	CMR International

Source: Own illustration

Not surprisingly, Table 1 indicates that failure rates vary across studies. However, all studies confirm that at least more than one third of new product development initiatives fail, underlining the significance of the topic for corporations from all industries. Not discriminating for industries, Boulding, Morgan and Staelin (1997) refer to a rate of 35 to 45% of new product failures. In an analysis using a diverse sample across several industries and technology base (from high-tech to low-tech) as well as customer markets (consumer, mixed and business), Griffin (1997) found that the average failure rate across the sample was 41%. While there is no difference in failure rates across product types in this study, it shows that the failure rates of high-technology companies are around 5% less than of low-technology businesses (39.5% vs. 44.8%) (Griffin, 1997).

In general, it can be concluded that there is no single valid failure rate that can be claimed to be correct. Extreme failure rates of 93% for pharmaceutical products (Garnier, 2008) and even 95% for consumer products (Clancy & Stone, 2005) might on the one hand trace back to industry specifics (as the pharmaceutical industry might provide an ultra-critical environment for new products due to its demanding approval processes). On the other hand, comparability might be limited due to different definitions either of the project stages or of the terms 'failure' or 'success' related to new product development. Stevens and Burley (1997) address the issue of variances in failure rates due to different NPD process stages as both of the following statements hold true: *"'60 percent of NPD projects succeed!' (from Stage 6, 'Launch'); or '99.7 percent of ideas submitted fail!' (from Stage 2, 'Ideas Submitted')"* (p. 22). The problem of differentiation between definitions is also discussed by one of the most cited reports on project failure within the IT sector, called the Chaos Report of the Standish Group (Eveleens & Verhoef, 2010; Glass, 2005). In its first report from 1994, the authors stated that 31% of IT development projects fail, 53% are challenged (reporting cost overruns or decreased functionality), and only 16% of all projects are completed successfully (The Standish Group International, 1994). Scholars criticize that basing the definition of success solely on adherence to the initial cost, time and functionality forecast does not represent the right measure to determine success, as a slight cost increase of 5% in reality does not automatically mean question the projects success (Eveleens & Verhoef, 2010).

In a nutshell, one can assume that overall at least one third of R&D initiatives fail and thus failure represents a significant phenomenon in business context that is worthwhile to be investigated. However, it became apparent that for determining project failure, it is of utmost importance to give a clear definition of ‘failure’ in the respective context. Therefore, when talking about project failure in this dissertation, it is important to first establish a clear understanding of what failure means.

2.3.1 Definition of failure

Several definitions of project failure can be found in extant literature (cf. Cannon & Edmondson, 2001; McGrath, 1999; Shepherd et al., 2011). While various scholars in management and entrepreneurship research provide definitions of failure in the context of business failure (cf. Shepherd, 2003; Zacharakis, Meyer, & DeCastro, 1999), this paper takes the perspective of project failure. As introduced in the previous chapter, the very general definition of project failure as any deviation – either in time, cost or functionality – from the initial forecast, as applied by the Standish Group, is not fully able to meet the requirements of the discussion of project failure in this dissertation. Glass (2005) supports this finding as he states: *“How do you categorize a project that is functionally brilliant but misses its cost or schedule targets by 10 percent? Literalists would call it a failure, realists a success”* (p. 110). Since there are numerous decision criteria to determine whether a project failed or was successful, often without a sharp line dividing both, it is crucial to find a clear definition to be applied in this paper.

A general conceptualization of failure is provided by Cannon and Edmondson (2001), they define failure *“as deviation from expected and desired results”* (p. 162), including avoidable mistakes as well as unavoidable results of risk taking. Another but nonetheless clear and comprehensive description is provided by McGrath (1999), she defines failure as *“the termination of an initiative that has fallen short of its goals”* (p. 14). Hence in the R&D context, a new development project that has been terminated by respective management authorities can be regarded as project failure. As already mentioned in the introduction, within this dissertation I refer to the very recent definition of Shepherd and colleagues (2011), who slightly extended the definition of McGrath as follows: *“project failure refers to the termination of an initiative to create organizational value that has fallen short of its goals”* (p. 1229).

When providing a definition it is always critical how it can be operationalized. Following Shepherd and colleagues’ definition, this implies that the perception of the respective manager responsible for the project on expected outcome is the yardstick to decide when a project has failed to meet its objective. It is based on his or her opinion, representing the respective company, to decide whether the project falls short of its goals and not the responsibility of the researcher to make a judgment on the project’s chances of success. This approach is consistent with extant empirical research, which claims that failure is ultimately based on the assessment of the manager / entrepreneur in charge as this person is the final authority to define whether a project failed or not (cf. Balachandra, Brockhoff, & Pearson, 1996; Boulding et al., 1997; Doctor, Newton, & Pearson, 2001; McGrath, 1999; Pinto & Mantel, 1990; Gimeno, Folta, Cooper, & Woo, 1997). For the purpose of this study, I will hence follow the definition of Shepherd and colleagues (2011).

Before addressing the positive aspects of learning from failure, the subsequent chapter attends to a particular feature on the negative side of failure: negative affect.

2.4 Negative affect related to project failure

Failure in R&D projects has both, positive and negative implications on the individual level as well as on the organizational level. Starting with negative implications, employees and team members may often feel grief when projects fail, which is similar to the feeling when losing a loved person. Organizations as well may suffer from failed projects as resources have been required to execute the failed project: R&D employees have been tied up at high opportunity costs, sunk cost have been generated and vital time to market of the respective product has been sacrificed. Moreover, managers may need to address decreased motivations among employees and teams or might even need to replace experienced people who left the company after their project had been discontinued.

Common sense as well as research indicates that success provides several positive aspects and, amongst others, increases satisfaction and motivation: *"the rewards of success stimulate confidence and persistence, increase the coordinated pursuit of common goals, and enhance efficiency"* (Sitkin, 1992, p. 233). Success, for example in the form of a completed project meeting its objectives, constitutes a formidable starting point for future activities and favor further successes in the future (Weick, 1984). In stark contrast to success, a different picture applies to failure. From the beginning of our childhood our parents and our social environment, for example schools, condition us to avoid failures (Cannon & Edmondson, 2001). Moreover, there is a general fear of failure and this fear is regarded to foster immobilization as well as to decline the quality of thought and action (Weick, 1984). Mirvis and Berg describe the fear to fail vividly: *"In our culture, failure is anathema. We rarely hear about it, we never dwell on it and most of us do our best never to admit to it. Especially in organizations, failure is often simply not tolerated and people avoid being associated with failure of any kind"* (Mirvis & Berg, 1977, as quoted by Sitkin [1992]).

The consequences of failure may have severe implications for persons involved as failure may even threaten remarkable managerial careers and jeopardize excellent track records, leaving a stigma with negative impact, e.g., on promotions and future opportunities amongst others (Cannon & Edmondson, 2001; Sitkin, 1992; Sutton & Callahan, 1987). In general, the experience of failure leads to negative emotions attached to this occurrence of unsuccessful events (Shepherd et al., 2011). Failures are usually painful and are almost always accompanied by negative affect, including anger, frustration, and other negative emotions, which in combination with stress ultimately can make failed people susceptible to burnout (Bakker, v. Emmerik, & Euwema, 2006; Shepherd & Cardon, 2009). Psychology research indicates that failure experience may even lead to the perception of defeat, which has been associated *"with the onset and exacerbation of a range of psychiatric conditions and disorders, including depression, anxiety, and suicide"* (Johnson, Gooding, Wood, Taylor, & Tarrier, 2011, p. 922). In addition, a focus on own failures may painfully reduce self-esteem, research showed that people with high self-esteem rather try to avoid to deal with their own failures as they *"tend to concentrate on their successes and positive qualities rather than their failures and negative qualities"* (Cannon & Edmondson, 2001, p. 165).

Furthermore, there is a positive correlation of the intensity of negative emotions and the importance of the project to the person (Shepherd & Cardon, 2009). As R&D employees and scientists, spending the majority of their time working on their research projects, usually invest a lot of devotion and energy to their work (in the case of the projects I interviewed this timeframe represented often more than one year), it can be assumed that their projects are of high importance to them (Shepherd et al., 2011). Employees often develop this psychological ownership for their projects in organizations, resulting in interwoven self-identities and identities of projects and teams (Pierce, Kostova, & Dirks, 2001; Shepherd & Cardon, 2009). Consequently, in the event when a project is lost, teams having worked on the project lose an important part of their daily work life. In his research, Archer (1999) identified that negative emotional reactions are likely to occur when something is lost that is important to the respective person.

In the context of entrepreneurship, the entrepreneur often regards his venture as his or her 'baby' expressing a strong connection and identification (Cardon, Zietsma, Saparito, Matherne, & Davis, 2005). Introducing the 'parenthood metaphor', Cardon et al. (2005) highlight this relation and provide a better understanding through depicting a very appropriate image for this very special relation. Consequently, failure of the venture may trigger feelings of grief that are similar to losing a loved one – although at a different but nonetheless high level (Shepherd, 2003). The parenthood metaphor also applies to the R&D environment, where the teams working on the respective project often regard it as their 'baby', too. The identities of the R&D employees are closely linked to their projects and a failure has the potential to threaten their identification with the organization (Shepherd et al., 2011). Emotions after project failure are strong, an overview provide Shepherd and colleagues (2011): *"For example, some of the emotions that research team members report after project failure are denial, anger, personal pain, sadness, dismay, worry, anxiety, annoyance, frustration, and depression"* (p. 1233). Last but not least, dealing with failure is likely to have an impact on upcoming challenges by undermining the key enabler of future successes: self-efficacy (Bandura, 1990; Cannon & Edmondson, 2001). The negative implications of failure described above introduced a pervasive anti-failure bias (McGrath, 1999).

As described above, employees in R&D projects suffer from failure. However, a distinct feature differentiates failure between these two contexts: economic dependence. While entrepreneurial failure represents the loss of the livelihood for an entrepreneur, the failure of an R&D project in most cases does not harm the existence of the organization. As opposed to the entrepreneur, the vast majority of R&D team members still will keep their employment and continuously receive their monthly salary after their projects have been terminated. Nevertheless, the loss of the project represents a significant cut in their daily life and often bears negative emotions. At present, too little is still known about negative affect resulting from project terminations in organizations: How do employees and teams react to failure in R&D departments of larger enterprises? How does it feel to fail in the environment of an R&D organization? Does an anti-failure bias prevail? As this phenomenon is not yet described exhaustively in current literature, this dissertation shall contribute to clarify these questions.

Having discussed the negative aspects related to failure, I want to change the focus now in the next chapter to the positive side of failure: Learning from failure.

2.5 Learning from failure

In addition to the negative emotions, a failed project might as well represent a cut or career-limiting move for project managers and key employees, e.g., senior researchers. Observers often tend to relate failure to higher rather than lower levels of the organization, in this case the project organization (Gibson & Schroeder, 2003). Hence, key employees are blamed and held responsible for failures – regardless of whether this policy is right or wrong.

However, in contrast to the discussed negative implications, failure as well bears upside potential – especially since failures, although painful, are found to be formidable learning opportunities (cf. Shepherd et al., 2011; Sitkin, 1992). It might represent the hardest and most inconvenient way to learn, but improvement potential becomes much clearer when objectives cannot be achieved and failure becomes transparent. Especially on the personal level, learning is supported, as colleagues and superiors talk about failures and a need for justification that might arise in everybody responsible for and working on the project, is likely to start digesting the incidents.

Due to the high number of failures in R&D organizations, two major responsibilities in handling project failure need to be considered: (1) safeguarding an appropriate NPD termination process and (2) ensuring learning from failure (Corbett et al., 2007). The important first part, proper project termination, aims primarily at optimizing the deployed resources and reducing respective waste by cutting-off any additional expenditures for the project at hand (Balachandra, 1996; Balachandra et al., 1996). The aspect of learning focuses on getting the most out of the terminated project despite its failure. Employing and leveraging a careful lessons-learned process might – although the initial objectives of the project cannot be met anymore – lead to important insights for future or surrounding projects (von Zedtwitz, 2002). This could even turn the failed project ultimately into a success, albeit with a different result than originally planned. Bill Gates concisely describes the importance of not neglecting existing failures: *"It's fine to celebrate success, but it is more important to heed the lessons of failure. How a company deals with mistakes suggests how well it will bring out the best ideas and talents of its people and how effectively it will respond to change"* (Fortune & Peters, 2001, p. 800). From a firm-level perspective, evaluating R&D project success based on the broader level of the whole organization seems important, as *"innovations often emerge from a chaotic sequence of innovation projects, described as an 'innovation journey'"* (Elmquist & Le Masson, 2009, p. 139). Thus, what is important is that learning across projects is a critical success factor within the development process of new products, regardless whether the knowledge is based on successes or as a byproduct from failed projects (Elmquist & Le Masson, 2009; Leonard-Barton, 1998).

Before starting to discuss the characteristics of learning in the specific setting of project failure situations, a brief general introduction and definition of the phenomenon of 'learning' needs to be given. Furthermore, I provide an overview and contrast two important types of learning for this dissertation: Individual learning, focusing on the individual perspective, and organizational learning rather directed towards the absorption of information and respective codification and exchange within larger teams and corporations.

2.5.1 Learning: Definition and facets of learning

In the corporate environment, many decisions need to be taken every day based on a broad variety of information and wealth of data points, originating from both internal and external sources. Therefore, a multitude of stimuli, information and data points need to be continuously captured, evaluated, interpreted and processed in order to derive conclusions and decisions based on relevant pieces of information, all within a limited amount of time (Daft &

Weick, 1984). After having collected and scanned available information in the first step, interpretation of data leads to the translation into meaningful constructs (Daft & Weick, 1984). Learning in this process represents the subsequent step of taking actions based on interpreted data and applying the results of cognitive processes (Argyris & Schön, 1978). Figure 4 provides an overview of this staged process.

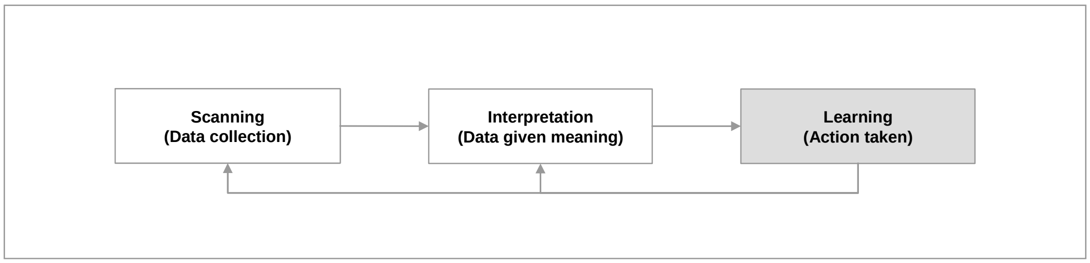

Figure 4: Relationships among organizational scanning, interpretation, and learning

Source: Daft & Weick, 1984, p. 286

Since during the learning phase again new insights and data are potentially generated, a feedback loop connects the three stages (Daft & Weick, 1984). A major source of information and data used to enhance knowledge is feedback obtained from past experience (cf. Minniti & Bygrave, 2001). Referring to Dweck (1986) and Elliott and Dweck (1988), Spreitzer, Sutcliffe, Dutton, Sonenshein, & Grant (2005) define learning as *"the sense that one is acquiring, and can apply, knowledge and skills"* (p. 538). Thus, one of its important characteristics is that learning leads to the application of this knowledge and skills to novel challenges and tasks, increasing the ability to master these tasks (Dweck, 1986; Elliott & Dweck, 1988). According to Shepherd (2003), learning occurs when this action results in the adaptation of existing knowledge which means *"to revise assumptions about the consequences of previous assessments, decisions, actions, and inactions"* (p. 320).

The process of learning, comprising extensive cognitive elements, is not a single, standardized process and different approaches to it are discussed in extant literature. The following paragraphs provide a short, fundamental overview of three categories of learning.

In its first dimension, learning can be differentiated in *individual vs. organizational learning*, thus discriminating which ‘unit’ performs and undergoes the learning experience. While individual learning embodies personal experience of an individual and knowledge acquisition through cognitive processes, organizational learning enhances the organizational memory (von Zedtwitz, 2002). Individual learning and the understanding of corresponding functionality of the human mind have been studied by psychologists extensively, but is still not understood exhaustively (cf. Kim, 2005 for an overview of contributions). According to Kim (2005), learning comprises two levels on the individual dimension: *“(1) the acquisition of skill or know-how, which implies the physical ability to produce some action, and (2) the acquisition of know-why, which implies the ability to articulate a conceptual understanding of an experience”* (p. 30). Hence, for employees in a company, it is important to learn content (know-how) as well as to understand its application (know-why) (Kim, 2005).

While individual learning leads to acquired knowledge in the form of personal memory, experience, and capabilities, organizational learning is even more complex and comprises more than just the sum of all individual learning (Fiol & Lyles, 1985; von Zedtwitz, 2002). In fact, knowledge indeed resides in both, the individual and the organization simultaneously and is continuously complemented, altered or even discarded based on cognitive findings from experiences (Madsen & Desai, 2010). A sound definition of organizational learning is given by Madsen and Desai (2010) as *“any modification of an* *organization's knowledge occurring as a result of experience"* (p. 453), concluding that successful learning of an organization can be observed through a change in performance.[3]

The quality of organizational learning is described in the well-acknowledged model of Argyris and Schön's concept of single- and double-loop learning (Argyris & Schön, 1978). This concept discriminates two levels: (1) Single-loop learning, which describes corrective actions after having recognized a deviation of expected and obtained outcome – without altering the underlying reference system. (2) Double-loop learning in contrast takes this process one step further and describes learning that modifies the reference system in order to improve the process sustainably (Kim, 2005). Signs of double-loop learning thus represent a higher quality of learning when discussing the learning results of the interviewees in the analysis part in chapter 5.2 of this dissertation. Interviewees that provided examples of adapted reference systems (e.g., processes or codified instructions) consequently show a higher learning achievement than interviewees who described lessons learned but which did not result in implemented adaptations of respective systems.

My research covers this first dimension explicitly with specific questions in the interview guideline. The two other dimensions are only covered implicitly, thus are discussed more briefly. The second dimension discriminates learning according to the source of information: *internal vs. external information*. External information is explicit by nature, based on the experience from others outside the organization and is available from a multitude of sources, e.g., published reports, databases, literature, consultants or information brokers (Lyytinen & Robey, 1999; Williams, 2008). External information often is required when own experience is missing, although it is regarded to be less advantageous as it is potentially available to competition as well. Moreover, the wide variety of available information from a

[3] The characteristic of required change of behavior is debated in literature, e.g., Huber (1991) claims that learning does not necessarily require a change in behavior but that the *"range of its potential behaviors is changed"* (p. 89), emphasizing that change could as well represent a new awareness which does not require a visible change.

multitude of sources might lead to follow a phenomenon of cognitive psychology, called confirmation bias, which results in looking for information that corroborates existing beliefs (Hedberg & Jönsson, 1978; Lyytinen & Robey, 1999; Nickerson, 1998). In contrast, internal information is based on own experience (e.g., information from colleagues, analyses or audits) and is regarded to provide a greater competitive advantage since this knowledge is likely to be tacit (Lyytinen & Robey, 1999; Williams, 2008). Nonaka and Takeuchi (1995) combine both dimensions in their dynamic model of organizational learning, which defines knowledge creation as *"social interaction between tacit knowledge and explicit knowledge"* (p. 61).

Last but not least, learning can be differentiated based on the time when the learning takes place: *Action* vs. *post-performance learning*. Action learning implies a learning-by-doing approach in situations where the amount of unknown information by far surpasses the known information (Corbett et al., 2007). In this case, learning itself is regarded as one of the major objectives of the development project, thus having an exploratory character. In contrast, post-performance learning implies that an organization derives lessons learned after a project has been finished or has been terminated due to failure (Corbett et al., 2007). In their research, Corbett et al. (2007) identified three clusters around which learning took place: (1) learning from execution (e.g., technical feasibility), (2) learning about competency gaps (e.g., lack of specialists) and (3) learning about fit of the innovation project with the company's strategy (e.g., following the wrong topics).

Bringing the theory into the perspective of this dissertation, every project can be regarded as experiment to test and validate existing theories through the evidence generated within the project (Lyytinen & Robey, 1999). As a consequence, organizational learning leads to the dissemination of the lessons learned and insights by adapting actions based on the accumulated internal experience and external information (Lyytinen & Robey, 1999).

Moreover, it is vital for companies to continuously extend their knowledge base. Learning is especially critically in R&D departments as learning *"is the precondition for sustaining significant improvements over long periods of time"* (von Zedtwitz, 2002, p. 256).

But it is also important to consider that learning does not happen automatically: *"Learning within a project does not happen naturally: it is a complex process that needs to be managed. Learning requires deliberate attention, commitment and continuous investment of resources"* (Ayas, 1996, p. 59). A survey on completed R&D projects indicated that 80% of all completed R&D projects lack a structured learning approach in the form of post-project reviews, and if they were executed often lack time and resources (von Zedtwitz, 2002).

Nevertheless, learning and knowledge creation in general are of utmost importance, especially in dynamic environments with high uncertainty (cf. McFadyen & Cannella, JR., 2004; Nonaka, 2007; von Zedtwitz, 2002). Therefore, the number of post-project reviews after failed projects is assumed to be higher, particularly as the setting of failure provides a very valuable basis for learning according to existing studies (e.g., Cope, 2011; Kim & Miner, 2007; Madsen & Desai, 2010; Shepherd, 2003; Shepherd et al., 2011; Sitkin, 1992). This significance of failure for learning is expressed by scholars in describing failure as *"key learning opportunity"* (Shepherd & Cardon, 2009, p. 942) or as *"potential engine for learning"* (Miner, Kim, Holzinger, & Haunschild, p. 239). Kerzner (2000) asserts that *"without 'discontinued' lessons learned, a company can quickly revert from maturity to immaturity in project management. Knowledge is lost and past mistakes are repeated"* (p. 129). An overview of reasons to actively manage learning from projects is provided by Williams (2008), who for example mentions the improvement of project management processes or the opportunity to apply the lessons in later phases of the new product development process to give only two examples. In general, Cooper regards the study of past failures and derived conclusions as one of the best ways to improve product development activities within corporations (Cooper, 1975).

After having established a general overview of the construct of learning, representing one of the key concepts explored within this dissertation, and having discussed the significance of learning in the corporate world, the following section provides an overview on extant literature dealing with learning from failure.

2.5.2 Learning from failure in extant literature

Although Cope (2011) points out that *"it is important not to necessarily privilege learning from failure over learning from success"* (p. 606), research indicates that people and organizations often have a higher learning experience from failure situations than after having experienced success. Referring to the Columbia Accident Investigation Board report (Columbia Accident Investigation Board, 2003), Madsen and Desai (2010) for example found that deliberate investigations resulting in learning happened only after the severe crash of the space shuttle Columbia in 2003 – although the same incident that led to the crash occurred earlier during the successfully completed mission of the Atlantis flight in 2002. If the broken insulation foam would have been given higher attention after the return of the Atlantis, the Columbia disaster might have been prevented. This example, backed by other scholars, indicates that when it comes to learning, investigation of problems after prior failures is likely to have a stronger impact on learning than investigation of successes (Madsen & Desai, 2010; McGrath, 1999; Sitkin, 1992).

One reason traces back to the fact that lessons learned from failure are more likely to be codified and embedded in processes and formal systems than experiences from successes, which are likely to reinforce existing systems and knowledge instead (Madsen & Desai, 2010). The impact of the magnitude of the failure – in the example of space ship Columbia a very severe and catastrophic event – on the significance of learning is discussed ambiguously in literature. While Sitkin (1992) argues that small failures generate higher learning results (as smaller failures are less threatening compared to large failures which would result in strong negative affective response and threat would truncate exploratory processes), Madsen and Desai (2010) concluded that organizations learn more from large failures than from smaller ones because (1) small failures do not bear significant consequences and thus might be redefined into successes and (2) small failures might be ignored – a reaction which is unlikely for large failures due to their visibility. It is not the intent of this study to answer this academic disagreement and discuss the relationship between magnitudes of failure and learning achievement; nevertheless it is of high importance that failure events constitute important opportunities to learn.

Table 2 provides a summary of key contributions with regards to the impact of failure on learning outcomes.

Table 2: Overview of studies to understand learning from failure

Author	Year	Context	Type of research	Summary of key findings
Baumard and Starbuck	2005	Corporate	Qualitative	Confirmation of problems to learn from successes. Small failures tend to reinforce core believes and foster incremental learning only. Large failures provide even less learning as predominantly attributed to external causes. Proposal that unlearning might represent prerequisite for learning from failure.
Cannon and Edmondson	2001	Organizational behavior	Conceptual	Barriers to learning from failure comprise damage to self-efficacy and self-esteem for individuals as well as risk of stigmatization and erosion of credibility for organizations. Small failures to communicate in work relationships can lead to major failures. Group-level beliefs can mitigate negative emotions that can arise in confronting failures.
Cardon and McGrath	1999	Entrepreneurial	Quantitative	Two approaches to learning from failure exist: (1) 'Helpless' reaction attributes failure to lack of ability and results in anxiety, depression, and a sense of shame. (2) 'Mastery' reaction attributes failure to lack of effort, seeking to redouble efforts and remain optimistic, recognizing failure as genuine learning experience. Predominance of mastery reaction to failure.
Cave et al.	2001	Entrepreneurial	Qualitative and quantitative	Stigmatization of failure in the UK as opposed to learning experience view in the US. All respondents reported lessons learned after failure, UK participants identified stigmatization, no problem for US respondents.

Table 2 continued

McGrath	1999	Entrepreneurial	Conceptual	Real options approach: key issue not to avoid failure but to manage its costs. Distaste for failure can lead to cognitive bias and avoidance of failure through direct manipulation. This anti-failure bias can interfere with learning from failure.
Scott and Lewis	1984	Entrepreneurial	Conceptual	Cultural norm in UK sees failure as negative, leading to breakdown in social relationships. Learning from failure may occur but not from all failures. Failure represents experience and may lead to more effective future actions.
Shepherd	2003	Entrepreneurial	Conceptual	Two ways of grief recovery (from failure and corresponding financial & emotional costs) prevail: (1) 'Loss orientation' involves active confrontation with the loss and process what happened to make sense of it. (2) 'Restoration orientation' is based on suppression and avoidance to distract from failure and achieve gradual fading of related memories. Most effective and fastest way to recover is 'oscillation orientation' meaning to oscillate between both orientations.
Singh et al.	2007	Entrepreneurial	Qualitative	Four aspects of life affected by failure: economic, social, psychological, and physiological. Two distinct coping strategies exist: (1) 'problem-focused' strategies that manage the problem faced and (2) 'emotion-focused' strategies, regulating emotional reactions. Learning occurs in these four areas of impact, particularly in psychological and social aspects for entrepreneurs.
Sitkin	1992	Organizational behavior	Conceptual	Complacency, myopia, and lack of experimentation are liabilities of success. Successes do not foster thoughtful processing. Small, 'intelligent' failures promote learning most effectively and are less challenging, not engendering a threat-rigidity response. Modest scale and that they are thoughtfully planned actions are key features of intelligent failures.
Stokes and Blackburn	2002	Entrepreneurial	Qualitative and quantitative	Failure encouraged respondents to continue entrepreneurial career and seen as positive learning experience. Most significant learning is personal management – coping with setbacks, self-management and adapting to change as well as learning about trust and relationships. Lessons learned lead to feeling of being better equipped and motivated to start next venture.

Source: Adapted from Cope (Cope, 2011, pp. 607–608)

In his conceptual work (see Table 2), Sitkin (1992) stated that failure has several beneficial implications: It drives to find solutions to problems; it fosters recognition of ambiguous outcomes and it motivates to change existing routines and stimulates action – which could be called 'learning'. Thus, when talking about learning from failure, it is important to recognize that the result is not only about knowing how to avoid the respective failure but rather the implementation of the lessons learned by adapting and modifying existing theories and adapt own actions (Lyytinen & Robey, 1999). An important prerequisite of learning is to identify a deviation of the expected from the obtained result, which obviously is easier to achieve in the case of failure and provides a clear signal to engage in learning (Sitkin, 1992).

A significant challenge, however, is to overcome the existing knowledge and actions that are in place – persistence and sticking to existing routines may prevent adaptation which might lead to 'failure to learn' as Lyyntinen and Robey (1999) framed it. When thinking about dissemination of acquired lessons learned in general, another critical issue to consider is that accumulated knowledge needs to be generalizable to ensure applicability and usability of the knowledge in different situations or projects (Williams, 2008). Therefore, to provide significant value to others in the organization, newly generated insights from failed R&D projects need to be processed and reconditioned to level out project-specifics before being made available to the organization.

2.5.3 Prerequisites and barriers to enable learning from failure

In failure situations, it is a common phenomenon that involved persons try to cover up failure as *"most people have a natural aversion to disclosing or even publicly acknowledging failure"* (Cannon & Edmondson, 2005, p. 302). Hence, before describing possible processes to ensure learning from failure, it is important to discuss prerequisites that allow lessons learned to happen. According to Fiol and Lyles (1985), several contextual factors support the effectiveness of organizational learning. These catalysts are: (1) a corporate culture that fosters learning, (2) flexibility of the strategy within an organization, being open to and permitting adaptation and change according to new insights. (3) An organizational structure that allows flexibility and the implementation of adaptations as well as (4) limited complexity of the internal and external environment, providing a basic stability of the organization, to enable learning and being able to map the environment (Fiol & Lyles, 1985). Taking the opposite perspective, Cannon and Edmondson (2005) present two classes of barriers that harm organizational learning from failure. In practice, organizations – regardless of size – rather perform the task of learning from failure inadequately (von Zedtwitz, 2002). In particular, they often miss to pay attention to small, ordinary failures (Cannon & Edmondson, 2005). Therefore, organizations need to address these barriers in order to successfully capture insights and knowledge from failed projects. On the one hand, barriers might be embedded in technical systems of the company, as they might technically prevent the diagnosis of cause-and-effect relationships, systematic data analysis or evaluation of statistics (Cannon & Edmondson, 2005). On the other hand, social barriers may prevent effective learning from failure. According to Cannon and Edmondson (2005), major social barriers are rooted in psychological reactions to failure: Not revealing own failures to maintain a good reputation and standing among their environment and the *"instinctive tendency to deny, distort, ignore, or disassociate themselves from their own failures"* (Cannon & Edmondson, 2005, p. 302). Moreover, inappropriate organizational structures, culture, and leadership can discourage failure identification, analysis, and experimentation (Cannon & Edmondson, 2005; Lee, Edmondson, Thomke, & Worline, 2004). A culture of blame, an anti-failure bias or a leadership style that encourages a finger pointing mentality often are deeply ingrained in organizations and prevent proactive learning from failure (Cannon & Edmondson, 2005).

Having addressed these prerequisites and barriers accordingly, organizations are prepared to capture valuable lessons learned by adopting the process steps introduced in the subsequent chapter.

2.5.4 Systematic learning from failure

What are the specific characteristics of learning in situations of project failure? As R&D projects are of temporary nature, organizations need to deliberately consider and pay attention to manage the accumulated knowledge during the project by having processes in place to collect, store, and embed it – otherwise generated lessons learned are likely to disperse (Williams, 2008). Shepherd (2003) emphasizes that the transfer of insights and lessons learned to other businesses in the entrepreneurial context (or to projects translated to the R&D context respectively) is vital and key to incorporate learning from failure. To provide a systematic approach, a three-step process of utilizing failure to learn, developed by Cannon and Edmondson (2005), is presented.

According to organizational behavior and social psychology literature, a trigger activates and facilitates learning (Hastie, 1984; Wong & Weiner, 1981; Zakay, Ellis, & Shevalsky, 2004). A crisis, to which failure can be subsumed, represents a trigger to initiate double-loop learning – or higher-level learning as Fiol and Lyles (1985) call it. Thus, failed R&D projects can be regarded as formidable starting points for organizational learning from failure (Fiol & Lyles, 1985). To make use of the trigger 'failed project', Cannon and Edmondson propose three key processes to ensure effective learning from it: (1) failure identification, (2) analysis of failure, and (3) deliberate experiments (Cannon & Edmondson, 2005). Implementing these steps, which are intended to be seen rather as independent competencies than as a process sequence, is the first step to achieve learning results within organizations after failure – albeit several other approaches exists (cf. Baum & Ingram, 1998; Cope, 2005, Cope, 2011; Huber, 1991).

The first step in the process of learning from failure represents at the same time probably the most important one: *failure identification*. It is a common observable fact that small failures, considered in isolation, often remain unidentified which in consequence leads to larger subsequent failures (Cannon & Edmondson, 2005). One obvious example is the previously introduced Columbia accident, in which small failures have not been identified or at least have been disregarded. These failures were not followed up with respective counter actions, resulting in repetition that ultimately led to a catastrophe (Columbia Accident Investigation Board, 2003). This phenomenon has two major origins: Firstly psychological barriers as humans tend not to reveal and ignore failure due to social norms as explained in the previous subchapter. Moreover, perceptions might have differed what failure constitutes, in particular team members' perceptions might differ of the customer view (Pinto & Mantel, 1990). Therefore, proactiveness and speed are key for failure identification. Both attributes are of utmost importance to foster learning, avoid repetition of the failure and thus minimize failure-related costs at the same time (Cannon & Edmondson, 2005). The second origin is missing availability of required data to identify failures as systems and processes often are missing to timely track key performance indicators (KPI) and indicate deviations for investigation quickly (Cannon & Edmondson, 2005). A well-suited mechanism to collect data and identify failures is feedback – either from outside (e.g., clients) as well as from inside (e.g., employees) – which nevertheless has to be actively driven and followed-up.

The second step or competency to learn from failure is the most obvious one: *analyzing failure*. However, organizations often lack thoughtful discussion and analysis of failures. For example, when analysis is restricted to large, significant failures only, platforms to discuss failures openly or the corresponding culture are missing (Cannon & Edmondson, 2005). Once again, social systems and human behavior interfere with the open and constructive analysis that is required to generate valuable insights. Learning from failure as analysis is often discouraged and psychological barriers (e.g., tendencies to attribute failure to others or denying responsibility) hinder to identify unpleasant truths (Cannon & Edmondson, 2005). Another observed practice related to an anti-failure bias is blaming failures to external reasons (e.g., market developments that led to a product flop). To achieve learning, organizations need to install and safeguard rigorous formal analysis processes, equipped with the necessary expertise (including external resources if required), and offensively approach failure with high management attention (Cannon & Edmondson, 2005). An adequate documentation of analysis results and explicit derived recommendations, combined with a methodology to share and manage the information facilitates the subsequent implementation.

With the third phase, Cannon and Edmondson propose a more proactive approach towards learning from failure by pursuing *deliberate experimentation*. This means, that part of the work is devoted to experimenting and actually trying out new things, allowing disconfirmation and seeking to discover new ways, opportunities and ideas – however obviously associated with a higher risk of failure. Precondition to successfully execute experimentation is that the rewarding mechanisms within the organization acknowledge not only successes but failure as well. Following this approach bears a significant upside potential, as experiments are likely to generate more innovative and novel solutions or product ideas. Only few companies, like the 3M Corporation, have implemented this approach so far (Cannon & Edmondson, 2005).

An underlying prerequisite for all three processes is that organizations provide sufficient resources to effectively implement the respective activities. Sitkin (1992) extends this requirement by pointing out that: *“Merely allocating resources is not sufficient for 'achieving' adequate failure levels. It is also important to monitor and reward failure, just as the firm monitors and rewards other aspects of an employee's or department's performance”* (p. 253).

But how does learning from failure happen in practice? What are prerequisites to learn from failure and become better? As described in the preceding chapters, personal learning from failure represents a widely discussed topic in research. On a more general level, organizational learning has as well been analyzed. I want to clarify how organizational learning happens in the specific context of R&D organizations. My research has the objective to shed a light and extend knowledge on these questions at hand.

Before the discussion of the questions based on the case content will be given, chapter three presents the design and methodology I used in this research to support the proper understanding of the results achieved from the empirical evidence.

3 Design of empirical investigation and methodology

In this chapter, the research design and approach applied during the empirical investigation will be illustrated. It starts with an explanation of the employed research strategy including the case study design and an explanation of how reliability and validity of the research was ensured. Second, an overview on the data collection process and data sources used will be given. Third, the rigorous data analysis process will be described, including an overview on the coding and assessment procedure.

3.1 Selection of research strategy

Fundamentally, research strategies in the field of social science can be differentiated into quantitative and qualitative approaches to investigate empirical evidence [cf. (Flick, 2007; Glaser & Strauss, 1967; Morgan & Smircich, 1980). While quantitative research strategies rely on non-verbal data to investigate theoretical frameworks and existing theory, frequently assuming an objective reality, qualitative approaches build on verbal data and on a subjective understanding of the phenomenon under investigation (Henwood & Pidgeon, 1992). The underlying epistemological element of quantitative research is the critical rationalism, based on Karl Popper in the 1930s (Popper, 1989). According to Popper and his school of thought in critical rationalism, science is based on deduction of hypotheses and in the next step attempts to falsify them, representing the key principle of quantitative research (Locke, 2007). The quantitative methods used thereby in social sciences primarily base on methods used in natural science and are applicable, when viewing *"the social world as a concrete structure"* (Morgan & Smircich, 1980, p. 498). In qualitative research, however, induction by *"proceeding from particulars to the general"* (Locke, 2007, p. 870) prevails, in most cases with an open collection of data (Kelle, 1994). This approach is – in contrast to quantitative methodology – more suitable when recognizing *"that the social world constitutes some form of open-ended process"* (Morgan & Smircich, 1980, p. 498). Given the context of this dissertation and a limited prevailing extant theory, a falsification approach seems hardly possible, thus favoring an inductive approach. In general, following several researchers (cf. Glaser & Strauss, 1967; Miles & Huberman, 1994; Morgan & Smircich, 1980), qualitative research has become increasingly established and accepted to expand knowledge on organizations.

A different perspective to determine which research approach, hence type of data, is appropriate for theory building take Edmondson and McManus (2007), who introduce that nascent theory (e.g., inductive research to understand how processes work or to explain phenomena in areas where no or only little theory prevails) is best to be built on qualitative data. Arguing "*that methodological fit promotes the development of rigorous and compelling field research"* (Edmondson & McManus, 2007, p. 1169), the authors provide as a result of literature analysis the model displayed in Figure 5 as guideline to design field research. They argue that the maturity of theory in the respective field (axis of abscissa in the graph) should influence the design, hence the type of data of the research (axis of ordinates respectively), whereas the diagonal line *"represents a mean tendency in effective field research"* (Edmondson & McManus, 2007, p. 1168) and the oval area allows for leeway in the design. Nevertheless, the recommendation does not imply a rigid rule, e.g., a qualitative approach to identify new aspects in a relatively mature area of research (point B) could still deliver interesting insights. Combining nascent theory with a quantitative research design (point A), however, seems to represent a less successful approach (Edmondson & McManus, 2007). Given the fact that the area of my research, terminated R&D projects in companies has not been investigated extensively yet and my aim is to understand the phenomenon of R&D

project termination and learning from this experience, I follow the model of using a qualitative approach as suggested by Edmondson and McManus.

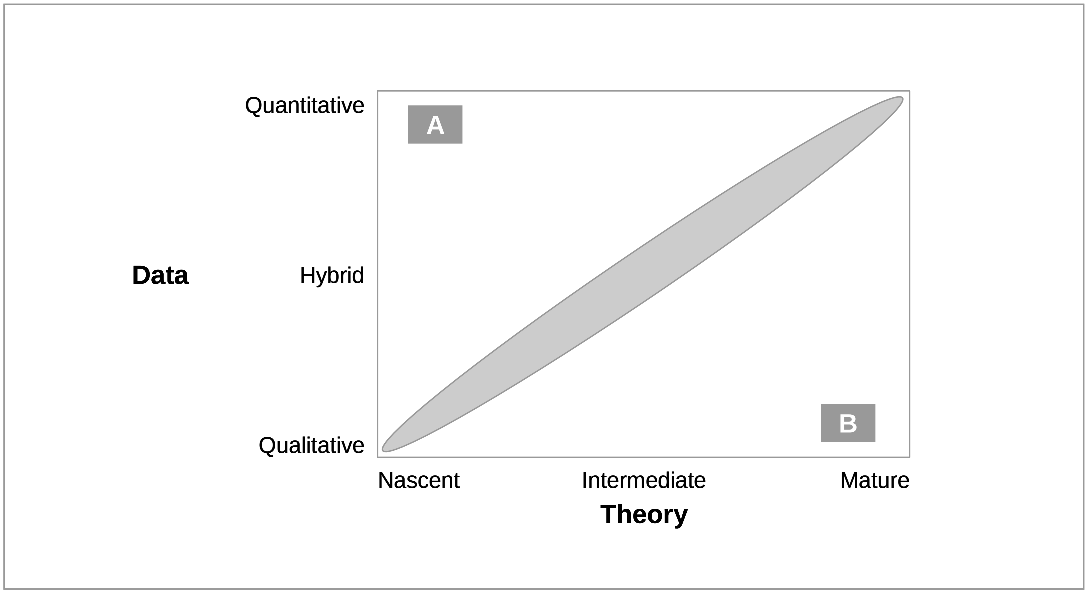

Figure 5: Methodological fit as a mean tendency

Source: Edmondson & McManus, 2007, p. 1168

According to Yin (2009), research strategies can be differentiated into five general categories: experiments, surveys, archival analyses, histories, and case studies. To decide on the suitable research method, three criteria can be applied: *"a) the type of research question posed, b) the extent of control an investigator has over actual behavioral events, and c) the degree of focus on contemporary as opposed to historical events"* (Yin, 2009, p. 8). Moreover, his categorization of research questions in *"'who,' 'what,' 'where,' 'how,' and 'why' questions"* further support the decision on the appropriate methodology (Yin, 2009, p. 9). Snow and Thomas (1994) complement the discussion by matching these questions with the purpose of theory to be investigated, which they divide into 'description', 'explanation' and 'prediction'. Eisenhardt (1989a) concludes that case studies are especially appropriate when new theory needs to be generated: *"building theory from case study research is most* *appropriate in the early stages of research on a topic or to provide freshness in perspective to an already researched topic"* (p. 548).

Compared to other research strategies, Yin (2009) points out that case studies are especially well suited for 'how' and 'why' questions and for the comprehensive analysis of contemporary events where the researcher cannot manipulate the relevant behaviors. For the explanatory purpose of my study with research questions of 'how' and 'why' character and the investigation of contemporary R&D project terminations (please refer to chapter 1.2 for the research questions in detail), the case study approach thus appears highly appropriate. Furthermore, I am building on direct observations and make use of a distinct case study feature: *"its ability to deal with a full variety of evidence-documents, artifacts, interviews, and observations"* (Yin, 2009, p. 11). This richness provides an ideal basis for the case study approach and is likely to lead according to Eisenhardt and Graebner (2007) to solid theory: *"since it is a theory-building approach that is deeply embedded in rich empirical data, building theory from cases is likely to produce theory that is accurate, interesting, and testable"* (pp. 25–26). In addition, the fact that limited extant theory is available requires a profound understanding of the circumstances and the procedures in the respective situations, favoring the case study approach conducted as an inductive study. Last but not least, the high sensitivity of the topic with regards to intellectual property requires intimate interview situations ensuring complete confidentiality and anonymity after the interviews and throughout the subsequent research process. Personal, one-on-one interviews and guaranteed anonymization created a trustful atmosphere, which fit the sensitive topic. Conducting one-on-one interviews moreover provided the upside of achieving deeper insights that would not have been possible to be gained in other settings or from other sources, e.g., questionnaires.

Taking these criteria into account and in line with Eisenhardt and Graebner's (2007) assessment of the relevance of case study methodology *"that it is one of the best (if not the* *best) of the bridges from rich qualitative evidence to mainstream deductive research"* (p. 25), I deliberately selected the case study approach for this dissertation and provide a more detailed description of the approach in the next chapter.

3.2 Case study design

Before defining the design of the case study applied in this dissertation, a general definition of the construct 'case study' needs to be provided. Yin (2009) gives a basic definition of the concept:

> "*A case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident. […] [It] copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as a result relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result, benefits from the prior development of theoretical propositions to guide data collection and analysis*" *(p. 18).*

Following Yin (2009), case studies can be discriminated along three dimensions: (1) types of research purpose (explanatory, descriptive, exploratory), (2) number of cases (single, multiple), and (3) number of units of analysis (single-holistic, multiple-embedded).

I use an explorative, multiple and embedded case study approach (Eisenhardt, 1989a; Yin, 2009). As described above, the missing extant literature on the research questions for terminated R&D projects of this dissertation favors an explorative approach to build a better understanding of the phenomenon. Concerning the number of cases used, Yin (2009) argues that insights from analyzing and contrasting multiple cases are more compelling and robust. At the same time he claims the disadvantage of more extensive resource requirements, which could be solved by the invested time for this dissertation. Eisenhardt (1991), too, favors the multiple case study approach since multiple cases *"develop [a] more elaborate theory"*, and

“[…] the researcher can draw a more complete theoretical picture” (p. 620). The overall number of cases of eight was limited by the availability of suitable failed R&D projects passing a critical mass required for an in-depth analysis.[4] However, this does not necessarily compromise quality as Eisenhardt (1991) concludes on the number of required cases:

> *“[…] a debate over numbers obscures an essential point. The concern is not whether two cases are better than one or four better than three. Rather, the appropriate number of cases depends upon how much is known and how much new information is likely to be learned from incremental cases” (p. 622).*

An embedded case design prevails as I discriminate between three organizational levels, thus considering multiple views on the research questions and achieving a greater richness (Bourgeois III & Eisenhardt, 1988) (see below for a more detailed description).

As described in chapter 1, a major goal of this study is to gain a deeper understanding of learning in the context of failed projects in R&D organizations. Consequently and as suggested by Yin (Yin, 2003a, Yin, 2003b), I contrast cases of projects that were terminated in which team members learned a lot from their experiences with cases of projects that were terminated in which team members learned little from their experiences. My approach for assessing the team members’ learning for each case is described in detail in chapter 5.2. Based on commonalities within this categorization of cases and differences across them, a model emerges that informs the role of the ‘who’, the ‘when’, and the ‘how’ of termination in understanding the cognitive and emotional outcomes of project failure.

I begin by exploring terminated R&D projects, representing the main level of analysis in this dissertation, nested within different subsidiary organizations of one multinational organization. The multinational organization operates in the energy technology industry,

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[4] The objective was to base this research on full-scale R&D projects, executed by teams working full-time on them in order to ensure a high commitment and emotional involvement of the respective team members. Small, part-time projects with only little involvement of the employees were not expected to show as clear consequences of project failure as those team members would still pursue other major activities while not losing their real content of everyday work life.

manufacturing a wide range of cutting-edge products. It has sales of more than $20 billion US-Dollar, over 50,000 employees, and spends approximately $1 billion US-Dollar on R&D. This significant R&D investment is a cornerstone to ensure a sustainable business in a highly competitive market. Equipped with a broad portfolio of research activities and development projects from basic research to customer-initiated developments, not all projects of the organization achieve their targeted results (consistent with other R&D organizations); hence several projects have been terminated recently, offering an ideal base for my research.

Given the setting of R&D projects in a high-tech company, the initial challenge was to identify and discover suitable projects to build the cases from as terminated projects before achieving their targeted objective are typically not communicated externally but rather shrouded in secrecy. Thus, a theoretical sampling of cases by doing desk research was not practicable. To overcome the hurdle, I identified failed projects to be potentially included in the study by discussions with (1) the Chief Technology Officer (CTO) of the parent organization, (2) technology and innovation managers of the parent organization, (3) managers of the strategy department of the parent organization, and (4) top managers in targeted subsidiary organizations. More than 40 telephone calls and meetings with members of the above mentioned groups were required upfront. For the initial, complete set of cases, I identified four subsidiary companies and chose two terminated projects within a subsidiary company, representing eight cases in total. To select the projects for investigation, the last and the most substantial terminated project of the respective subsidiary have been chosen. Brown and Eisenhardt (1997) described the excellent suitability of the subsidiary company (which is equivalent to a strategic business unit) as central unit of analysis *"because of its centrality in the product innovation process"* (p. 4). The subsidiary organizations are focused on (1) high efficient conventional electricity generation products, (2) fast growing decentralized electricity generation products, (3) highly efficient conventional electricity systems, and (4) leading technologies for electricity distribution. All subsidiaries are actively engaged in R&D – R&D projects ranged from $0.75 million US-Dollar to $150 million US-Dollar. Thus this dataset is ideal for studying failing R&D projects and their termination.

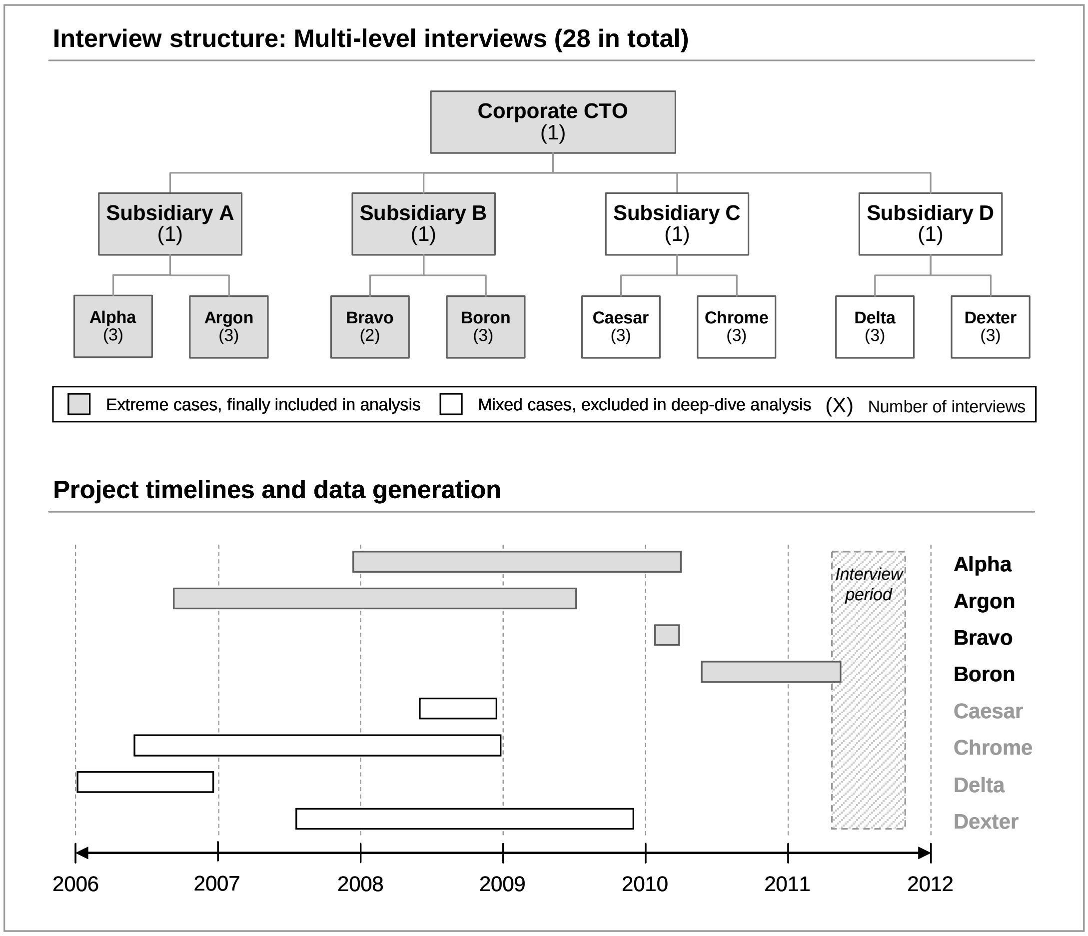

Figure 6: Overview of interview structure and timelines

Source: Own illustration

Figure 6 provides an overview of the interview structure, comprising three organizational levels and the eight selected projects. Furthermore, it indicates the timelines when the respective projects have been executed as well as the period the interviews have been conducted in.

As a result and as opposed to statistical sampling in quantitative research, I followed the theoretical sampling approach, which is appropriate when developing theory as particularly suitable cases to illustrate the research questions are selected (Eisenhardt & Graebner, 2007). For the central part of my analysis, I selected terminated projects in which all members' learning was high (two terminated projects) and terminated projects where all members' learning was low (two terminated projects), which are highlighted in grey in Figure 6. I determined learning by the members' reports on new knowledge generated from their experience with the terminated project. Two raters independently assessed each semi-structured interview of team members for learning, classifying each member of each project as 'High', 'Medium' (for a clearer picture dichotomized into 'Medium-high' and 'Medium-low'), or 'Low' (for details see chapter 3.5.3). Following the suggestion of Eisenhardt (1989a) to apply a theoretical sampling approach to *"provide examples of polar types"* (p. 537), I eliminated the four 'mixed' projects, where some members of a team were rated as high learning and others members of the same team were rated as low. Extreme cases at either end of a continuum provide greater contrast for theory building (consistent with the multiple case study method [Yin, 2003a, Yin, 2003b]). This means, that recognition of patterns, relationships, and central constructs are supposed to be clearer and more easily to achieve (Eisenhardt & Graebner, 2007). Fortuitously (not by design), the two terminated projects with high learning by all the team members were in the same subsidiary organization and the two terminated projects with low levels of learning by all team members were in the same subsidiary organization (but different to the high learners). In Table 3, details about the projects, subsidiaries, and parent organization used in this study are provided. Both projects of subsidiary A, which operates in the area of centralized conventional electricity products and systems, have a comparably high budget. Project Alpha had been started with the objective to achieve higher performance levels, thus finally representing the next generation of the product line. Around 1,500 man months had been invested before the project had been put on hold for an indefinite time and ramped-down. The investment of project Argon has even been more than four times as high, when the subsidiary tried to develop a major upgrade of the existing product. The two remaining projects in focus of this dissertation are housed in subsidiary B, a player in decentralized energy production from alternative forms of energy. Here, the first project Bravo was significantly smaller in terms of investment due to the fact that a small team tried to change the raw material of the products. The second project called Boron, however, again comprised a significant investment of approximately 5,000 man months. As the project was aiming at setting up a new manufacturing location, the budget nevertheless was with ~$16 million USD smaller than the projects of subsidiary A.

Table 3: Details about the projects, subsidiary companies, and parent organization (while maintaining confidentiality)

Parent Organization	
General:	A large multinational player in the energy technology industry
Sales:	>$20 billion USD
Employees:	>50,000
R&D investment:	~$1.0 billion USD

Subsidiary A		Subsidiary B	
General:	Centralized conventional electricity-generation products and systems	General:	Decentralized, alternative energy products
Sales:	>$10 billion USD	Sales:	>$3 billion USD
Employees:	>10,000	Employees:	>3,500
Project Alpha		*Project Bravo*	
General:	Development of new product generation to enter new performance level	General:	Material innovation: introduction of new raw material for serial production
Budget:	~$30 million USD	Budget:	~$0.75 million USD
Man months:	~1,500	Man months:	~3
Project Argon		*Project Boron*	
General:	Major upgrade of existing product generation, corresponding to new development of major components	General:	Development of new manufacturing location, ramp up of local production
Budget:	~$140 million USD	Budget:	~$16 million USD
Man months:	~4,000	Man months:	~5,000

Subsidiary C		Subsidiary D	
General:	Highly efficient conventional electricity systems	General:	Leading technologies for electricity distribution
Sales:	>$3 billion USD	Sales:	>$2 billion USD
Employees:	>5,000	Employees:	>5,000
Project Caesar		*Project Delta*	
General:	Design to cost project: increase of cost position by change of material for key components	General:	Development of new product platform to achieve higher capacity level
Budget:	~$1 million USD	Budget:	~$2,5 million USD
Man months:	~100	Man months:	~150
Project Chrome		*Project Dexter*	
General:	Development of new product generation to improve performance and efficiency	General:	Development of a new product line to expand existing range of products
Budget:	~$10 million USD	Budget:	~$40 million USD
Man months:	~500	Man months:	~3,600

Source: Company publications, internal company reports, and emails (for project data)

3.3 Validity and reliability of the study

One common criticism of qualitative research, especially expressed by researchers following a positivism scientific approach, is as already mentioned that case study research in general is subjective and interpretive (Flyvbjerg, 2006). As described earlier, the purpose of this dissertation is neither to give a judgment on philosophy of science nor to solve the ongoing dispute among followers of qualitative and quantitative researchers (Bryman, 1984; Morgan & Smircich, 1980). Nevertheless, following a rigor and transparent research approach, I want to discuss the potential pitfalls to avoid unreliable research and explain how I managed to ensure a valid and reliable approach within this dissertation.

According to Yin (2009), there are four major criteria that are *"commonly used to establish the quality of any empirical social research"* (p. 40) and thus can be applied as well for in case study research: (1) construct validity, (2) internal validity, (3) external validity, and (4) reliability. In general, the measures of validity (1-3) address the question whether the research measures what it is intended to measure, whereas reliability (4) addresses the fact whether the findings of the study can be repeated, thus having a stable and precise measurement under stable conditions (Mayring, 2010). Yin (2009) described deliberate tactics to address the above-mentioned criteria in case studies, which have been applied in the design of this dissertation. Hence, I am giving a brief overview of how validity and reliability have been addressed in an adequate manner in the following paragraph.

(1) *Construct validity* refers to the development of correct operational measures for the concepts under investigation. Following Yin (2009), I ensured construct validity by using multiple sources of information to find the evidence through triangulation among the different data sources and through triangulation of different investigators during the analysis (Patton, 2002). Moreover, I use a chain of evidence by documenting findings through ample data,

especially interview quotes in the body of this dissertation as well as in numerous tables throughout the analysis section.

Although (2) *internal validity* is less important for exploratory research than for explanatory and causal studies, I nevertheless paid attention to causal relationships in order to present correct findings and conclusions (Yin, 2009). I achieved a sufficient level of internal validity by making ample use of pattern matching during the data analysis, especially in the cross-case analysis as well as by performing explanation building, always iteratively comparing data and findings from individual cases and perspectives to build a general explanation fitting all cases (Yin, 2009).

(3) *External validity* describes whether the findings and conclusions of the research can be generalized beyond the cases studied. However, it is important to differentiate between statistical and analytical generalization (Yin, 2009). While research based on surveys, following statistical generalization, is intended to generalize from the sample to a larger universe, case studies intend an analytic generalization. This means that a defined set of findings is generalized to some broader theory (not necessarily to the total population), ideally by following replication logic, seeking for replication of results obtained across multiple cases (Yin, 2009). In my study, external validity is ensured by the replication of results and conclusions across different cases within the multiple case study approach. Thus, the conclusions have been established for the domain of R&D organizations in high technology companies.

Last but not least, (4) *reliability* of the research, i.e., generating identical results that would also be achieved by a second investigator repeating the research by following the same approach and procedures, needs to be ensured (Yin, 2009). This has been partly achieved by following the tactics of Yin, namely of applying a case study protocol (please refer to appendix 2 for further details) and developing a case study database by organizing and storing the collected data of the cases (e.g., interview transcripts, field notes, internal documents and emails, information available in separate folder to ensure the guaranteed confidentiality). Moreover, I tried to make the analysis process as transparent as possible in this dissertation, for example by documenting the coding scheme (see appendix 3) or by detailing the categories including definitions for each respective level in the analysis part (refer to chapter 3.5.3 for a detailed description). Reliability of coding is commonly evaluated by an inter-coder reliability test. However, this test has not been performed in this research as an inter-rater agreement measure has been regarded to be more important to ensure reliability (for further information see chapter 3.5.3). For the purpose of this dissertation, I consider the evaluation of the quality of an interview statement (e.g., whether a statement represents a high or a low level of learning) significantly more critical than coding text passages from the interviews to the right categories. Furthermore, as I conducted all interviews myself, I was deeply familiar with the respective context and interviewees, a coding of a second person new to the interviews would make limited sense (Pratt, 2009). Therefore, the focus of the second researcher, engaged to ensure objectivity and non-biased findings within the research, concentrated on review and verify the assessments of the coded passages. Nevertheless, she as well had a close eye on the coding as well by completely reading several interviews alongside making the assessments to get a comprehensive picture of the projects and interviews. Thus she was checking the coded passages simultaneously while evaluating the interview quotes and by this safeguarding the coding process as well. In addition to having a second author reviewing all assessments made, the supervision by two professors with profound knowledge of the research topic at hand should have supported a consistent approach as well. Last but not least, detailed quotes in the body and tables of this dissertation taken from transcripts and other documented sources on which the propositions and conclusions are drawn upon should support the reproducibility of the results by third persons. As a result, theory building is linked very closely to empirical data leading to the fact *that "resultant theory is often novel, testable and empirically valid"* (Eisenhardt, 1989a, p. 532).

Nevertheless, the objective of this case study research is rather to generate first propositions on the limited knowledge of R&D project failure and its implications for employees and organizations than to develop a completely generalized theory. The findings and proposition of this dissertation should provide the basis for further research and testing for a general theory in the final step. In the words of Suddaby (2006): *"Grounded theory is not perfect. […] It was founded as a practical approach to help researchers understand complex social processes"* (p. 638).

3.4 Data collection

Yin (2009) recommends not to use one single source of evidence for case study research, but to triangulate the data of several different sources. The concept of triangulation is commonly applied in navigation and refers to the use of multiple sources of reference to determine the exact position of an object (Smith, 1975). Applying this concept in qualitative research, *"researchers can improve the accuracy of their judgments by collecting different kinds of data bearing on the same phenomenon"* (Jick, 1979, p. 602), thus corroborating results and conclusions by considering several different data sources in the analysis process (Eisenhardt, 1989a; Yin, 2009).

Using this distinct advantage of triangulation, data on each case was collected through interviews, observations, and archival sources. As mentioned earlier, a key requirement for the company was ensured anonymity and confidentiality for all data that is used for this research. As a result, the company was very open towards the investigation and did not drive the data collection towards its own interests. I was fully able to follow my defined research path and focus on the relevant questions while collecting the data, not limiting the methodological fit adequate to the context at hand (Edmondson & McManus, 2007).

3.4.1 *Interview approach and setup*

Consistent with many studies using the multiple case study approach (e.g. Eisenhardt, 1989b; Gilbert, 2006), the primary source of data was semi-structured interviews. According to Eisenhardt and Graebner (2007), interviews are *"a highly efficient way to gather rich, empirical data"* (p. 28) and allow including subjective feelings, emotions and opinions – information that cannot be obtained from other methods of collecting data.

For each case – terminated project – I interviewed four types of respondents. The first two types were members of the team on the terminated project – *employees* (lower level team members) and the *project leader*. The next level included a member of the *top management of the subsidiary organization*. At the highest level I interviewed a *top manager of the parent organization*. Therefore, each case consisted of two employee project members, the project leader, a top manager of the subsidiary organization, and a top manager of the subsidiary firm (the one exception is terminated project Bravo, which had one [rather than two] employee level team members). At the employee and project leader level, all informants were engineers, and, consistent with Brown and Eisenhardt (1997), top managers were a mixture of vice presidents of technology and marketing. Figure 7 provides an illustration of the multiple sources for data collection I used in this study and the respective periods of time of collection.

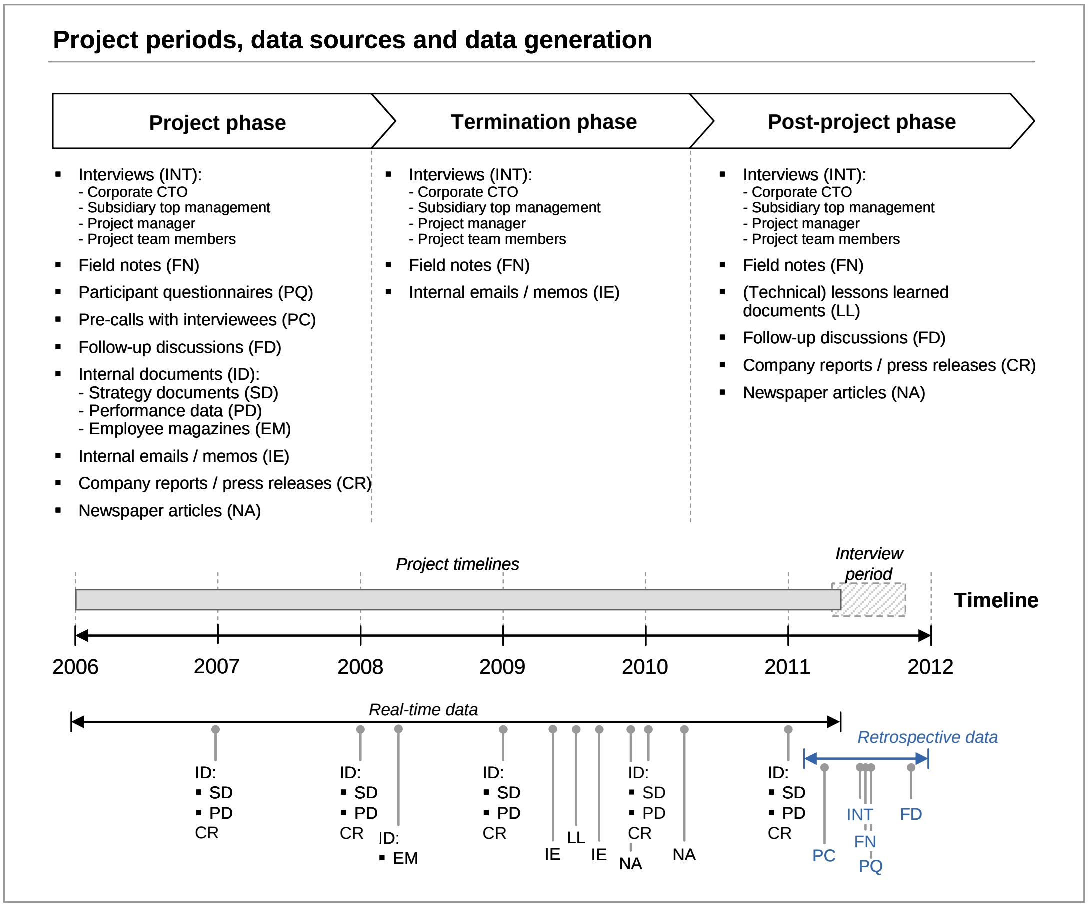

Figure 7: Overview of the multiple data sources

Source: Own illustration

Identifying the required persons for the interviews often provides a challenge (cf. Flick, 2007), especially from outside of the respective organizations. To identify the right people with the required knowledge of the R&D projects to answer the areas of interest of my research, I used the previously mentioned discussions with various managers of the organizations to identify the suitable projects to be included. After having identified the respective projects, I used the opportunity to either directly obtain the names of interview candidates or to identify contact persons to support the identification of the interviewees. In doing this, I also stressed and ensured to select the most suitable interview candidates with a particularly high exposure to the interview topics based on the assessment of the managers or the contact persons familiar with the project. This approach had another advantage as I could refer to the respective managers as reference points supporting my work when contacting the interview candidates afterwards. Moreover, it proved to be crucial given the confidential topic of R&D projects and – even more critical – of failed projects, to establish a situation of trust right in the beginning when contacting the prospective interview partners. Being able to mention the support of management proved to be a formidable entry and building on that, I subsequently focused on creating a trustful and confidential atmosphere by ensuring that all obtained information will be made anonymous before further processing and described the research and data analysis process in detail to them (Miles & Huberman, 1994). Last but not least, offering to provide all participants with the results of the study, combined with the opportunity to have a personal discussion on it, further raised the willingness to participate in my research.

As a result, I conducted in-depth interviews over a four-month period at the respective office locations. Exceptions include a phone interview with one manager (he could not be at the interview location due to an unexpected business event) and a phone interview for one project employee who had been assigned to a different continent. I taped and then transcribed all interviews. I conducted 15 interviews in the respective native language of the interviewees and the rest in English. Those in the native language were transcribed in that language, then translated into English, and the translation was verified by a second researcher who is fluent in English and the native language of the interviewees. Interviews typically lasted about 90 minutes, but some were as long as two hours. The interviews have been complemented by a short questionnaire to capture background information on the interviewee as well as quantitative data on the respective projects, both aiming at achieving a better understanding of the person and the project in the respective interviews.

3.4.2 Interview questionnaire, pre-test and execution

On the question on how to design the interview questionnaire, Edmondson and McManus (2007) point out that: *"In general, the less known about a specific topic, the more open-ended the research questions, requiring methods that allow data collected in the field to strongly shape the researcher's developing understanding of the phenomenon"* (p. 1159). I followed this open approach while designing the semi-structured interview questionnaires for all three levels of investigation. Various types of interviews exist (e.g., focused, narrative or standardized interviews) in social sciences (Gläser & Laudel, 2010). The advantage of the chosen semi-structured interview lies in its character to ensure the coverage of mandatory key questions and areas of interest to be covered in each interview and at the same time allows flexibility in the exact phrasing and sequence, thus allowing more deeper conversations than just answering standardized pre-defined questions (Gläser & Laudel, 2010). The interview guidelines included open questions to capture the explicit knowledge combined with more specific questions to support the inclusion of more implicit knowledge of the interviewees (Flick, 2007). The more closed questions have been asked when required, depending on the information that has been revealed through the open questions.

To prepare the data collection, I performed a real-life pre-test of the semi-structured questionnaire during an interview with a senior executive of a subsidiary that had a three-digit million US-Dollar project failure to evaluate the applicability before entering the cases selected for this research. This pre-test delivered important insights and helpful feedback to further improve the semi-structured questionnaire by focusing on the relevant questions and content according the topic of interest in the R&D environment. Since the industry structure of the business the pre-test was executed in was very similar to the ones included in this research, the test was particularly helpful in deciding on the appropriate questions and focus to finalize the interview guidelines and enter the interviews for this dissertation.

The project team members' interviews were structured into five sections: (1) the nature of the project (e.g., the technology, the target market, the size and composition of the team, and the resources invested into the project), (2) the termination event (e.g., how it was terminated, by whom, whether it was anticipated, and if they agreed with the decision) (3) the emotional reaction (if any) to the termination, (4) organizational processes related to project terminations (e.g., processes or routines for regulating emotions, processes or routines for generating/capturing feedback about failed projects), and (5) learning from the experience and moving forward (e.g., had they learned from the experience, how and when they were redeployed). I used a similar structure (but slightly different questions) for the top managers of both the subsidiary and parent organizations, which however needed to be adapted concerning the level of detail and for questions on management level to capture the overarching perspective. Furthermore, I included questions asking on the perception of how the respective (higher or lower) level experienced the situation. This serves on the one hand to link the hierarchical levels (triangulation of different interview levels and viewpoints) and achieve a more complete picture and on the other hand to reveal possible differences in perception among the hierarchical levels. For an overview on the project level interview sections and key content, please refer to Figure 8. A detailed version of all semi-structured questionnaires including interview questions can be found in appendices 4 - 6.

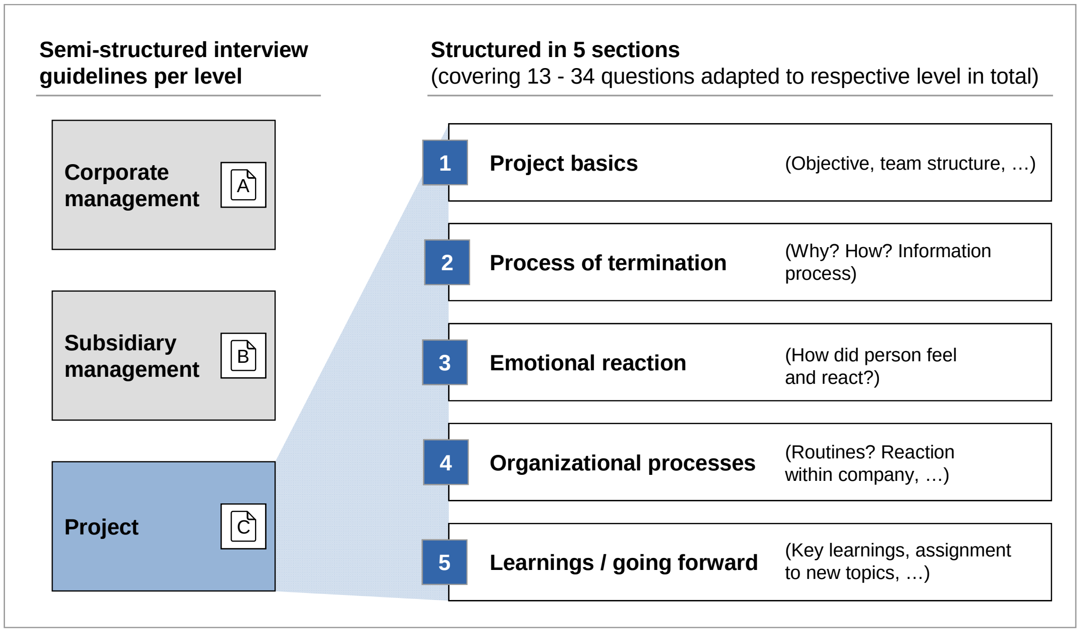

Figure 8: Overview of the project level interview questionnaire

Source: Own illustration

After a short mutual introduction and clarification of the topic and terminology used, all interviews started with narrative elements to enter the discussion and 'break the ice' before moving on to the increasingly tangible questions when following the semi-structured interview guidelines. An agenda indicating the five categories on project level helped to structure the interview and to guide the discussion. At the end of the interview, each interviewee had the opportunity to mention whatever critical information from his point of view has not been asked for or was missing concerning either the discussed topics or as well issues of interest in the larger context. By including this very open question to conclude the interviews, I ensured a sound and complete interview as each interviewee had the opportunity to include missing parts of information or – as it was used in some interviews – to recapitulate the most important issues, thus laying a particular emphasis on key information. In total, the transcripts comprised roughly about 800 pages and provided a rich data source for the process of theory building in a later step.

3.4.3 Additional data sources

In addition to conducting interviews, while on site, I had the opportunity to take notes on my impressions and other observations as I engaged in factory tours, product demonstrations, coffee breaks, lunches and other informal discussions around the interviews (Yin, 2009). These observations complement the information obtained within the interviews in the following analysis part and have been thoroughly documented in interview reports shortly after having conducted the interviews to ensure completeness and correctness.

Further, I supplemented data from interviews and observations with archival records and additional interviews with employees of the central technology office and strategy department. A large part of this information was only available within the organization, for example, project level and subsidiary level performance data including internal strategy and reporting documents, internal memos/emails and employee magazines. Some archival records were publicly available, such as, company reports, company press releases, newspaper articles, trade magazines, and analyst reports. Please refer to Figure 7 in chapter 3.4.1 for an overview on all sources used. The data collection of this research is mainly based on the interviews and archival records of the company, as the publicly available data may lack the scientific rigor, thus have been carefully used serving only to complement the other sources (Yin, 2009, p. 103). Nevertheless, a triangulation with the residual sources has been performed to achieve a more complete and comprehensive picture of the specific situations and events within the respective projects.

3.5 Data analysis

Although data collection and data analysis often overlap, I use a consecutive process chart in Figure 9 to provide an overview of the research methodology and the applied analysis approach in more detail. Having achieved to gather a comprehensive data set, this chapter describes the data analysis approach of my research.

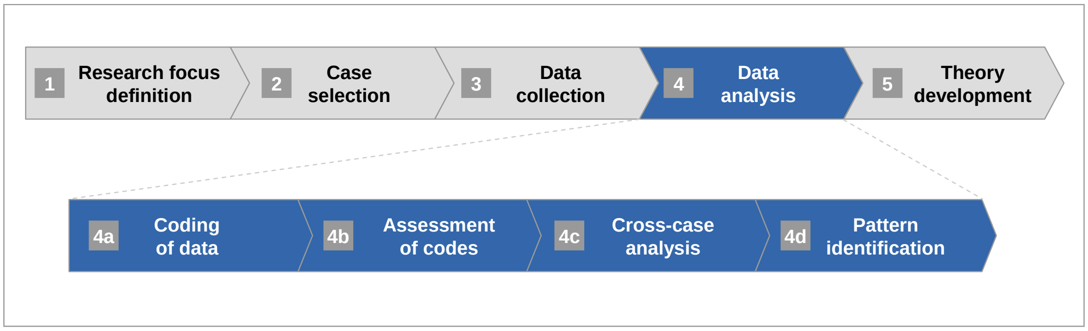

Figure 9: Research and analysis process

Source: Own illustration

Of utmost importance when doing qualitative research is applying consistent rigor in the analysis of the data, especially since: *"Analyzing data is the heart of building theory from case studies, but it is both the most difficult and the least codified part of the process"* (Eisenhardt, 1989a, p. 539). She continues: *"Since published studies generally describe research sites and data collection methods, but give little space to discussion of analysis, a huge chasm often separates data from conclusions"* (Eisenhardt, 1989a, p. 539).

Thus, I want to allay this criticism by following the acknowledged standards of analysis in qualitative research (e.g., Miles & Huberman, 1994) as well as by providing a detailed description of the analysis approach. Moreover, the supervision of my work by two very experienced professors, Professor Dr. Dr. Holger Patzelt and Professor Dean A. Shepherd, Ph.D., further supported a very thorough and rigorous research approach of this dissertation.[5]

[5] I am very grateful to both, Prof. Dr. Dr. Holger Patzelt and Prof. Dean A. Shepherd, Ph.D., for their unparalleled mentoring, support and feedback on this study, especially on the analysis and modeling sections.

3.5.1 Preparation of analysis

The transcription of the primary interview data represents an important key enabler for all subsequent analyses and needs to be performed thoroughly. Taping the interviews with a digital voice recorder proved to be a convenient way to capture the interviews as it generated Windows media audio files, which could be directly imported by the transcription software. The program I used is a freeware called ‘F4’. It offers an audio tool to play the recorded interviews combined with a word processing section that allows typing while synonymously listening to the audio file. A key feature represents the function to adjust the speed of the playback as well as a ‘repeat’ functionality to automatically rewind and playback with a defined interval by just pressing one button, the F4 key. Last but not least, the timestamp function marked every passage with the respective time to facilitate the retrieval for subsequent crosschecks or refinements. As spoken language is significantly less clear and precise as written language, I had to smoothen some words and sentences to establish a clear and readable language. However, it is of utmost importance not to change the meaning and content of the interviewees’ words, thus paying close attention not to alter what the interviewee wanted to convey and express by his statements. Although the software facilitated the transcription to a great extent, a time factor of approximately 1:6 applies to transcribe an interview, including a final check for completeness and correctness.

3.5.2 Coding of data

First, after having executed and transcribed all interviews, I started to analyze the data in a structured way by coding the content to categories in order to facilitate the handling of data by reduction in volume and assignment to specific content – not to be lost in a data overload. Miles and Huberman (1994) describe the construct of a ‘code’ as preparation for the analysis:

“Codes are tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study. Codes usually are attached to ‘chunks’ of varying size-words, phrases, sentences, or whole paragraphs, connected or unconnected to a specific setting” (pp. 56–57).

Prerequisite for coding the data is a defined set of codes (often referred to as ‘coding scheme’) used to extract the corresponding data of the respective categories for analysis.

The coding scheme constitutes a central element of the analysis as it defines the major categories to be extracted from the data for more detailed examination. In this research, it has been developed by applying a combination of an inductive and deductive approach, however the inductive approach predominates.

Deductively, general categories based on extant concepts from literature and questions covered in the interview (e.g., learning from failure) have been defined as a starting point and have been inductively complemented by constructs that emerged during multiple readings of the transcripts (e.g., creeping death) (Thomas, 2006). During the coding of the data, the scheme has been adopted iteratively where required, e.g., by adding new categories, merging existing ones or dropping categories. After several iterations a stable category system evolved, consisting of 44 different categories in total. Overall, the coding took about three weeks.

An overview of the coding scheme is presented in appendix 3. The coding has been performed in NVivo 9.0of QSR International as the standard software for qualitative research which allowed flexibility concerning the scheme and to assess the data systematically. I approached the cases with an open mind (without preconceived propositions) to allow the data to speak to me (Glaser & Strauss, 1967). Following Yin (2003a; 2003b), I coded segments (or chunks of text and other information) that I identified as possibly being relevant to addressing the ‘how’ or ‘why’ questions consistent with the ‘project failure’ purpose of the study. Specifically, segments were classified (assigned to a category or ‘node’ in NVivo terminology). The data was coded and recoded line by line until the classification system covered the material. Although I began to notice similarities and differences across cases, I withheld drawing any inferences until all the coding was complete. Figure 10 shows a screenshot of my research project in NVivo, on the left side, an excerpt of the node structure is displayed in the form of a node tree. The interview transcript is situated in the middle of the window. In this area, the text passages are coded to the nodes by simple dragging and dropping selected passages to the respective nodes in the tree on the left. After successful coding, the respective text passages are highlighted. Furthermore, on the right, the coding stripes indicate the used codes in different colors as well as a coding density, providing information on the quantity of nodes coded in the respective lines of the interview. The darker the coding density, the more nodes have been coded to the corresponding text.

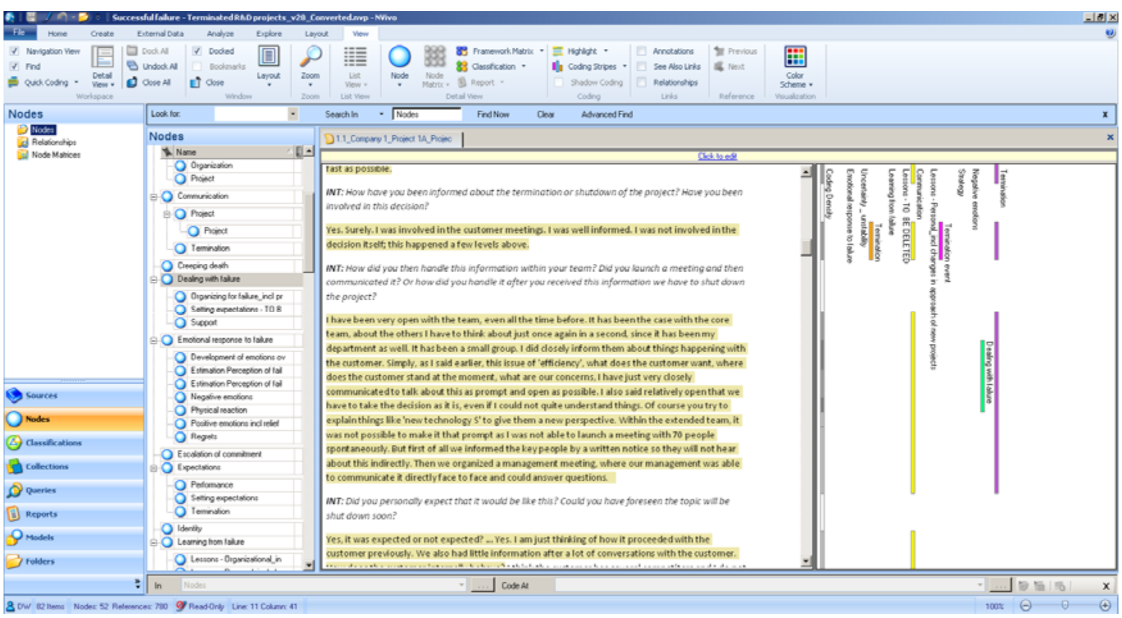

Figure 10: Coding of interviews in NVivo

Source: Own illustration (Screenshot)

3.5.3 Assessment of codes

For analyzing data in qualitative research, numerous tools and methodologies exist (Miles & Huberman, 1994). In line with my research focus, I decided to focus on cross-case analyses for identifying relevant patterns.

As a preparation, the second major step was assessing the previously defined nodes with regards to their respective characteristics (e.g., level of learning). To achieve this, I needed to assess each node in NVivo for each interview. Before being able to do the assessment, I defined for each node a clear explanation of the respective content as well as category dimensions, indicating available levels for the assessment (e.g., 'High', 'Medium-high', 'Medium-low', 'Low'). For some nodes, only two polar values were used (e.g., 'Short' or 'Long' for the time of emotional recovery) or could be classified by 'Yes' or 'No' values (e.g., for the clarity of failure definition). In this 'detailed' assessment of the interview quotes of each respondent, representing a micro-level perspective within the analysis, each category had to be assessed for each interview according to the defined assessment scheme. To achieve this, I first read all quotes of all interviewees per category to get a feeling for overall breadth of answers before I went back and rated each category for each interviewee on its own.

To illustrate the assessment and to increase the transparency on the assessment logic, I provide the example of the category "Learning from failure–lessons– personal level". In this category, a high learning is defined as *"significant insights have been achieved that led to changes and implemented measures"*. A medium level of learning represents *"insights have been achieved and recognized"*; however this did not result in a significant change in behavior, at least not up to the point when the interviews had been conducted. In order to achieve a clearer picture and stronger contrasts, all 'Medium' assessments have further been detailed into either a 'Medium-high' or 'Medium-low' evaluation, depending on the strength and frequency of the interview statements. Last but not least, a low level of learning means that *"no or only limited learning has been achieved but no implementation of respective changes occurred or is likely to happen in the future"*. Applying these category definitions to the coded passages for one of the most relevant categories of my research "Learning from failure – lessons – personal level", a diverse picture with significant variance across the cases became apparent.

As an exemplary case for an assessment of a 'High' level of personal learning, the project leader of project Argon stated: *"But our cost calculations were not able to consider this fact. This was one of the 'lessons learned' from the project – that we have many weaknesses in the way we calculate product costs."* He continued: *"We have learned a lesson from this and consequently have set up a new organization which focuses on the cost management of our products, which together with experts from other departments tackles the whole issue of product cost. Unfortunately, it was too late for this project, but nevertheless our project initiated the change."* The fact that the project leader generated a significant insight on the shortcoming of product cost calculation in his business and the resulting implemented change of the organization to resolve this issue led, together with further similar interview quotes, to the assessment of 'High' for this category.

The personal learning of employee team member 2 of the same project has been assessed as 'Medium-high' as he also indicated important insights in the interview but did not implement significant changes accordingly. Several examples can be found, one is the following: *"And seeing that top management's focus is not directed to this topic is just frustrating. The hierarchical level of the project in the organization is of utmost importance. We have simply wasted so much time on working through the lower levels of management to the top management."* His colleague, employee team member 1 of project Boron showed a 'Medium-low' level of his personal learning from the project: *"I probably knew it somewhere in the back of my head beforehand …. But regarding how I relate to our company as an* *employee and how we do the projects, I would say no [whether he changed the way he worked on projects] …. So the recipe itself for how I perform projects will not change a lot."* In comparison to the 'Medium-high' evaluation above, this interviewee clearly mentioned that he generated lesser lessons learned which he implemented as well – but just small insights that resulted only in minor implemented actions. Since several other comments from eleven coded passages altogether could be found in the interview, the evaluation led to a 'Medium-low' assessment rather than a 'Low' evaluation. To complete the example, the project leader of project Boron did not report any significant lessons learned from the project, instead he quickly moved on to the next project without having time to reflect on actions for improvement: *"During that very night [when the project was stopped], I do not think that I got much sleep. I was not thinking that much about project Boron; I was thinking about the new project [which had been assigned to him two hours after the project had been stopped]."* Obviously, this example represents a 'Low' level of personal learning from terminated R&D projects.

Not all interviews covered every single category. In cases, when the respective interviewee did not mention anything for a respective category – although the topic has been covered within the interview – a 'Low' level has been assumed in the assessment, indicated by a '(0)' following the assessment in the respective cell of the detailed assessment matrix. This approach is reasonable as following the interview guideline, the same questions have been asked during the interviews. Therefore, it can be assumed that if the interviewee did not mention anything for the respective category, it was either not present or it has not been regarded of high importance by the interviewee.

To discriminate the level 'Medium' into 'Medium-High' and 'Medium-Low' proved to be very useful as the assessor could not just chose the middle category but was forced to decide whether it was rather high or low respectively. This finally resulted in a clearer 'black and white’ picture than an all grey picture of ‘Medium’ assessments, facilitating to identify patterns for theory building in the later stage of the research.

After having finished all assessments, a second, external researcher assessed all categories independently after I had explained the respective levels including examples in very detail to her. After she had performed her assessment, we met in a workshop to compare the results of our autonomous ratings. This inter-rater agreement test achieved an initial agreement of 93.5% over all categories, thus indicating that the individual assessments followed according to the defined evaluation criteria and have not been performed randomly. Having reviewed the literature, Guttman, Spector, Sigal, Rakoff and Epstein (1971) concluded that there is an implicit consensus that the minimal acceptable percentage of agreement would be 65%. Following Guttman et al. (1971), this would still allow a disagreement of one third, which I do not recognize as high enough. In other qualitative studies, levels above 90% are regarded as adequate to ensure reliability of the assessments (cf. Haynie & Shepherd, 2011), thus the result of this study fulfills appropriate and common reliability requirements. Differences in the assessments occurred predominantly at the ‘margins’ of the categories. The sources of disagreement were discussed and an agreement was reached. According to Tinsley and Weiss (1975), the inter-rater agreement measures *“the extent to which the different judges tend to make exactly the same judgments about the rated subject”* (p. 359), thus is ideal for calculating the reliability with regards to having taken the exact same decision for each evaluated item during the content assessment. Inter-rater reliability, however, *“represents the degree to which the ratings of different judges are proportional when expressed as deviations from their means”* (Tinsley & Weiss, 1975, p. 359), thus a high reliability means that differences on the content (‘High’ for rater 1 and ‘Medium’ for rater 2) among judges may occur as long as the difference in the ratings is identical (i.e., the raters have always the same gap in their rating). In conclusion, for content analysis inter-rater agreement is the more suitable measure to indicate the quality of the assessment of data within this dissertation.

After having described the methodological fundamentals of the empirical investigation of this dissertation, I am continuing with the data analysis by presenting the cases and the general results of the within case analysis in the next chapter.

4 Case outlines and within-case analyses

As Eisenhardt (1989a) points out, *"analyzing data is the heart of building theory from case studies, but it is both the most difficult and the least codified part of the process"* (p. 539). Concerning key steps of analysis, she first mentions in her article the *within-case analysis* with its primary goal to manage and condense the large amounts of data in write-ups, followed by the *cross-case analysis* to identify patterns and generalize findings over cases (Eisenhardt, 1989a).

In the following chapter, I will briefly outline the content of the projects that constitute the cases as well as provide some information on the respective interviewees. I will try to provide the best information possible on the case content; however, due to the required high degree of anonymization, these descriptions will rather remain brief and general. Therefore, unlike typical case studies, details concerning the project setting, project content, company details and its environment that constitute the starting part of the within-case analysis cannot be provided. The description of the specifics of the project, the explicit name of the business the R&D project is housed in and its corresponding processes must remain in secrecy. Nevertheless, analyzing the core objective and the intention of the dissertation – how R&D project failure is dealt with and how the involved persons react and handle such situations within its context – is not affected. As the specific content and details on the projects are not decisive for my research questions, the richness of data results stems from the termination situations and subsequent experiences of the interviewees, not from the project content and its specifics itself. Based on the comprehensive assessment matrix of all variables, a matrix with the most striking variables for the analysis (i.e., the same variables focused on the core research questions across all cases) and corresponding explanations are presented as the main lenses of investigation for each case. In the within cases analysis, first general findings could be provided based on comparing the obtained information from all interviews within one case without revealing the specifics and details on the projects and subsidiaries themselves. In general, the case outline as well as in particular the within-case analysis provided are significantly shorter compared to other case studies due to the above mentioned anonymity requirements. As a consequence, the within case analysis is intended to identify the most important pattern only and to serve as support in extending the understanding of the projects in addition to the case outlines. Nevertheless, this approach is in line with the purpose of the following section: Providing the background to the understanding of the case situations and specifics. Building on this, the main scientific contributions are derived from the extensive cross-case analysis in the subsequent chapter, representing the core part of the analysis of this dissertation. At the same time, literature is enfolded correspondingly and results in the form of initial propositions are derived. Within the analysis, the extensive use of quotes in tables and within the text is used to provide and support evidence. Comprehensive information and all detailed data are included on an aggregated level in the appendix and full transcripts of the interviews are available from the author on request.

4.1 Within-case analysis approach

First of all, I referred to the case study database and the transcripts of the interviews to summarize the project basics to briefly outline the case specifics. Then I moved on to the analysis part. After having assessed the codes as described in the previous chapter, the next step within the analysis process focused on the individual cases by providing a 'macro perspective' across all assessments within an interview and across all interviews for a project respectively (the same approach will be applied in the cross-case analysis across all projects consequently). According to Bourgeois III and Eisenhardt (1988), *"unlike positivist research, there is no accepted general model for communicating interpretive research"* (p. 820).

Therefore, I followed one approach of Miles and Huberman and generated a summary matrix of all assessed categories in the form of a partially ordered display (Miles & Huberman, 1994). Due to the lack of an established standard for within- and cross-case analyses, I decided to follow the concept of partially ordered displays to be able "*to look at the data in many divergent ways*" (Eisenhardt, 1989a, p. 540). By doing this I was able to avoid drawing conclusions based on limited data or even dropping disconfirming statements. The partially ordered case displays described above proved to be a formidable way to achieve this rigor and to later build propositions on. Thus, within each within-case analysis I will provide an overview table on the most important categories and its assessments of the individual interviews. The aim is threefold: (1) to provide an overview of the assessments of the research questions on an individual level as preparation, (2) to make transparent the basis for the aggregation on case level in the subsequent cross-case analysis (based on selected examples), as well as to (3) provide brief first insights and specifics of the respective case.

The partially ordered display for all cases aggregated on project level can be found in appendix 7, covering the assessments for all categories. In the within-case section of this dissertation, I limited the display to twelve important categories that cover the main research questions and which showed considerable variation across the cases (please refer to the tables within the cases for the included categories). Although the number of categories is limited, the included categories in the displays allow a complete picture of the respective case on the process and consequences of R&D project termination (e.g., decision making, emotional consequences, timing and learning from failure). When writing up the dissertation after having performed all analyses, I decided to focus the text and explanations of the within-case analyses on the central variables of the developed model (as introduced in chapter 6.1). These are in particular 'Time – Anticipation of failure' and 'Creeping death' to provide clarity on timing and a possible delay of the termination, 'Emotional reaction – Negative emotions /

neutral reaction' to assess the impact on the emotional consequences for the team members as well as 'Learning from failure – Personal lessons'. By focusing on the categories that represent the main areas of differentiation and distinguish the polar types of the cases, transparency on the key constructs of interest is facilitated throughout this paper (cf. Eisenhardt, 1989a).

4.2 Introduction to the subsidiaries that comprise the individual cases

To better understand the case setting, this chapter provides an overview and brief description of the subsidiaries in which the cases are housed in. As introduced in the case design, for every subsidiary, two cases have been selected for further analysis in this dissertation.

4.2.1 Subsidiary A

The overall setting for all projects is the energy technology industry, in which all subsidiaries act on a global basis. Project Alpha and project Argon are both housed in subsidiary A, which produces and sells centralized conventional electricity-generation products and systems. Its projects are characterized by rather large project sizes, resulting in high sales volume and R&D budgets as well as large project teams. Subsidiary A has annual sales of more than $10 billion US-Dollar and employs more than 10,000 people altogether. Similar to the other subsidiaries investigated in this dissertation, subsidiary A is regarded as very innovative, possessing cutting edge products and systems. Hence, the business keeps a strong focus on research and development activities and is making a huge effort to remain among the technology leaders worldwide. It recently successfully completed the development of a new product generation that defines a new benchmark in the industry. However, large development projects have been ramped-down as well during the last years.

4.2.2 Subsidiary B

Projects, Bravo and Boron are housed in subsidiary B, which manufactures decentralized, alternative energy products. The company has been acquired several years ago and now is a fully integrated subsidiary, sharing the same processes and organizational routines of the company. More than 3,500 employees generate annual sales of more than $3 billion US-Dollar. In line with the other subsidiaries, it strives for technology leadership and is considered to be innovative. A special characteristic is the fact, that the Chief Technology Officer of the subsidiary, having an outstanding track record, experience and industry knowledge, is the key decision maker of the business and drives most of project decisions himself. As the project leader of Bravo states: *"It is impressive: his emails decide things"*. So his strong leadership is clearly observable in the technology-driven project Bravo. Project Boron, however, took a broader scope and here the decisions have been taken by the subsidiary management team jointly.

4.2.3 Subsidiary C

Subsidiary C is acting globally in the business of highly efficient conventional electricity systems with focus on a defined range of industries. The industry is already relatively mature, covering standard products. Nevertheless, subsidiary C is competing successfully by still trying to push innovations within its portfolio. Furthermore, it is shifting towards engineering solutions around its products as well as trying to develop and expand its products to new, growing markets. The business generated more than $3 billion US-Dollar in sales and employs more than 5,000 people on a worldwide basis.

4.2.4 Subsidiary D

The last subsidiary covered in my research, subsidiary D, deals with technologies and systems for electricity distribution and is considered as leading and innovative among its industry peers. Employing more than 5,000 employees and generating sales of more than $2 billion US-Dollar, subsidiary D is still a large business in absolute terms but compared to the other subsidiaries the smallest organization of this study. Nevertheless, it is just as its counterparts acting globally and has to keep its innovative spirit in order to remain competitive. A distinguishing characteristic of subsidiary D is its comparably large portion of software and IT within its solutions, as illustrated by the second case Dexter.

4.3 Case 1: Project Alpha

The first case, project Alpha, is housed in subsidiary A. The following passage provides an overview on the project fundamentals as well as first findings on patterns within the case.

4.3.1 Outline

Project objective: Project Alpha has been started in the end of 2007 and was targeted at developing a new generation of the existing product, pushing the limits to achieve a higher efficiency of the product. The research on the technology had already started some years before, but only project Alpha led to a major ramp-up of the activities, dedicating a whole team to the development. As an efficiency increase was not possible without a complete redesign of the existing product, the endeavor required extensive resources.

Project resources, duration and termination event: A core project team of around 20 persons had been assigned to project Alpha, working full-time on the development. As specialists from other units and functions (e.g., purchasing) were required due to the full and comprehensive redesign of the old product, the extended team comprised more than 50 employees at peak times. This resulted in a total invested resource capacity of 1,500 man months. Complexity has also been induced as new materials and tools had to be specifically researched on and developed for this project. Moreover, the team composition as well emphasized the significance of the project – a very senior team comprising senior engineers and specialists had been assigned to Alpha. Overall, a budget of approximately $30 million US-Dollar was assigned to ensure the required financing of project Alpha until its completion. The challenge of the development is as well reflected in the project duration – four to fives years had been projected at project start. After a little more than two years of project work, it became apparent that market prospects as well as product cost developed differently than expected. Jointly with fact that the key employees of project Alpha were requested for other initiatives as well, management decided the ramp-down of the project. Due to the related costs and resource scarcity in other projects, management decided to follow a quick ramp-down instead of a slow phase out approach finishing all current activities as planned. After having achieved an alignment in the leadership team, the decision had been officially communicated to the overall team. Team member 1 experienced the situation after the meeting with a lead customer about the 'difficulties' as follows: *"After this visit, we met then here, let's say, only in our team and first of all evaluated for us, what this actually means. Then we came to the conclusion that we said that it makes absolutely no sense from our perspective to simply continue with this 'full steam production test', with all that was entangled, also with the high financial expenses. Actually, this didn't make any sense at all. In this respect, the next step was then to discuss the situation with the relevant responsible managers at the headquarters."*

Background of interviewees: As introduced above, a senior team was involved in project Alpha. The project manager, aged 45, has a background in mechanical engineering and gained a PhD before entering the company and the industry 13 years prior to the interview. 48 year old team member 1 has extensive experience as well, having worked 21 years in the industry after having finished his degree also in mechanical engineering. Last but not least, 50-year-old team member 2, graduate engineer with PhD in mechanical engineering, complemented the interviewee group and having gathered rich expertise during 20 years of work in the industry. All three engineers have worked extensively on project Alpha and experienced the ramp-down.

4.3.2 Within-case analysis - general patterns

Project Alpha is an example of a substantial project that had the objective of pushing technology to its limits but nevertheless had to be ramped-down. This ramp-down happened quite fast due to the need of the team resources on other development projects. Although it had been decided to ramp it down very quickly, two of the three employees interviewed had foreseen this development quite clearly – a phenomenon which is described as ‘creeping death’ throughout this dissertation. What is important to note is that the perception of the interviewees concerning the velocity of the termination was that it did not happen quickly but it was rather a process over a longer period of time. To explain this perception, referred to as ‘creeping death’, more precisely, I provide some quotes from the interviews. For example, the project leader stated: *“But in the end, it was the way it was shut down, a kind of slow decent with a sudden end as other topics became more interesting. […] For me personally it has been a creeping process.”* Team member 2 did not use the word ‘creeping’ but when talking about the end of the project, his expression described it in a very similar way: *“From that point of view, the driving force of the whole thing stopped. This happened a little bit in a ‘dripping’ way.”* Although the third interviewee did not deliberately mention this fact, the congruent descriptions of his colleagues allow the conclusion to have observed a ‘High’ level of creeping death for project Alpha. Furthermore, all interviews have been rated for a ‘Long’ period of anticipation of the termination. Two further striking insights can be derived from analyzing the project level interviews of Alpha, covering the categories of negative emotions to failure and personal lessons from failure (please refer to Table 4). In both situations the descriptions of two interviewees can be assessed at a high level, one at a medium to high level.

Table 4: Assessment of key variables – Case 1: Project Alpha

Categories (coded items)			Case 1: Project Alpha			
#	Category	Sub-category	Project leader	Employee team member 1	Employee team member 2	Overall
10	**Creeping death**	---	H	L	H	**H**
16	**Emotional response to failure**	Negative emotions / Neutral reaction	H	M-H	H	**H**
19	**Emotional response to failure**	Regret	H	H	L	**M-H**
20	**Escalation of commitment**	---	M-H	M-H	L	**M-H**
25	**Learning from failure**	Lessons - Org. level (incl. changes in org after event)	M-H	L	L	**M-L**
26	**Learning from failure**	Lessons - Personal level (incl. changes in approach after)	H	H	M-H	**H**
29	**Re-motivation**	Implemented measures	M-H	L	M-L	**M**
31	**Termination**	Clarity of failure definition [1)]	n/a	n/a	n/a	**Yes**
33	**Termination**	Decision on termination	Mgmt	Mgmt	Mgmt	**Mgmt**
35	**Time**	Anticipation of failure	Long	Long	Long	**Long**
36	**Time**	Emotional recovery	n/a	n/a	Long	**Long**
37	**Time**	Right timing to terminate	n/a	n/a	Just right	**Right**

Abbreviations:
H: High M-H: Medium-high M-L: Medium-low L: Low (0): not mentioned n/a: not applicable Mgmt: Management
1) Question asked to subsidiary management only

Source: Own illustration, interviews

All interviews show that the employees of project Alpha related strong negative emotions with the ramp-down of their project. The following quote of team member 1 shows representatively an assessment of ‘High’ level of negative affect: “*My hope was that we reach the milestone M2 [completion of concept design]. We have been given the very clear objective to demonstrate the feasibility of this technology to 100% at this milestone, having performed all these large-scale testing and manufacturing experiments. And not to achieve 99% […] so that we really know that it works and we also know how to do it. […] The fact is we have not gotten that far. So, we have made the large-scale tests and we have seen that we needed to put actually some more effort into it, we had developed ideas, how we would be able to most probably get it under control. To prove this once again, to really do a successful M2 – we did not have the time. That did hurt me personally.*” The assessment of a high level of negative emotions seems reasonable since after more than two years of hard work, only a little piece was missing to a success. This has been made impossible due to the ramp-down and the interviewee directly mentions the feeling of being personally hurt. Similarly, the fact that all interviewees reported a high level of personal learning is interesting. Although facing negative emotions, the experience led to lessons learned and changes in behavior. When asked about key insights from the project, the project leader reported: *"As I said before, to stop a project conscious, to bury it. In my opinion you should think about such a thing. In general, we do it insufficiently. You should certainly celebrate a success. We do this insufficiently as well. But to really finalize, to 'check off' topics. Then the employees would think they have really finished something, even if we have finished a project by stopping it. I think you have to do it more consciously."*

Based on these patterns, several intermediate results can be drawn. It can be concluded that project Alpha showed a longer period of perceived uncertainty, which can be summarized as 'creeping death'. Furthermore, negative emotions related to the ramp-down of project efforts prevailed and significant personal learning could be observed. In order to avoid to directly jumping to conclusions, the cross-case analysis will further analyze these patterns.

4.4 Case 2: Project Argon

4.4.1 Outline

Project objective: At its start in 2006, the initial objective of project Argon was to develop a new generation of an existing product, which means to upgrade and improve its components in order to achieve a better performance and meet changing customer requirements. During the project, it however became obvious that the desired results could not be achieved by simple upgrades but required the development of literally a new product. Despite these changes, the project timeline could be kept, setting a new benchmark.

Project resources, duration and termination event: Compared to project Alpha, Argon required even a higher resource intensity: more than 50 engineers were working full-time on the execution, a lower three digit-number comprised the extended project team (including employees working only part-time on it). This translated into an investment of roughly 4,000 man months as well into extensive financial requirements: a $140 million US-Dollar budget had been approved for Argon, making it the largest project included in this research. After having worked for almost three years on Argon, the team achieved the first prototype of the new product by the middle of 2009. At that time, already signs that the market success might be limited existed. A milestone to sell the product and perform real-life tests in existing systems of customers has not been achieved within the planned project timeline. As during the next months market prospects did not change and still real life testing was not possible, the project had been extensively discussed within management. One aspect of the discussions always was production costs, which had been perceived as comparably high due to a weakness in calculation processes. Due to the fact that a different product that could address comparable customer requirements with a different design, achieved market readiness shortly after, top management had stronger beliefs in the other design and decided to invest further into project Argon in order not to potentially cannibalize sales.

Background of interviewees: Subsidiary A staffed the project team as well with senior engineers. The project leader joined the company right after having finished his engineering studies at university 19 years prior to the interview. Team member 1, possessing a PhD in mechanical engineering, had ten years of experience in the industry and in the company prior to the interview. Team member 2 graduated from the university with a degree in process engineering and worked one year at a competitor prior to joining the company 14 years prior to the interview.

4.4.2 Within-case analysis - general patterns

Analyzing the interviews on project Argon, it stands out that the termination of the project has been anticipated early by the interviewees, according to team member 2 the termination *"was to be expected – it was to be feared"*. Towards the finalization of the prototype, according to the project leader, the project *“was between life and death. It was not yet dead, but it was also not fully alive.”* His colleague, team member 1 even used the words ‘creeping death’ when describing the long period of uncertainty before the termination *“I guess, a point was, it was at some point good that there is a definitive decision. This arouses still a shaking of the head today, because it has been just such a creeping death.”* Hence, during the last months of the project a high uncertainty without clear decisions and clear communication prevailed that led to an assessment of a strong feeling of creeping death for all interviews (see Table 5).

In terms of emotional reaction to the termination, the overall picture indicates strong negative emotions related to the project termination. Although team member 1 only showed a ‘Medium-high’ level, the two other interviewees both had strong negative emotions leading to a rating of ‘High’. The following quote of team member 2 is exemplary for these strong emotions: *“It was a disaster, of course. You think: ‘Now I have invested two years and now the thing collects dust in the plant and will be scrapped and the work itself was for nothing’. ”* The fact that the team members believed in the project and the quality of their work during the last years but could not change the management decision for sure increased the negative emotions related to the termination of the project.

Table 5: Assessment of key variables – Case 2: Project Argon

Categories (coded items)			Case 2: Project Argon			
#	Category	Sub-category	Project leader	Employee team member 1	Employee team member 2	Overall
10	**Creeping death**	---	H	H	H	**H**
16	**Emotional response to failure**	Negative emotions / Neutral reaction	H	M-H	H	**H**
19	**Emotional response to failure**	Regret	L (0)	L (0)	L (0)	**L**
20	**Escalation of commitment**	---	H	L (0)	H	**M-H**
25	**Learning from failure**	Lessons - Org. level (incl. changes in org after event)	H	H	L	**M/H**
26	**Learning from failure**	Lessons - Personal level (incl. changes in approach after)	H	H	M-H	**H**
29	**Re-motivation**	Implemented measures	M-H	M-H	L (0)	**M-H**
31	**Termination**	Clarity of failure definition 1)	n/a	n/a	n/a	**Yes**
33	**Termination**	Decision on termination	Mgmt	n/a	Mgmt	**Mgmt**
35	**Time**	Anticipation of failure	Long	Long	Long	**Long**
36	**Time**	Emotional recovery	Long	Short	Long	**Long**
37	**Time**	Right timing to terminate	n/a	Too late	Too late	**Too late**

Abbreviations:
H: High M-H: Medium-high M-L: Medium-low L: Low (0): not mentioned n/a: not applicable Mgmt: Management
1) Question asked to subsidiary management only

Source: Own illustration, interviews

With regard to learning from failure, once again a ‘High’ overall assessment for personal learning was achieved, a stronger consensus than for lessons on organizational level could be achieved. Despite the perception of a creeping death, the related uncertainty and negative emotional affect, the team members could benefit from the experience of project Argon. For example, the project leader generated the important learning that the existing cost calculation processes were not adequate to reflect development costs of the first machine. He claimed: *“Then, the machine was much too expensive. What no one wanted to hear anymore is that one usually goes through a learning curve. In other words, the first machine will cost most and the more we build, the cheaper it gets. But our cost calculators were not able to include that. This was one of the 'lessons learned' from the project that we have many weaknesses in the way we calculate product cost. In my personal opinion we have calculated the machine to death ourselves. In my view, if I just make the technical comparison between the previous machine and this machine, what has changed technically and what product cost changes should cause that, I still think that we can get the machine to the target cost. Only, the way we do it, that the designers only make the sketches, then the drawings and then give* *them to the manufacturing and purchasers, who return with the costs, but have no real responsibility for what they calculate and have also no disadvantage if they are too high, but have a disadvantage, however, if they are too low. That simply does not work, because breathtaking amounts are the result of this process."* A high level of learning is indicated because this learning consequently was implemented and resulted in an adaptation of established processes: *"We […] have set up a new organization which deals with product cost management, where you really sit down together at a table together and tackle the whole issue. It is too late for this project, but it was born out of this project."*

In sum, project Argon shows similar patterns than Alpha: A creeping death phase before termination, rather strong negative emotions induced by the termination as well as a high individual learning experience of the team members.

4.5 Case 3: Project Bravo

Project Bravo, the third case, is housed in subsidiary B. As with the previous cases, the next paragraphs aim at delivering an overview on the case setting, background information and the events that led to the termination. Moreover, first insights across the interviews are provided.

4.5.1 Outline

Project objective: Project Bravo has been planned late 2009 and finally initiated in the beginning of 2010, targeted at testing a new material for a major component of the existing products. According to the interviewees the project was very ambitious and exciting, since its success would have had great impact on the product lines of subsidiary B, providing better and more competitive products. It comprised basic research on the material and its characteristics for the specific application as well as the manufacturing of first test products and their testing. To achieve this, the projected schedule envisaged a project duration of 18 months in total.

Project resources, duration and termination event: Bravo is a comparably small project within this research, a budget of approximately $750,000 US-Dollar as well as a team of four engineers, of which two formed the core team, had been assigned to this R&D endeavor. One of the core team members was a senior researcher of an external research partner, which had been contracted to jointly execute the project. The research organization brought in vital and latest know-how in material science as well as a supplier network for the material to be evaluated. Having worked for only a few weeks on the project, subsidiary B was not fully confident about the ability of the collaboration partner and key supplier of the external research partner to provide the stable delivery of the material in the required amount. Requested plans to prove the ability to deliver could not be provided and thus the delay in the delivery of first testing material and further information increased the doubts. In the meantime, cost calculations on product costs using the new material did not achieve competitive rates. Thus, approximately one and a half months after the start of the initiative, the Chief Technology Officer of subsidiary B took a management decision to stop any further work on the project. This decision was based on a rational basis due to the two major reasons: (1) doubted ability to ensure a stable material delivery and (2) missing cost competitiveness of the new material. The work was terminated quickly and on short notice and resources have been shifted towards other topics.

Background of interviewees: The project leader of Bravo has a significant industry experience of 34 years. First, being an entrepreneur as well as having worked with the company for the last four years. His background is civil engineering, although he did not finish his degree due to his decision to become entrepreneur. Team member 1, the research specialist of the external research organization, possessed a 36-year industry experience as well as having earned a PhD in composites and material mechanics. Both core team members have been personally deeply involved in this project as both had investigated the material at hand already prior to the project, the external researcher even continued on his own to evaluate the potential of the material, however, lacking resources and the partnership of a strong player in the industry.

4.5.2 Within-case analysis - general patterns

Comparing both interviews on project Bravo, it stands out that the assessment of both interviewees shows overall a very high degree of agreement. Examining the key variables, several first insights stand out. First, both interviewees agreed that the termination decision was clear and straightforward, but has not been anticipated by them. However, both team members agreed at the same time with the termination decision, team member 1 stated when being asked about any early indicators of the termination: *"No, not until I had this meeting with our collaboration partners. And then I thought: 'Ok, then we have to terminate because we have no chance to get the material.' So we could not continue."* Consequently, there were no indications of a period of uncertainty or 'creeping death' before the termination event. Second, the termination seems not to have initiated a strong negative emotional reaction among the team members. Despite their strong personal involvement and interest in the success of the project, both interviews have been assessed with a 'Low' negative emotional response. Even team member 1, who initially came up with the project idea and hence can be regarded as the 'father' of the project, described his emotional reaction as *"It was just a small scratch - 'one' or 'two' or something like that [on a scale from 1-10]. Because I was more disappointed with my collaboration partner than I was with subsidiary B."* The third area of interest, learning from failure, shows as well a congruent picture across the interviewees. Evidently, the level of personal learning from the terminated project is rather low, as evidenced by a 'Medium-low' assessment for the team members. While the project leader admits that *“I am not always that good at learning from failure […]”*, he nevertheless showed lessons learned from the pitfalls in collaborating with the material supplier as well as increased knowledge on material properties of the investigated raw material. His colleague, team member 1 as well showed some lessons learned how to collaborate with and manage relations with material suppliers which changed his behavior towards these collaborations, nevertheless, the magnitude, especially when compared to the other interviews is rather low. Table 6 summarizes the results of the assessments on the key variables.

Table 6: Assessment of key variables – Case 3: Project Bravo

Categories (coded items)			Case 3: Project Bravo			
#	Category	Sub-category	Project leader	Employee team member 1	Employee team member 2	Overall
10	**Creeping death**	---	L (0)	L (0)	n/a	**L**
16	**Emotional response to failure**	Negative emotions / Neutral reaction	L	L	n/a	**L**
19	**Emotional response to failure**	Regret	L (0)	L (0)	n/a	**L**
20	**Escalation of commitment**	---	L (0)	L (0)	n/a	**L**
25	**Learning from failure**	Lessons - Org. level (incl. changes in org after event)	L (0)	L (0)	n/a	**L**
26	**Learning from failure**	Lessons - Personal level (incl. changes in approach after)	M-L	M-L	n/a	**M-L**
29	**Re-motivation**	Implemented measures	L	M-H	n/a	**M-L**
31	**Termination**	Clarity of failure definition 1)	n/a	n/a	n/a	**No**
33	**Termination**	Decision on termination	CTO	CTO	n/a	**CTO**
35	**Time**	Anticipation of failure	Short	Short	n/a	**Short**
36	**Time**	Emotional recovery	Short	Short	n/a	**Short**
37	**Time**	Right timing to terminate	Just right	n/a	n/a	**Just right**

Abbreviations:
H: High M-H: Medium-high M-L: Medium-low L: Low (0): not mentioned n/a: not applicable CTO: Chief Technology
1) Question asked to subsidiary management only

Source: Own illustration, interviews

In general, Bravo did not show indications of a creeping death due to the very short-term termination. Interestingly, both variables of key interest show low manifestations – both interviewees had low negative emotions as well as generated little insights caused by the project and its termination.

4.6 Case 4: Project Boron

4.6.1 Outline

Project objective: Project Boron differs to a little extent from the other projects investigated in this research as it is not directed towards the development of a product or solution but its objective was to develop a new manufacturing and engineering facility abroad. Induced by a prospective large strategic customer project and respective local content requirements, the project nevertheless comprised all elements of a development project (e.g., project planning, designing and optimizing the layout as well as determining capacities according to specifications) and thus is comparable to the other cases in terms of the research questions of this dissertation.

Project resources, duration and termination event: A project team of approximately 50 persons has been assigned to the project, of which around ten persons worked full-time on the project and the rest devoted a significant portion of their capacity to the project. A budget of $16 million US-Dollar budget has been assigned to the project, of which a large portion already has been spent. Altogether, around 5,000 man months had been invested after the commencement of the project in early 2010. The project was running for about one year, when an unpredictable event occurred. An *"earthquake victory of the opponent party happened which nobody saw coming"*, as the project leader framed it, changed political powers during an election. Thus, resulting changes on the regulatory side blocked the customer from issuing the order to which subsidiary B was delivering components leading to a first official postponement of the project. In addition, the prospects for a resumption were not promising, at least not within the next months. As a consequence, the project that consumed a high investment as well as operating expenses was decided to be shut down by the global management team of the subsidiary.

Background of interviewees: Three team members have been interviewed for project Boron, all of them were in leading positions on the project. The project leader spent more than twelve months working full-time on the planning and implementation of the project. His background is in production engineering and he had a working experience of six years at subsidiary B as well as in the industry. Team member 1 was the local manager on the project site and joined the company shortly before the project start. Prior to joining subsidiary B, he was leading projects in the industry for more than ten years after graduating as an engineer from university. Team member 2, leading a sub-module of project Boron, as well earned a university degree in engineering and had three years of industry experience prior to the project start.

4.6.2 Within-case analysis - general patterns

The analysis of project Boron shows a less congruent picture across the three interviews. While the assessment of all interviewees does not find any indications of a creeping death, there is a mixed picture concerning the anticipation of the termination. The project leader himself saw the likelihood of a termination and even has been asked by colleagues: *"They had already come to my desk on their own just to ask: 'What is status and what is happening?'"* Similarly, team member 2 felt the termination coming for some time: *"For almost a month we paddled [were in a waiting position] […] Of course, ... I could figure out that this could be [the termination] because of the lacking demand. It is not like you know it but you make up your own reality instead of knowing the truth."* In contrast to these rather long periods of anticipation, the interview of team member 1 has been assessed as having faced a 'Short' anticipation time induced by the following exemplary quote: *"No, no. Because there was no indication. Because this was just a decision taken high up in the system. So you can say ... I was not prepared for that."* In sum, the evaluation on the anticipation of the termination led to a 'Mixed' assessment. The same variance holds true for the second key variable: Negative emotions. Overall, when assessing the level through the lens of the reaction to the ramp-down itself, the team members showed a relatively 'Low' level of negative emotions. Here, the exception again is team member 1, who had stronger negative emotions compared to his colleagues (see Table 7 for the detailed results). The following passage is a good example describing his emotional situation after the project had been stopped: *"I remember that the one thing that I for sure had in mind was that somewhere in this system there must be some people high up the system that actually do not know what is really going on. Since you can have a project that should be the fastest start-up in history and before you know it is a full stop. I had the feeling that I guess that somebody did not do the homework properly. You know were playing with a lot of people here and I had ... people brought in that resigned from their old job. So I had a really ... bad feeling about having people signed up for something that now struggles* - *and also in the hiring process I had said: 'Our company is one of best companies in the world and our product is just going up and up.' And then I have to back saying: 'We are on a full stop!' ... I felt bad about that."* Apart from these reasons, a further possible explanation for his reaction might be his specific situation of having transferred to a different country, having prepared his family to relocate as well, including a change of schools for his kids, which now all of a sudden became invalid. He stated: *"Actually, the worst thing was that I was not prepared myself and I had not prepared my family that this could actually happen. There was no... stop sign on the way or anything. It was suddenly a reality. And you have to adapt to that, of course."*

Table 7: Assessment of key variables – Case 4: Project Boron

Categories (coded items)			Case 4: Project Boron			
#	Category	Sub-category	Project leader	Employee team member 1	Employee team member 2	Overall
10	**Creeping death**	---	L (0)	L (0)	L (0)	**L**
16	**Emotional response to failure**	Negative emotions / Neutral reaction	L	M-H	L	**L**
19	**Emotional response to failure**	Regret	L (0)	L (0)	L (0)	**L**
20	**Escalation of commitment**	---	L (0)	L (0)	L (0)	**L**
25	**Learning from failure**	Lessons - Org. level (incl. changes in org after event)	L (0)	L (0)	L (0)	**L**
26	**Learning from failure**	Lessons - Personal level (incl. changes in approach after)	M-L	M-L	M-H	**M-L**
29	**Re-motivation**	Implemented measures	H	M-H	L (0)	**M-H**
31	**Termination**	Clarity of failure definition [1)]	n/a	n/a	n/a	**No**
33	**Termination**	Decision on termination	Mgmt	Mgmt	Mgmt	**Mgmt**
35	**Time**	Anticipation of failure	Long	Short	Long	**Mixed**
36	**Time**	Emotional recovery	Long	Short	Long	**Long**
37	**Time**	Right timing to terminate	Just right	Not clear	Just right	**Just right**

Abbreviations:
H: High M-H: Medium-high M-L: Medium-low L: Low (0): not mentioned n/a: not applicable Mgmt: Management
1) Question asked to subsidiary management only

Source: Own illustration, interviews

The variation in the assessments continues for the third category of personal learning from the failure. Interestingly, here team member 2 learned more than his peers, who only showed a 'Medium-low' level of learning. For example, he changed his approach to projects in paying a higher attention to environmental aspects: *"I would say working on big projects like Boron, I would definitely in future more look on the surrounding of the projects… But that is very concrete because of this case now I have learned."* The assessment of his team colleagues could not provide a clear change in behavior, thus a lower level of personal learning is assumed.

In summary, Boron has not been regarded as a project facing creeping death; it generated noticeable negative emotions but provided only a comparably low level of personal learning for the team members.

4.7 Case 5: Project Caesar

4.7.1 Outline

Project objective: Project Caesar has been initiated in order to achieve a cost reduction for an existing product. As the operational environment of the product requires specific material characteristics, major components of the product consist of a special, cost-intensive material. Changing the material has been regarded as a major lever to achieve the desired cost reduction and consequently a design to cost (DTC) project has been started to find cost-effective alternative materials for the components in focus. A second objective of the project was also to harmonize the component between the very similar other product lines as well.

Project resources, duration and termination event: Management equipped Caesar with a budget of roughly $1 million US-Dollar to investigate the proposed cheaper material and its applicability for the components. A project team has been put together to execute Caesar consisting of eight engineers in the core team, supported by experts from other functions (e.g., purchasing, manufacturing and service). The core team was located at two different sites of subsidiary C and started work by the middle of the year 2008. Within the project, cost calculations have been performed constantly in order to estimate and monitor the cost reduction potential. The change of the component material required significant modifications of the design of the components and hence bore a high complexity. Unfortunately, some technical problems occurred that again require further design modifications, which turned out to be very expensive. The combination of the eroded cost reduction potential together with the increased technical risk induced by the design modifications ultimately led to the termination of the DTC project Caesar six months after its start. The steering committee of the project, the R&D management of subsidiary C, has taken the decision, respectively. In total, the team spent around 100 man months working on the project before its termination in late 2008.

Background of interviewees: The selected interviewees all have been senior and passionate engineers. The project leader, having pursued a university degree in mechanical engineering, worked eleven years in the industry and the same time for the company. His previous position before managing project Caesar was as well project leader. Team member 1, mechanical engineer by profession, too, had 30 years of industry expertise and joined the company six years prior to the interview. He led the design department of the second project location. His colleague, team member 2, holds a PhD in engineering and as well has significant industry experience, having worked for 16 years in the industry and six years for subsidiary C.

4.7.2 Within-case analysis - general patterns

Overall, project Caesar shows a picture with rather 'Low' assessments. It is striking, that no signs of a creeping death prevail, although both team member 1 as well as team member 2 have been rated at a 'Long' anticipation of the termination. The following quote of team member 1 can be used to make this rating more transparent: *"Maybe one month before the termination, there was already the feeling that the project might be terminated. Then we understood that the design started to be more and more complicated. We understood that there is a possibility; there is a risk that the project will be terminated."* There is no clear explanation observable, why these weeks of anticipation did not lead to the feeling of a creeping death. A possible explanation might relate to the management style, which the R&D manager of subsidiary C described as rather decisive – although they need some time to decide on the termination, it is a clear decision. Take the following statement of the manager when asked about the timeframe from recognition of problems to termination: "*Maybe between weeks and months. I think the one we terminated, the one which we were very late that we had to do certain investigations, performance-wise, etc., so then it maybe takes months before we can really decide. In some other examples where we decided quicker,* *maybe within a few weeks. But I think that is the time frame."* Clearly defined KPIs trigger the review of the respective project and a consequent termination decision, as the R&D manager points out: *"I think in general it is because of any of our KPIs. […] Is any of those four not fulfilling their targets, it goes to the gate review. There we need to consider if we should continue with the project or if we official stop it*".

What else stands out is that the emotional response to the failure is very low across the interviews. Both, the project leader as well as team member 1 showed very low negative emotions as they despite all passion for the project clearly understood the necessity – take the following quote of team member 1: *"It is always a pity when a project is terminated because an effort has been invested and of course, usually the engineer wants to see the results of his work. So in this case, the project was terminated and of course this is bad. But on the other hand, everybody understood that there is no reason to continue because the [project] objective could not be achieved."* There was as well an agreement among the project leader and all responsible managers of subsidiary C as reported by the project leader: *"We had a common agreement here in the headquarters about how we should continue with the project. I had three experts with me and everyone agreed that we should terminate the project and spend the money on other important projects. And the steering committee was also agreeing with me, so the management was with me and it was no problem."* Team member 2 showed some negative emotions related to the termination, but focused on the positive aspects at the same time: *"I was sad because of the project termination and I did not see the result of my previous work. […] To me, it was not a disaster. I gained experience from this project and I developed new models as well as new data now. I am sure that the time was spent well and not without any good reason."*

An interesting fact is, that for project Caesar, the level of negative emotions seems to match the trend of how much people learned from the project. While both employees with low negative emotions as well indicated limited lessons learned from the termination, team member 2 faced stronger negative emotions and higher personal lessons learned. The two 'low learners' referred to having extended their knowledge on some technical details and to learned that to manage scope creep as their key insights from the project. Team member 2, however, provided a wider-range of insights, covering examples of technical knowledge, project management basics, motivational aspects and last but not least a key improvement of his own processes: *"I tried to change all my final documentation software models, all components of my activity, my whole working place except my space."* which he implemented after the termination. Table 8 provides a summary of the assessments of project Caesar for the key variables.

Table 8: Assessment of key variables – Case 5: Project Caesar

Categories (coded items)			Case 5: Project Caesar			
#	Category	Sub-category	Project leader	Employee team member 1	Employee team member 2	Overall
10	**Creeping death**	---	L (0)	L (0)	L (0)	**L**
16	**Emotional response to failure**	Negative emotions / Neutral reaction	L	L	M-L	**L**
19	**Emotional response to failure**	Regret	L (0)	L (0)	L (0)	**L**
20	**Escalation of commitment**	---	L (0)	L (0)	L (0)	**L**
25	**Learning from failure**	Lessons - Org. level (incl. changes in org after event)	L (0)	M-L	L (0)	**L**
26	**Learning from failure**	Lessons - Personal level (incl. changes in approach after)	M-L	M-L	M-H	**M-L**
29	**Re-motivation**	Implemented measures	L	M-L	M-H	**M-L**
31	**Termination**	Clarity of failure definition [1)]	n/a	n/a	n/a	**No (0)**
33	**Termination**	Decision on termination	CTO	n/a	CTO	**CTO**
35	**Time**	Anticipation of failure	n/a	Long	Long	**Long**
36	**Time**	Emotional recovery	Short	n/a	Short	**Short**
37	**Time**	Right timing to terminate	n/a	Not clear	Too early	**Too early**

Abbreviations:
H: High M-H: Medium-high M-L: Medium-low L: Low (0): not mentioned n/a: not applicable CTO: Chief Technology
1) Question asked to subsidiary management only

Source: Own illustration, interviews

In sum, project Caesar showed mixed effects induced by the termination, allowing no clear aggregated overall picture on project level. Especially for the magnitude of the emotional reaction and the level of learning achieved. For the project leader and team member 1, the termination led to a low negative reaction as well as a low level of learning. Team member 2 as well generated low negative emotions after the termination but showed significant personal learning experience.

4.8 Case 6: Project Chrome

4.8.1 Outline

Project objective: Competitive pressure in the market was the trigger to start project Chrome. Its target was to develop a new generation of the existing product that outperformed the new generations of competitive products in performance as well as in efficiency. To achieve this, two major components should be improved, which required a complete redesign in both cases. Furthermore, an underlying objective and secondary aim of the efforts was to improve the service intervals of the products, also contributing to the competitiveness on the market. This twofold objective of improving efficiency and product life at the same time has been regarded as very ambitious.

Project resources, duration and termination event: The project organization reflected the twofold improvement levers efforts around the two components to be improved. Within these two pillars of the project, the team has been staffed with experts of all required disciplines. Altogether, a core team of 15 engineers was working full-time on the project, resulting in around 500 man months of invested effort up to the termination. From a financial perspective, more than $10 million US-Dollar have been spent on Chrome. The project commenced by middle of 2006 and passed all basic design tests, for which expensive tooling had been purchased. Then in the detailed design phase, detailed models of how to balance and align the components have been developed. Afterwards, the team moved on to the final design milestone, which marks the last stage of the design process, centered around the development of the real product for the market. The final design phase had been achieved roughly by mid of 2008, after two years after project start. When running the machine in this last phase during the tests, the team realized that something was wrong with the performance of the product and first concerns arouse. Several attempts to identify the error and compensate for the loss did not yield in a positive result. During the tests, it became evident that the first component worked fine and it was the second component that caused the weak performance. After various and extensive tests and several months of work with the assistance of external experts from an university, it became clear that a fundamental design flaw was the root cause of the problems. Now, after approximately two and a half years, it became apparent that a major design error prevailed that could not be bypassed without a major design change. Consequently, the project was stopped after discussions with senior management. Within these review meeting, it was agreed that the product would retain the working new component but would also keep the old, existing component instead of continuing to work on the faulty new developed one. Thus in total, the objectives of Chrome could not be achieved, but a little step forward in efficiency because of the one new component was gained. Unfortunately this resulted only a little but not the big step.

Background of interviewees: Senior employees were assigned to form the team of project Chrome. The project leader completed a mechanical apprenticeship and has 44 years of industry experience. Working since 8 years for subsidiary C, he managed projects and manufacturing programs during the last years. Team member 1, holds a degree in mechanical engineering and works since his graduation for the company and in the industry, resulting in 25 years of experience at the time of the interview. Team member 2 as well is an engineer with university degree. He even has an industry experience of 34 years but worked for the company only for eight years at the time of the interview.

4.8.2 Within-case analysis - general patterns

Concerning anticipation of the termination, all interviewees agree that the actual termination could be anticipated, at the latest after the stable negative testing results, for example, team member 1 described: *"Not terminated at that point. But there was now the first concern. So up until that point, we had gone through the design, passed all the reviews and we then got into validation. We were into the early days of validation and we realized that we* *were lacking performance. It was already quite a long way out - compared to other units."* Nevertheless, just as in project Caesar, the interviewees of Chrome did not have the impression of a creeping death of the project.

Different to the other investigated project from subsidiary C, the termination of Chrome generated significant negative emotions within the team. Both, the project leader and team member 2 have been assessed to have had strong negative emotions (ranging from 'High' to 'Medium-high') induced by the failure. Take for example the following quote of the project leader: *"I think just disappointment and 'What is next?'. You know we failed, if you like. […] I felt gutted, absolutely gutted inside."* Team member 2, described his feelings after the failure similarly: *"Oh, pretty dreadful, very dreadful. You feel really awful, thinking, what I do next, this sort of thing. You take that to a personal level, would I have a job and anything?"* He even feared that the consequences could threaten the engineering department at their site: *"Corporate, are going to say: 'They do not know, what they are doing and so on.' So, the emotional low said: 'Death to the engineering of our plant!' and this sort of thing."* The fact that a significant failure might endanger the existence of the R&D department at their site, moving activities to other locations, might be one part of the explanation, why the reactions have been this strong. Moreover, the project duration is one of the longest of the projects investigated; hence it is likely to bear a higher personal investment from the team members.

Regarding learning from failure, first of all some disagreement among the interviewees prevails. While the assessment of team members 1 and 2 clearly indicated a 'Medium-high' level of learning, the project leader seemed to have learned less than his colleagues. As a possible explanation, this could be related to his experience, having worked for 44 years in the industry, nevertheless, the other engineers as well had substantial experience themselves. All interviewees share the insight that more rigor and crosschecks are required and consequently implemented measures to change their behavior and processes. In addition to the shared key learning on the level and precision of sanity checks and early cross-checks when developing new technologies, team member 1 fosters the inclusion of external experts at major milestones: *"We have external people involved as well at the serious points. So developing the design would have probably been quite a serious point for internal decisions. So, making sure that we have external people […] more actively involved…."* Moreover, he suggests some kind of process audits by experienced persons from outside the subsidiary, e.g., Corporate. Team member 2 adds further insights, e.g., on design tools in the development process and the review process in particular: *"One thing, that really did dent my confidence on, was the review process. The review process is perceived as stopping anything going wrong. It did not. And the next time neither. Because at the end of the day there are things that will creep through, there are judgments that have to be made, there are risks that are involved. We try and give visibility to risk, but it is not bullet proof, it is a subjective judgment of how big the risks are, people will disagree. And the end result is, that maybe there is risk in there that you were not expecting or that is much more severe than it was estimated in the review process that passed it but in retrospective should not have. Very easy, being wise after an event. But the review process, you know, I think is good. It is still vulnerable. And as long as there are people involved, it will be. You know, engineering, some people think engineering is clear cuts, and it is sort of right or wrong, but it is not. It is all about compromise and judgment. Well, and I have an expression, I use a lot, which is: You cannot win, you can only lose gracefully."* Thus, after the project, he forced himself to be much more questioning and, in case his evaluation differs, to speak up more openly: *"I am getting my guys to ask many questions and also, I always was trying to persuade and have to believe what I was told. And in my young days, people used to say, people would not believe anything if it came from a computer program. And that is as true now, as it was then."*

Furthermore, there is no direct (linear) relation between level of negative emotions and rate of learning observable. For example, although the project leader had strong negative emotions tracing back to the failure, he learned less than team member 1, who had less negative feelings. Compared to team member 2, who indicated comparable strong negative emotions, the project leader again learned less. Please refer to Table 9 for an overview of the assessments of the Chrome interviews.

Table 9: Assessment of key variables – Case 6: Project Chrome

Categories (coded items)			Case 6: Project Chrome			
#	Category	Sub-category	Project leader	Employee team member 1	Employee team member 2	Overall
10	**Creeping death**	---	L (0)	L (0)	L (0)	**L**
16	**Emotional response to failure**	Negative emotions / Neutral reaction	H	M-H	H	**M-H**
19	**Emotional response to failure**	Regret	L (0)	L (0)	L (0)	**L**
20	**Escalation of commitment**	---	L (0)	L (0)	H	**M-L**
25	**Learning from failure**	Lessons - Org. level (incl. changes in org after event)	M-H	H	L (0)	**M-H**
26	**Learning from failure**	Lessons - Personal level (incl. changes in approach after)	M-L	M-H	M-H	**M-H**
29	**Re-motivation**	Implemented measures	L (0)	M-H	H	**M-H**
31	**Termination**	Clarity of failure definition [1)]	n/a	n/a	n/a	**No (0)**
33	**Termination**	Decision on termination	Mgmt/HQ	Mgmt	CTO	**Mgmt**
35	**Time**	Anticipation of failure	Long	Long	Long	**Long**
36	**Time**	Emotional recovery	Long	Long	Long	**Long**
37	**Time**	Right timing to terminate	Just right	Just right	Too late	**Just right**

Abbreviations:
H: High M-H: Medium-high M-L: Medium-low L: Low (0): not mentioned n/a: not applicable CTO: Chief Technology
Mgmt: Management HQ: Headquarter
1) Question asked to subsidiary management only

Source: Own illustration, interviews

To put the whole matter into a nutshell, project Chrome represents another project where the phenomenon of creeping death could not be observed despite a longer period of anticipation of the termination. The evaluation of the dependency and characteristics of learning from failure and negative emotions induced by project termination showed no linear relation. In particular, all interviewees had significant emotional reactions but varied strongly in the related level of learning. As the number of interviews was only three for the project, no clear indication on the research questions of the impact of terminated R&D projects on learning and emotional reaction at the employee level could be derived.

4.9 Case 7: Project Delta

4.9.1 Outline

Project objective: The objective of project Delta was to develop a completely new type of product, which included hardware and software components. The product to be developed was very complex, thus the requirement specification was a key issue in the process.

Project resources, duration and termination event: A core team of ten engineers worked full time on developing the new product, supported by five more experts from other locations part-time. Compared to the other projects investigated, a quite junior team was in charge of Delta as a new group has been ramped up for this project, which hired several highly motivated university graduates to complement their experienced engineers. All relevant disciplines have been on board, essentially electrical engineers, software engineers and computer scientists. A budget of roughly $2.5 million US-Dollar was available for the development in total. The project has been kicked off in January 2006 and the project team worked for almost a year on developing the product. In the course of the project work, first time to market and cost estimations have been based on the incomplete specifications and were discussed with management during review meetings. Due to the fact that the product, based on cost and time requirements, was regarded as not competitive given the estimated volume sold by the management team, project Delta was finally terminated after some days of discussion in December 2006. One major reason that led to the failure was the fact that the requirement specification of the product – usually a key milestone that is completed before the development activities start – has been postponed several times and finalized very late when the preparatory work for project was already ongoing for several weeks based on general statements on the product requirements. Thus, on the one hand indications might have prevailed that the product management misses a clear understanding of market requirements and on the other hand and a more valid basis for cost and time estimations was missing. Very interestingly, a similar development project has been executed by a different subsidiary of the company later. Unfortunately, it led to the same result: It needed to be terminated as the cost targets could not be fulfilled as well.

Background of interviewees: As the most senior team member, the project leader worked for 30 years in the industry and for 24 years for the company respectively. Before leading various development projects, he gained experience as hardware developer after having graduated as electrical engineer. Team member 1 joined subsidiary D directly after his graduation from university in computer science as a software developer. At the time of the interview, he consequently had five years of industry experience. The same applies for team member 2, who joined the company after completion of his university degree in electrical engineering.

4.9.2 Within-case analysis - general patterns

The analysis of project Delta shows a very mixed picture when looking at the key variables for my research. The inequalities start with the question whether the team members anticipated the termination. Differently from the other interviews, the experienced project leader anticipated the termination rather short-time. The premier reason for that might have been the good market prospects despite the problems with the finalization of the specifications: *"It was not so clear to me why this happened. Because again and again, it was announced that there is a market, that it is a lucrative market."* His junior colleagues paid more attention to spreading rumors, as team member 1 explains: *"Of course a few weeks or perhaps one or two months earlier you would have expected that because there were also rumors that it is then canceled, and then it was not. It was, I believe, so a few times back and forth, through the grapevine."*

Nevertheless, this interviewee surprisingly did not mention anything that related to a creeping death process during the last months before the termination of project Delta. More interestingly, the project leader, showing a short anticipation time of the failure, clearly states a creeping termination process: *"So, that was a creeping process, because the document was not there, because the base [for the development work] was actually missing at our site."* Please refer to Table 10 for an overview of the diverging assessments with regards to anticipation of the failure and perception of a creeping death.

Table 10: Assessment of key variables – Case 7: Project Delta

Categories (coded items)			Case 7: Project Delta			
#	Category	Sub-category	Project leader	Employee team member 1	Employee team member 2	Overall
10	**Creeping death**	---	H	L (0)	H	**H**
16	**Emotional response to failure**	Negative emotions / Neutral reaction	M-H	M-H	M-L	**M-H**
19	**Emotional response to failure**	Regret	H	H	L (0)	**M-H**
20	**Escalation of commitment**	---	H	H	L (0)	**M-H**
25	**Learning from failure**	Lessons - Org. level (incl. changes in org after event)	M-L	M-H	M-L	**M-H**
26	**Learning from failure**	Lessons - Personal level (incl. changes in approach after)	L	M-L	M-H	**M-L**
29	**Re-motivation**	Implemented measures	L	M-H	M-L	**M-L**
31	**Termination**	Clarity of failure definition [1]	n/a	n/a	n/a	**No (0)**
33	**Termination**	Decision on termination	Prod. Mgmt	Prod. Mgmt	Mgmt	**Prod. Mgmt**
35	**Time**	Anticipation of failure	Short	Long	Long	**Long**
36	**Time**	Emotional recovery	Long	Short	Long	**Long**
37	**Time**	Right timing to terminate	Too early	Too late	Too late	**Too late**

Abbreviations:
H: High M-H: Medium-high M-L: Medium-low L: Low (0): not mentioned n/a: not applicable Prod. Mgmt: Product Mgmt: Management
1) Question asked to subsidiary management only

Source: Own illustration, interviews

These diverging assessments continue across other variables. Concerning personal learning from failure, all three interviewees showed different levels of insights. While the project leader recognized that in estimations political issues are somewhat important, he did not indicate a changed behavior due to the project experience. His colleagues did generate lessons learned, although with varying intensities. Team member 1 claims that due to their junior status, the sole experience provided valuable insights: *"Almost all junior hires can also use this knowledge of what they have adopted themselves at that time. This represented in this respect also training... So for us, something has come out."* His colleague, team member 2 learned from the termination to focus his personal investment and prioritize: "*When investing energy today, I am considering very well for what. Is it worth it to invest that motivation? Is it useful for the project? What does it mean for me personally? What does that do for me? Do I gain more knowledge? Therefore, I am considering it much more accurate. Earlier, I have been a little aimless and gained all knowledge without knowing if I really need it for the project.*" In comparison, the three interviewees clearly utilize the entire spectrum – from 'Low' learning to a 'High' level of learning from the terminated project.

The evaluations of the last key variable are more even across the three interviews. All interviews have been assessed with a 'Medium' ('Medium- high' or 'Medium-low') level of negative emotions, while team member 2 showed a little less negative affect after the termination.

For the project leader of Delta, it was the first time that one of his projects had been cancelled, which might explain his more negative emotional reaction, together with the importance of the product: "*First, it was my first project, which has been canceled at all. Previously, all projects have been finalized. And there were also really big ones. So, this was the first project. I was disappointed. It was a very interesting topic, it was a new topic. There was the perspective, that we would establish a whole platform family. This is not only the one device, but that we set up a whole family. This would have become an important pillar for the site here.*" He continues: "*First, there was a certain kind of emptiness. This means we have previously worked on the project and at suddenly there was nothing. It was also not the case that you directly got a new project. In other words, you fell into a 'hole' at that moment.*" This 'Medium-high' assessment can be applied to team member 1 as well. Team member 2 tried to change perspective to the future to manage the disappointment: "*I have worked quite long, worked extra hours, and put all my effort into it. And then I realize there is nothing out of this investment, this commitment. It was a pity. […] But I think, I then thought: 'Well, go to* *work the next day and check how to continue'. I needed this distance to manage this disappointment and all that stuff."*

In sum, project Delta shows no clear pattern across the key variables of the interviews. A reasonable aggregation of the assessments on project level is not possible due to the missing commonalities for project Delta – an aggregation would just represent an 'mathematical average' that would not reflect any of the interviews.

4.10 Case 8: Project Dexter

The last project analyzed within this dissertation is project Dexter. The following case discussion complements the previous cases and closes the within-case analysis.

4.10.1 Outline

Project objective: The aim of last project investigated in this dissertation, project Dexter of subsidiary D, was to develop a solution to upgrade an existing system at various customer locations. Thus, the project itself was directly coupled to a customer order and represented a large-scale and complex development of a new product line. The dimension of the project were special, it represented a high-end scale compared to other projects in the market. It was believed that if subsidiary D could deliver this project, it could cope with any other project worldwide successfully and become the leading platform of the business. The solution consisted of various sub-systems and was software-based to a large extent but included some new infrastructure as well.

Project resources, duration and termination event: A very large project team was involved in the execution of Dexter. Around 150-200 employees across were working on the development in a complex project organization distributed across three locations in different time zones. Altogether, they worked approximately 3,600 man months on the development. The project budget also reflected the magnitude of the project and totaled in more than $30 million US-Dollar. More than three years passed between the project start in summer 2007 and the termination in late 2010. Retrospective, the project complexity has been partly the reason why the project failed. On the one hand, the project specifications needed to be adjusted several times, mainly due to language barriers, missing direct customer interaction and coordination problems of the client himself. On the other hand, the customer was not convinced with the project organization. By mid 2009, the customer was invited to subsidiary D in order to review a demonstration system in the laboratory. The concerns of the client were not based on the technical feasibility but whether subsidiary D would be able to deliver the system on time due to lack of coordination across the different sites. A large portion of the failure in fact led back to the missing clear specification of the solution. Although the product managers of Dexter have visited the customer several times, it was hard to find out what their client really wanted. This was driven to a large extend by the complex organizational structure of the customer, who often did not reply to questions regarding the specifications of the subsystems. As many requirements still came in late or had been redesigned, the project ran into a delay of about three months. Aggressive planning and high commitment of the project team allowed compensating a large portion of the delay. The first final acceptance tests of some sub-systems were already finished, but some were still missing when rumors came up that the project might not be continued. In parallel, the subsequent delivery of the solution to the public had been started. However, the requirements once again had not been released and there has been am uncertainty about the direction and positioning on the target market. This disagreement and discussion on the positioning was supported by a change of the management, which also played a role for the delay. In an official meeting, the management decision to terminate the project due to the lack of confidence of the customer, leading to a significantly reduced scope of the order, as external reason and the internal ambiguity of the strategy of the business was communicated. During the closing of the project, parts of the solution that had already been finalized were delivered to the customer. An interesting fact is that, after the termination, the research on the project content still continued but with a broader perspective directed towards the general market.

Background of interviewees: The project team has been described as a mixture of senior engineers and colleagues with less experience. The interviewees represented a representative cross-section of the team. The project leader, a graduated electrical and information technology engineer, worked for eleven years in the industry prior to the interview and had an even longer track record with the subsidiary, having worked 16 years for the company. His colleague, team member 1, has a background in computer science. He worked four years in the industry. In total, he gathered experience during 19 years of employment at the company, having worked in different industries before. Team member 2, who also holds a university degree in computer science, was responsible for a sub-component of the project. She worked for 9 years both in the industry and at the company.

4.10.2 Within-case analysis - general patterns

The analysis of project Dexter also shows varying values of the key variables of interest across the interviews. The different views on the project and its termination already start with the anticipation of the termination. While the project leader started to foresee a possible termination, it was quite unexpected for the other two interviewees. Take the following statement of the project leader: *"We knew at some point during summer, that after the colleagues from site X more or less have shut down their work, the whole topic is reviewed again and there will be a decision until October. Until October, we had nothing official yet, but it was already foreseeable that it won't be continued."* Team member 2 by contrast answered the question whether she anticipated the termination: *"Actually not, because it was such a big thing, the customer had also invested much, was also waiting for two and a half years, that I thought: 'The topic has to go through. It will work!'."*

More interestingly, it was also team member 2 who was the only one to perceive a phase of creeping death towards the termination, describing that she constantly had to ask for the status of the project towards the end and that she even did not know, whether the project had finally been completed. The driver for these different perceptions cannot be inferred from the interviews; in particular, it is unclear why the assessments vary to this large extent.

A similar picture applies for the emotional response to the failure. Assessments vary from a ‘Medium-high’ to a ‘Low’. Although all interviewees showed a high commitment, the engineers obviously have been differently attached to the project. The most negative emotional reaction showed the project leader, who not only felt a *“real motivational trough”*. He continued: *“I was emotionally bitterly disappointed. I believe many colleagues, especially all project leaders who have worked with us and had invested very heavily, and had to endure a lot. Being a project manager of this project is like a spinal disc, so you have the teams and their dissatisfaction from below and pressure from above.”* Ultimately, this pressure even contributed to health issues: *“Very much of my free time has been lost due to the project. So I actually like to do sports and I am running much or ride my bicycle. Just at the end of the project, I've had personal health problems. I got a herniated vertebral disc.”* His two colleagues had less serious negative responses to the termination, e.g., team member 2 stated: *“But honestly, I have to say it has not touched me in this sense because we have finished the thing [the sub-component he worked on].”* She continued: *“Personally I am not attached to it that much. I love my work, but I know from experience that that just can happen, especially if I have projects, which take such a long period like this one. This can happen … It has not affected me personally, there are other issues that affect me more.”*

Comparing the level of negative emotions with the level of lessons learned from the termination, a slight trend becomes apparent: A positive correlation relates both variables, the more negative the emotions were, the higher the learning from failure seemed to be. However, this trend cannot be based on extreme differences since all interviewees generated insights of 'Medium' ('Medium-high' to 'Medium-low') intensity (please refer to Table 11 for the respective assessments). In general, the lessons learned relate to a large extend to project management issues. For example, the project leader learned that: *"We really have to keep focus on any indicators or we need to define them. So to have a basis to be able to say: 'If such a project is running, if the respective indicator is deviating significantly at a certain time, it must be terminated.' – not to let it run quite as far. I personally, I prefer a miserable end than endless misery, but the disappointment when it has expired this way was great for me and for people, I believe."*

Table 11: Assessment of key variables – Case 8: Project Dexter

Categories (coded items)			Case 8: Project Dexter			
#	Category	Sub-category	Project leader	Employee team member 1	Employee team member 2	Overall
10	**Creeping death**	---	L (0)	L (0)	M-H	**M**
16	**Emotional response to failure**	Negative emotions / Neutral reaction	M-H	M-L	L	**M-L**
19	**Emotional response to failure**	Regret	L (0)	L (0)	L (0)	**L**
20	**Escalation of commitment**	---	L (0)	L (0)	L (0)	**L**
25	**Learning from failure**	Lessons - Org. level (incl. changes in org after event)	M-L	M-L	M-L	**M-L**
26	**Learning from failure**	Lessons - Personal level (incl. changes in approach after)	M-H	M-H	M-L	**M-H**
29	**Re-motivation**	Implemented measures	M-H	M-L	L (0)	**M-L**
31	**Termination**	Clarity of failure definition 1)	n/a	n/a	n/a	**No (0)**
33	**Termination**	Decision on termination	n/a	Mgmt	Mgmt	**Mgmt**
35	**Time**	Anticipation of failure	Long	Short	Short	**Short**
36	**Time**	Emotional recovery	Long	Short	Short	**Short**
37	**Time**	Right timing to terminate	Too late	n/a	n/a	**Too late**

Abbreviations:
H: High M-H: Medium-high M-L: Medium-low L: Low (0): not mentioned n/a: not applicable Mgmt: Management
1) Question asked to subsidiary management only

Source: Own illustration, interviews

The comparison of the interviews of project Dexter bears some inconsistencies, e.g., the different perspectives whether the termination has been anticipated or the contrary perceptions whether a creeping death prevailed or not. Furthermore, the correlation of the key variables 'negative emotions' and 'level of learning' is as well missing a strong, clear picture that prevents an unambiguous aggregation on project level.

Project Dexter was the last project to complete the case outlines and its initial findings with regards to the key areas of interest. The subsequent chapter now goes into greater detail and deeper level of analysis.

5 Cross-case analysis and theoretical discussion

Having identified emerging patterns and key variables for more detailed investigation during the within-case analyses, I now move on to the core part and the 'heart' of theory building in this dissertation. In particular and compared to the single cases, the analysis across the different cases revealed interesting insights on the processes within the project teams and respective team members' actions and emotions. Before discussing the content, I briefly present the approach of the cross-case analysis.

5.1 Cross-case analysis approach

The intended initial step to prepare the cross-case analysis was to compile a complete raw matrix with all interviews and all categories from the partially-ordered case displays from each within-case analysis, providing the highest detail level available ('micro perspective'). However, creating a matrix including all interview quotes per node and interview proved to be impracticable due to the numerous data points, as the cells would have contained several hundred pages of corresponding segments of text. Thus, I instead used a separate text document for each node that included all interview quotes clustered according to each interview to make a handling of the comprehensive raw data possible. I then cross-checked the compiled complete raw matrix with all interview assessments from the within-case analyses by reading through the text documents with all interview quotes per node and comparing it with the assessments in the complete raw matrix. In the course of the analysis, I used the complete assessment matrix to identify patterns, always moving back to the text documents with the respective interview quotes when required. Table 12 shows a small excerpt to provide an overview on how the matrix looks like.

Table 12: Complete (‘raw’) assessment matrix – Extract of node “Learning from failure – lessons – personal level”

Categories (coded items)					Subsidiary A		Subsidiary B		Subsidiary C		Subsidiary D	
#	Node	Sub-node	Category dimensions	Category definition	Interviewee	Assessment	Interviewee	Assessment	Interviewee	Assessment	Interviewee	Assessment
26	**Learning from failure**	Lessons - Personal level (incl. changes in approach after)	High	significant insights / change / implemented	1. - BU	Low	3. - BU	Low	2. - BU	Medium - L	4. - BU	Medium - L
			Medium	"normal" insights	1.1 - PL	High	3.1 - PL	Medium - L	2.1 - PL	Medium - L	4.1 - PL	Low
			Low	no / very limited learnings, not implemented	1.2 - E1	High	3.2 - E1	Medium - L	2.2 - E1	Medium - L	4.2 - E1	Medium - L
					1.3 - E2	Medium - H			2.3 - E2	Medium - H	4.3 - E2	Medium - H
					1.4 - PL	High	3.4 - PL	Medium - L	2.4 - PL	Medium - L	4.4 - PL	Medium - H
					1.5 - E1	High	3.5 - E1	Medium - L	2.5 - E1	Medium - H	4.5 - E1	Medium - H
					1.6 - E2	Medium - H	3.6 - E2	Medium - H	2.6 - E2	Medium - H	4.6 - E2	Medium - L
					Overall	**High**	**Overall**	**Medium - L**	**Overall**	**Medium**	**Overall**	**Medium**
27	**Learning from failure**	Organizing to learn from failure (incl. belief in learning)	High	lessons learned/documentation process (beyond pure technical learnings) available / applied	1. - BU	High	3. - BU	Low	2. - BU	Medium - L	4. - BU	Medium - L

Source: Own illustration, interviews

In order to be able to see patterns, the next step was to develop an aggregated ‘summary’ table from the ‘raw’ assessment matrix, in which I clustered and further aggregated the individual assessments of each interview to the higher-ranked project level. Again the rows were the nodes and the columns were the cases but this time the cells represented assessments of the level of the specific category for the corresponding case. To illustrate the approach, the following example provides an overview into the aggregation mechanism. Taking again the category of “Learning from failure – lessons – personal level”, the detailed, raw or micro-level table indicates for project Boron two ‘Medium-low’ (data points 3.4 and 3.5) assessments and one ‘Medium-high’ (data point 3.6) assessment. The aggregation of these data points on a macro-level in the partially ordered table (aggregation matrix) resulted in an overall assessment of ‘Medium-low’ due to the fact that the ratio of the data points favored the latter dimension. Having performed this aggregation for all projects, I then let the data speak and approached the results with an open mind. Table 13 shows an extract to provide an impression of the table; the complete aggregated assessment matrix on project level is included in appendix 7.

Table 13: Aggregation matrix – Extract (including node "Learning from failure – lessons – personal level")

Categories (coded items)			Subsidiary A		Subsidiary B		Subsidiary C		Subsidiary D	
#	Category	Sub-category	Project Alpha	Project Argon	Project Bravo	Project Boron	Project Caesar	Project Chrome	Project Delta	Project Dexter
1	Blame for failure	---	L	L	L	L	Mixed	Mixed	L	L
...										
26	Learning from failure	Lessons - Personal level (incl. changes in approach after)	H	H	M-L	M-L	M	M	M (mixed)	M (mixed)
...										
44	Uncertainty/ Unstability	Strategy	H (mixed)	L	L	L	L	L	L	H

Source: Own illustration, interviews

The aggregation of the assessments on project level was not clearly identifiable for all cases. Applying the logic of Eisenhardt (1989a) to use extreme cases that possess a high transparency on the key constructs to be analyzed, I focused on cases of high and low learners that showed homogenous assessments across all interviews for the key constructs and thus could be clearly and unambiguously aggregated. The key variables for projects Caesar, Chrome, Delta and Dexter varied to a significant degree across the respective interviews, so that a clear overall assessment could not be taken. For this reason, I excluded them from the cross-case analysis. As an example, for project Caesar, the anticipated termination was generally not perceived as creeping death by all interviewees, but the impact on emotions and learning varied. The project leader and team member 1 both generated low negative emotions and showed a low level of personal learning. However, in stark contrast, team member 2, who as well generated low negative emotions, has been assessed to have had a significant personal learning from the termination. This difference in the pattern cannot be explained from the data. Thus, in sum a clear pattern is missing, in particular due to the above mentioned contrary tendencies and differences in the main categories of my analysis.

The final step of the analysis is to examine and triangulate the data with the goal of identifying propositions on themes, constructs and potential interrelations and effects, leading ultimately to the proposition of a model to present the findings holistically. To achieve this, I used a cross-case comparison to allow differences across groups (high learners versus low learners) to emerge (Eisenhardt, 1989a; Miles & Huberman, 1994). Specifically, I oscillated between the 'raw' material and the 'summary' table consistent with moving my thinking between details and abstractions. As a result, the key constructs and their relationships began to emerge. To validate these findings, I went back to the detail level in a last step to review the respective quotes behind them and to test the identified propositions based on the interview responses.

Having executed the methodology discussed above and as the words from the interviews matched the propositions, I could identify several patterns from the cross-case analysis. These patterns provided a basis to generalize the evidence and to derive propositions ultimately leading to a model, which will be described in the following chapter. The following sections present the results of the previously discussed analysis and introduce propositions, which are designed to act as starting point for further investigation and research due to the explorative character of this dissertation.

The analysis process yielded in several results. The first major insight that emerged from the data was that those who experienced the greater negative emotions learned the most from the failed project – a finding that at first appears to challenge recent findings that negative emotions obstruct learning (Shepherd et al., 2011). Interestingly, however, the negative emotions were not over the project lost but that the project had not been terminated sooner – consistent with the data, I refer to this as *creeping death*. Project team members were emotionally invested in the engineering *process* and not so much in any one *project*. Delayed termination (i.e., termination perceived as creeping death by the team members) generated negative emotions but also provided the time to learn from the experience – organizational members learned from *failing* projects rather than *failed* projects. The second major insight was that an anti-failure bias manifests itself in a way that accelerated termination but obstructed learning. Specifically, by separating termination from the 'loaded' term of failure through (re)definitions (of the labels ‘project’ and ‘failure’), managers were able to (in their minds) avoid failure and were ‘free’ to terminate the project. The third major insight was that while speed to termination was accelerated by an autocratic process and these ‘non-participative’ processes alleviated rather than exacerbated the negative emotions of team members, they also both cut short a period of decline necessary to learn from the experience (given rapid redeployment to the next project) and obstructed organizational ‘learning from failure’. These findings are discussed and brought into perspective with extant literature in the following sections.

5.2 Learning from a failing / failed project

Details emerged from the data linking project termination to both team members’ emotional reactions to and learning from the experience. I asked team members to reflect on how much they had learned, an approach that is consistent with the sense-making perspective on the importance of developing a plausible story in order to move forward (Weick, Sutcliffe, & Obstfeld, 2005), especially in terms of making sense of project failure (Shepherd et al., 2011). Although groups (organizations and teams) can learn (Fiol & Lyles, 1985), I focused on the outcome of individual team members’ learning from their experiences (I investigate organizational processes and routines that facilitate learning from failure).

Table 14: Team members' reflection on and learning from the terminated project

Project Alpha		Project Bravo	
Interviewee	Level	Interviewee	Level
Project Leader Example: *"Therefore, there is a learning effect for me personally…. I learned, on the one hand, that I cannot…influence it [the project success] in general… On the other hand, I learned to protect myself a little bit more by simply keeping it at a distance."*	High	Project Leader Example: *"I am not always that good at learning from failure…, but I was fighting and fighting and fighting, and I was blind because I wanted the project to succeed. And that was the failure in itself."*	Med-Low
Employee team member 1 example: *"I think if we had signed project contracts [with the customer before the R&D project], they would have been very bad for us. Realizing this has been very, very important for me."*	High	Employee Team Member 1 Example: *"As a researcher, you are always ahead of technology. Being in front, you have to make decisions. You should be aware of why you made the decision to go in that direction at that specific point and not to go in another direction."*	Med-Low
Employee Team Member 2 Example: *"It is not only important to understand the headline but also the sub-items [details]. This became very, very clear during this project…. Even then you can still find certain problems you have not thought of before. It has been very important learning from this."*	Med-High		

Project Argon		Project Boron	
Project Leader Example: *"In other words, the first machine will always cost the most, and the more we build, the cheaper it gets. But our cost calculations were not able to consider this fact. This was one of the 'lessons learned' from the project – that we have many weaknesses in the way we calculate product costs."*	High	Project Leader Example: *"…during that very night [when the project was stopped], I do not think that I got much sleep. I was not thinking that much about project Boron; I was thinking about the new project [which had been assigned to him two hours after the project had been stopped]."*	Med-Low
Employee Team Member 1 Example: *"I personally have learned a lot from this. I've gained a lot of experience regarding the technical content, as well as when to communicate with the internal client and all involved."*	High	Employee Team Member 1 Example: *"When we have a situation like this, I think, we are very short sighted in our company. If we have one set of goals but cannot meet those goals, then we spend a lot of time trying to repair instead of saying 'It is not possible to reach these goals, at least not right now.' Do we have other options? We do not try and say 'Ok what can we then do?' We are just saying 'Ok, then we just have to wait now or to close.' Instead of trying to say…'What other possibilities do we have?'"*	Med-Low
Employee Team Member 2 Example: *"…and seeing that top management's focus is not directed to this topic is just frustrating. The hierarchical level of the project in the organization is of utmost importance. We have simply wasted so much time on working through the lower levels of management to the top management."*	Med-High	Employee Team Member 2 Example: *"I probably knew it somewhere in the back of my head beforehand… . But regarding how I relate to our company as an employee and how we do the projects, I would say no [I did not change the way I work on projects]…. So the recipe itself for how I perform projects will not change a lot."*	Med-High

Source: Own illustration, interviews

As illustrated in Table 14, there is a considerable difference across groups of cases. In projects Alpha and Argon, the team members reported learning a great deal from their experiences. For example, the leader of project Alpha stated that he learned that open communication is a vital prerequisite in managing project terminations: *"The most important thing [I learned] about this open communication [about project termination] is to be honest. If you do not know something, it is best to say it right away than to 'build castles in the sky'."* The leader of project Argon demonstrated learning by realizing the importance of team members' preparation for key project meetings: *"The other thing I have observed is that people [who are not involved deeply in the project on a regular basis] are not prepared properly for such an important meeting… [They do not have] the capacity to go into a meeting unprepared, to listen to such a complex situation and then to make the right decision… I need to make sure that these people are well-prepared [for such a meeting]."* Similarly, team member 1 of project Alpha noted: *"If it is really about a specific product development, it is important that we set targets…and impose the question whether we are really convinced that we will have a chance to achieve these goals. Is it possible? Yes or no? At least [now] I am trying to emphasize this more."* These quotes are consistent with field notes made during my visit to the project Argon site; I heard from a conversation between the project manager and team member 1 that as a result of terminated projects, the subsidiary manager had established a 'lessons learned' database, and they discussed specific lessons that had been entered in to the database.

The high level of learning for each team member within both projects Alpha and Argon is in contrast to the rather low level of learning of each team member within both projects Bravo and Boron. For example, all interviewees of subsidiary B stated that they did not generate any specific learning about how to manage R&D projects or how to improve the R&D process. Although the project manager of Boron mentioned a meeting to capture lessons learned from the terminated project, the majority did not see a reason to change the way they perform future projects. This was indicated by the project leader of Boron: *"I will do it [in the future] in exactly the same way."* Similarly, when asked if he had changed anything about the way he managed projects, the project leader of Bravo responded *"No, not at all."* Further, team member 2 of Boron concluded: *"But regarding how I relate to our company as an employee and how we do the projects, I would say no [I did not change the way I work on projects]…. So the recipe itself for how I perform projects will not change a lot."*

The subsequent part of the dissertation deals with my attempt to understand these differences. First, I found that delaying project failure was a double-edged sword: On the one side, it enhanced learning from the experience, but on the other side, it was perceived as creeping death that generated negative emotions. Second, I found that an anti-failure bias was manifest in redefining project failure that reduced (or eliminated) the delay of project termination. Finally, I found that autocratic processes that enhanced the speed of project transition eliminated important mechanisms for learning from failure.

5.3 Delayed project termination: A double-edged sword

When is the 'right' time to terminate a poorly performing project? Financial research based on an expected present value approach suggests termination at the point when current losses (expenses) exceed the present value of expected profits (Ansic & Pugh, 1999). However, behavioral and psychological research has found that people often delay such decisions despite the negative financial consequences of doing so. For example, Gimeno, Folta, Cooper and Woo (1997) explained variance in entrepreneurs' decisions to terminate poorly performing businesses in terms of alternative opportunities, psychic income, and switching costs. Given that delayed termination is financially costly, it is often explained in terms of biases, such as those associated with personal sunk costs; over-generalizing from past successes; and, more generally, escalation of commitment (Staw, Sandelands, & Dutton, 1981), as well as procrastination (Anderson, 2003; Lazarus & Folkman, 1984). Shepherd and colleagues (2009) proposed that there are benefits to deciding to delay the termination of a poorly performing business; it provides time for those invested in the business to emotionally prepare for the termination, which reduces their negative emotional reactions to its loss (up to a point, but after that point, doing so generates negative emotions). By reducing the emotional costs of termination, the entrepreneur is more motivated to try again, but such a benefit should be weighed against the financial cost of delay.

An analysis of the data for the current study suggests an alternate view, at least when it comes to the decision to terminate R&D projects (as opposed to a business). In Table 15, I offer a summary of the evidence.

Table 15: Decision to terminate the project and negative affect (NA)

Project Alpha		Project Bravo	
Delayed termination ('creeping death'): the team members used the terms 'creeping death' and 'creeping process' explicitly to describe termination.		Early termination: the termination was described as decisive and abrupt after a steering committee meeting with Bert, the top manager.	
Interviewee	Level of NA	Interviewee	Level of NA
Project Leader Example: *"It was painful, as it had always been the 'flagship' before…. If we still want to be competitive in five or ten years, we have to focus on technology, and this has been the only major technological topic."*	High	Project Leader Example: *"[It cost me] One night's sleep, I think [to get rid of any negative emotions]. That is because I think there were no implications to my working situation."*	Low
Employee Team Member 1 Example: *"I mean, let's be clear about it: a year ago we were the pioneers, and everyone in the community around the world knew it…. The fact is we have not gotten that far…. That hurt me personally."*	Med-High	Employee Team Member 1 Example: *"It [the negative emotion] was just a small scratch – on or two or something like that [on a scale from 1–10]…. But it was not a deep frustration…. I had no problems."*	Low
Employee Team Member 2 Example: *"You start to get angry and you shake your head because a lot of effort and money would have been wasted. You then have to wonder why you did this stressful work over the last three years…. It is extremely bad if you have the feeling motivation is not only getting lost but is switching completely because you cannot provide any perspective to the people [including external suppliers] because you cannot provide a clear explanation…. It is painful that the efforts up to this phase suddenly are not important for this project anymore."*	High		
Project Argon		**Project Boron**	
Project Leader Example: *"I think this is the real frustration because I have analyzed it, and I think I knew where it went wrong, but I couldn't change it."*	High	Project Leader Example: *"And with a snap…for an instant I felt free…. I was kind of relieved…. When I stopped the project in country B…, I had this empty feeling inside, but I did not have this empty feeling with this project."*	Low
Employee Team Member 1 Example: *"Thus, I realize that there is a certain caution and no longer a free 'We can do it' mentality. That has left marks."*	Med-High	Employee Team Member 1 Example: *"It was a three or four [on a scale from 1 to 10 for negative affect] because it is just bad when something like this happens. But then quickly, the day after, I just said: 'Ok, now my task has changed, and this is what I am doing from now on.'"*	Med-High
Employee Team Member 2 Example: *"I felt helpless at having to admit to the customer we could not to deliver the product. I was also acting against my own convictions because the machine in my view was indeed the right development."*	High	Employee Team Member 2 Example: *"We talked a lot about it the day that we got the news [of the project ramp down], and when I left the office, I just actually left it behind…. Let me put it this way: when I coped with this – which in this case, I could do relatively quickly – I looked ahead."*	Low

Source: Own illustration, interviews

Creeping death: Negative emotional reactions to a ‘stalled process’ not ‘loss of a project’

I found that those who had the most time to emotionally prepare for a termination had the greatest negative emotional reaction to project failure. Indeed, it was the delay in the termination decision itself that generated negative emotions in the team members. Team member 1 from project Argon aptly described this notion as ‘creeping death’: *“I guess it was good that at some point there was a definitive decision. To this day, it still causes people to shake their heads [in disbelief] because it was such a creeping death.”* Although other members of projects Alpha and Argon did not use the term ‘creeping death’, they all expressed a sentiment consistent with it. For example, the project leader of Argon mentioned: *“The motivation and the belief in the project were already set at this time – through this long impasse…. It was between life and death. It was not yet dead, but it was also not fully alive.”* The project leader of Alpha described that management wanted to ramp down the project repeatedly: *“And to be fair, I have to say that also within our company, we always had to do a lot of lobbying [for the project]. There were opinions at the corporate level that said: ‘We are not interested anymore. It is better to do something else instead. We do not trust in the performance of the new product anymore.’ We always had to fight a little bit for the project.”* Internal minutes of meetings from the company also provided evidence of the creeping death of projects. For project Alpha, the minutes of a project review meeting in January referred to a ‘soft-landing approach’ in which work on the project was to be slowly ramped down. It was not until March that the meeting minutes referred to a ‘hard-landing approach’ to stop the project more aggressively. Finally, in September, this ‘hard landing’ had been implemented.

This creeping death generated negative emotions. Team member 2 of project Argon in his interview expressed this sentiment when he commented on the decision to terminate finally being made: *“We experienced a long period of uncertainty with no decisions being made; at least it [the decision to terminate] was a decision. This decision was overdue.”* I found additional evidence of negative emotions generated from creeping death in the interviews with project Alpha team members. For example, team member 2 of project Alpha expressed feeling frustration and anger (*"You start to get angry and you shake your head because a lot of effort and money would have been wasted."*), humiliation and embarrassment (*"It is extremely bad if you have the feeling motivation is not only getting lost but is switching completely because you cannot provide any perspective to the people [including external suppliers] because you cannot provide a clear explanation."*), as well as passive negative emotions, i.e., fear, grief and regret (*"That concern that everything will be damaged without having thought it through to the end….You then have to wonder for which reason did you do this stressful work over the last three years."*). Field notes also revealed negative emotions induced by the tedious process of terminating the projects. In several side discussions between interviewees, they repeatedly expressed the emotional impact of the delayed (late) termination. Indeed, a top manager of subsidiary A expressed negative emotions that project Alpha's termination had been delayed: *"It was a pity that we put so much money into it [the project]."*

In contrast, projects Bravo and Boron were terminated rather quickly – there was little time for the team members to emotionally prepare for the loss of the project. One team member explained project Boron's termination by saying: *"It was suddenly a reality."* Similarly, the termination of project Bravo happened rapidly. When asked about anticipating project Bravo's termination, a team member replied: *"No, not until I had this meeting…. And then I thought: 'Ok, then we have to terminate because we have no chance to get the material.' So we could not continue."* As illustrated in Table 15, the team members of projects Bravo and Boron did not generate many negative emotions with regards to the fact of the ramp-down even when I directly asked about it. For example, when asked about the duration of his emotional reaction to the termination, the project leader of Bravo reported that it cost him *"One night's sleep, I think. That is because I think there were no implications to my working situation."* The project leader of Boron noted: *"I am not that hurt by it. I now have another really big project."* Only team member 1 of Boron expressed any real negative emotional reaction to the termination; however, his emotional reaction as previously discussed had more to do with his reassignment, which required that he and his family relocate to a different continent – it was moving his family that caused anguish, not the terminated project per se. In my field notes from my site visit observations, I also recorded the absence of strong and lasting negative emotions before and after the project Bravo and Boron terminations. For example, in side conversations after the interviews, team members of projects Bravo and Boron said they had no psychological or physical reactions to the terminations.

Although in multiple case study research, the major interest of this research lies in contrasts across (groups of) cases, it is interesting to note the consistency across all cases in terms of team members' emotional reactions to termination and to contrast it with the literature. The literature on loss suggests that most people will have negative emotional reactions to the loss of something important (Archer, 1999), such as the losses associated with divorce (Kitson, Babri, Roach, & Placidi, 1989), amputation (Wilson, 1977), death of a loved one (Stroebe, Schut, & Stroebe, 2005), and bankruptcy (Shepherd, 2003). Similarly, Shepherd, Patzelt, and Wolfe (2011) recently found that research projects were important to research scientists and that they had negative emotional reactions to these projects' failure. Despite expectations based on the literature that the R&D projects are important to the team members and their failure would generate negative emotions, this was not the case in the current study; all team members for all projects had a minimal negative emotional reaction to the termination of their failing project. A possible explanation for this lacking negative emotional reaction to the termination event is that the team members had become desensitized to failure (either through experiencing many failures or operating in an organization that normalizes failure [Ashforth and Kreiner, 2002]), but my data suggests something different.

Although I found that terminating failing projects did not generate negative emotional responses, delayed termination did. This finding points to a slightly different interpretation of both the 'emotional loss' and 'desensitization / normalization' literature. Emotion is not absent in my research setting; rather, what team members deem important is different, and it is this difference that helps explain both the absence of a negative emotional reaction to project termination and the presence of a negative emotional reaction to delayed termination. Specifically, what is important to team members is not so much the project itself but the 'engineering' process. For example, the project leader of Argon commented: *"It was also satisfying when you design a machine and everything fits. So if the top was put on the machine, our machines are very large, several meters long and several meters in diameter and you have gaps that are tolerated in tenths of millimeters…and everything fits, this is a great feeling. Therefore, this project was really satisfying for me."* This demonstrates that what was important to him was solving engineering problems – whether the overall project survived or not was far less important. Another example of this phenomenon is noticeable in the description team member 1 of project Argon provided of the terminated project: *"Ultimately, I believe that we have had a very good project here from a technical perspective: we have set a benchmark in the time line we needed, we have gone through the product development process appropriately; we have involved all necessary parties…"* As Green and colleagues (2003) noted, *"innovators like to innovate; being on the leading edge of a technology can be both scientifically satisfying and ego gratifying"* (p. 423). It appears that the engineers in my sample weren't upset because they still got to do what they love to do (solving technical problems) even if the project did fail.

Consistent with this notion of the importance of process over project, I found that it was only when the ‘opportunity’ to work on important problems was denied that team members generated negative emotions. When a project is terminated, team members are quickly deployed to work on other tasks. For instance, one team member noted that his transition to another project was ‘immediate’. However, when the decision to terminate is delayed, the team members perceived this creeping death as being ‘stuck with’ working on an unimportant engineering question/problem. That is, they felt they were being denied the opportunity to work on important engineering challenges. What was important to these engineers was not so much the project but the process; the loss of the opportunity to proceed with the engineering process (by being stuck in creeping death) generated negative emotions.

‘Learning from Failing’ rather than ‘Learning from Failure’

Unlike the first insight above, the second interesting insight involves a contrast between the groups of cases. In contrast to Shepherd, Wiklund, and Haynie’s (2009) notion of delayed termination providing an emotional benefit, I find that there is an emotional cost to delay (discussed above as ‘creeping death’). However, despite this emotional cost, there is evidence that delayed termination enhances learning from project experiences. The literature acknowledges that individuals can learn from their failures (Shepherd, 2003) – perhaps even more than from their successes (Sitkin, 1992) – because a failure indicates that current knowledge structures were inadequate, which can motivate sense-making activities (Ginsberg, 1988; Morrison, 2002). That is, after the termination event, the individual can reflect on his or her experiences and work to construct a plausible account for the failure (Shepherd et al., 2011; Weick et al., 2005). My findings suggest that the time provided by a delayed termination of a failing project is important in explaining who learns from their experience with failure and who does not (or who does to a lesser extent).

A possible explanation for the learning benefits of delayed termination is that when there is insufficient time after termination to reflect on one's experience and build a plausible account of why the project failed, the period provided by delaying termination takes on increasing importance. For example, despite the fact that new tasks and projects were already awaiting team members in their department, the time it took to ramp down projects Alpha and Argon (during the creeping death phase) allowed the team members to learn from the failure experience. As the project leader of Alpha commented: *"In our department, we by far did not have enough capacity for the new projects already waiting for us. So, our management decided that the new projects had high priority, and we had to finish our documentation within one month before having to start the new research topic."* In contrast, team members of the projects in subsidiary B had little to no 'down time' after project termination – they went straight into the next project. For example, one field note stated: "*Both teams of project Bravo and project Boron seem to have transitioned rapidly from one project to another."* For example, during a joint business lunch between interviews, one team member lamented that he had not had sufficient time to process and document the lessons learned from the terminated project because he was immediately transitioned to a new project due to the large pipeline of development projects in the firm. Indeed, team member 1 of project Boron noted that the transition happened rapidly: *"The day after [the termination], I just said: 'Ok, now my task has changed. I need to do this and that [new project], and this is what I am focusing on now.'"*

Therefore, I found that delayed termination was a double-edged sword. On one side of the sword, delayed termination was perceived as creeping death that generated negative emotions among individuals who were (for the most part) more emotionally invested in the engineering process than in the specific project. On the other side of the sword, delayed termination provided a time for reflection that was unavailable to team member whose projects were terminated quickly and who were thus rapidly redeployed to new projects (projects that were new to the individuals being redeployed).

5.4 Anti-failure bias and project termination: Redefining the labels of project failure

McGrath (1999) pointed out that managers (and for that matter scholars) have an anti-failure bias, and as a result, they experience failures that are more costly than they need to be. The implication is that by acknowledging that the pursuit of opportunity occurs in a highly uncertain environment, managers need to accept that project failure is part of the entrepreneurial process. Only then can the uncertainty be managed and one can learn from failures to move the organization forward (e.g., using a real options perspective [McGrath, 1999]). This can be achieved by more quickly acknowledging and terminating failing projects, learning from the experience, and moving forward. On the other hand, research has found that by not acknowledging a failing project, managers persist with poorly performing projects and may even escalate commitment toward them (Brockner, 1992; Staw & Ross, 1987; Staw et al., 1981).

My findings represent a different relationship between anti-failure bias and persistence. I found that denying a failing project led the manager to more rapidly terminate it (as opposed to delaying termination). In Table 16, I contrast the 'failure' mindset of a top manager of subsidiary B in which projects Bravo and Boron were housed with those of a top manager of subsidiary A in which projects Alpha and Argon were housed.

The top manager of subsidiary A (I will call him Arthur) acknowledged that project failure occurs within his organization and that he had grappled with the definition of what it means for a project to fail. For him, failure not only constitutes an economic loss and possible strain on team members' motivation but also offers the opportunity to learn: *"On the one hand [failure represents an] economic loss – that is quite clear. Investment in R&D that does* *not deliver a return.... Sometimes [there is] also a motivation issue, sometimes also a reorientation in the organization because you have to change certain ways. In general, there is a learning... so the question: 'What went wrong, what can I do differently next time?'"*

In contrast, the top manager of subsidiary B (who I will call Bert) believed that 'no projects' failed within his organization. Not only is Bert's 'treatment' and lack of 'acknowledgement' of failure in contrast to Arthur, it is also in contrast to the engineers within his organization. In Table 17, I provide evidence that at least in the minds of the team members of projects Bravo and Boron, they had experienced project failures. Indeed, whereas Bert indicated: *"Once we start a project, we carry it through. I cannot recall a project we did not carry through"*, the project leader of project Bravo said the following: *"And as it turned out, the figures would not be so fantastic, and at the same time, on the horizon, we could see problems of automating [the production]…. Then it was abandoned."* My field notes from discussions with managers at the parent organization indicated that subsidiary B would be a *"good place to go to explore project termination"* as did field notes on discussions with engineers in subsidiary B (not associated with projects Bravo and Boron). This disconnect between Bert and others is not a matter of the two groups having different experiences (project Bravo was 'terminated' by Bert); the difference is a matter of the definition of key labels.

Table 16: 'Failure mindsets' of subsidiary managers

Top Manager of subsidiary A	Top Manager of subsidiary B
Subjective definition / view of failure	Subjective definition / view of failure
Example 1: *"On the one hand [failure represents an] economic loss – that is quite clear. Investment in R&D that does not deliver a return.... Sometimes [there is] also a motivation issue, sometimes also a reorientation in the organization because you have to change certain ways. In general, there is a learning... so the question 'What went wrong, what can I do differently next time?'"*	Example 1: *"Yeah, if something failed, I would assume that you set something in motion and you decide it was wrong. That is not what happens here."*
Example 2: *"For setting up projects, we focused primarily on the business case, so what profit is generated by the project. Since last year, we have introduced significant improvements with regards to 'What are actually the success factors?'…. The success of a project – and this is actually the essential change in quality – actually starts earlier with a clear analysis of the surrounding circumstances and factors, including how prepared the market is to take the product. There are still project failures, not because goals are not achieved but because the customer does not want this project or product."*	Example 2: *"I think we don't have projects that are lacking performance. We do have projects where the effort was not necessarily fully exploitable in the first place but then it was in the second phase. And with that I mean that some years back in time, we developed a light version of product X, and actually the timing was such that product Y took over faster than anticipated, and therefore, the market was smaller than anticipated. But the upside was that the learning from developing product X and the testing and so on – that learning was all beneficial in a later phase. It would be too narrow minded to say that it failed."*
Perceived occurrence of failure	Perceived occurrence of failure
Example 1: *"Only few [of the R&D projects fail] – much less than 20 percent – but we have not done any analysis."*	Example 1: *"Yes, [project Bravo] that was not really a failed project; we had a project proposal from our external R&D partner, and we formally committed that we wanted to have a look at it. The project could eventually become a project, but it needed to pass some defined gates first, and it didn't. Thus I would not consider that as a failure…"*
Example 2: *"Our biggest problem was not whether the project was successfully finished or not but that the outcomes were not sustainable enough because the differentiation was not large enough. This is indeed a further point: you often bring projects to an end, and then you are still not satisfied because they are not successful in the long run."*	Example 2: *"Once we start a project, we carry it through. I cannot recall a project we did not carry through. The fact that we decide not to start them, I don't regard as a failure…. […] I do not consider projects that after careful examination, we decide not to initiate, I do not consider them as a failure."*
Decision process of project termination	Decision process of project termination
Example: *"We review the business case on a quarterly basis; we record visible deviations in the technical issues regarding timeline and budget and assess this by using a business case model. And if deviations occur that have a significant impact on company results, then these things are passed on to management where a review and decisions are made. For example, acceleration or change of direction or even termination..."*	Example: *"No, I look at the project in the context of a larger scheme. I get a monthly reporting, and then I decide. I don't have a formal point scale or anything like that because I don't think it makes sense. At the end of the day, this is the leadership you want to exercise here. It all has to do with exercising qualified, and that's what I do."*

Source: Own illustration, interviews

Take the following exchange between Bert and the interviewer as an indication of redefining labels: *Interviewer: "And, for example, projects like the project Bravo that you stopped?" Bert: "Yes, [project Bravo] that was not really a failed project; we had a project proposal from our external R&D partner, and we formally committed that we wanted to have a look at it. The project could eventually become a project, but it needed to pass some defined gates first, and it didn't. Thus, I would not consider that as a failure…. Once we start a project, we carry it through. I cannot recall a project we did not carry through. The fact that we decide not to start them, I don't regard as a failure…. The project Bravo never materialized: it did not have a project specification; it did not have a project manager; it did not have all the other things; it did not have a kickoff meeting. As part of the initial evaluation I said: 'Ok, that's good. I really would like to do this. I just need to be sure of some initial parameters before we start spending resources on it.' And it did not pass that gate."* Presumably, if it is not a project, it cannot be a failure.

The interesting insight here is that denying that projects are failing enables projects (or, in the language of Bert, pre-projects) to be terminated more quickly. This appears to be a 'new' form of anti-failure bias but one that does not lead to persistence with poor performance (see Gimeno et al., 1997) or escalation of commitment (see Staw et al.,1981); rather, the anti-failure bias has an opposite effect. By (re)defining project failure – so it does not characterize the current initiative – the manager is 'free' (from the implications of a 'failure') to terminate the ('pre-') project and as a result, there is little delay in doing so. While this seems salutary because it reduces persistence despite poor performance (and reduces the likelihood of escalating commitment), given my findings reported in the previous section, the reduced delay in deciding to terminate has implications for project team members. On the one hand, it eliminates creeping death – and the associated generation of negative emotions – but on the other hand, it provides little time for team members to learn from their experiences.

5.5 Non-participative management processes and project termination

The organization and strategy literatures have highlighted the importance of organizational speed – speed in entering new markets (Chen & Hambrick, 1995), speed in adapting to changes in the competitive environment (Eisenhardt, 1989b; Eisenhardt & Bourgeois III, 1988), and speed in introducing innovative products to the market (Schoonhoven, Eisenhardt, & Lyman, 1990). Speed can be achieved by accelerating decision making and improving the efficiency of transitions from one project to the next (Brown & Eisenhardt, 1997; Eisenhardt, 1989b). A review of the literature suggests that although an autocratic process can accelerate decision-making speed in some cases (Eisenhardt, 1990; Field & House, 1990; Vroom & Yetton, 1973), it can alienate those who did not have a say in the decision yet were impacted by it. For example, studies found that CEOs' autocratic decision making can lead to an atmosphere of frustration among management team members because it requires substantial effort from team members and the use of politics to counteract the CEOs' power (Bourgeois III & Eisenhardt, 1988, Eisenhardt & Bourgeois III, 1988). My data, however, point to a different emotional reaction to autocratic decision processes.

Table 17 illustrates how project leaders and team members perceived the events leading up to project termination and the decision-making process. As illustrated in Table 17 (and also in Table 16 above), fewer people and organizational hierarchies were involved in the decision to terminate projects Bravo and Boron than for projects Alpha and Argon, and unsurprisingly, this resulted in less delay in the decision to terminate the project.[6] For example, Bert noted that he alone makes all decisions to terminate projects: *Interviewer:*

[6] This might result from simpler decision-making routines in the acquired subsidiary, which kept parts of its pre-acquisition culture. The parent company has a more complex decision-making process and culture (projects Alpha and Argon).

"Whose decision terminates a project?" Bert: "Always mine, nobody else." Organizational members of subsidiary B confirm Bert's assertions. For example, regarding the project termination, the project leader of Boron stated the following: *"It is impressive – it is Bert; his emails decide things."* Indeed, an internal email to project team members documents Bert's fast and direct decision making: *"Project Bravo was cancelled by Bert on March 2, 2010."*

Table 17: Termination events and decision-making process

Project Alpha	Project Bravo
Events leading to termination	Events leading to termination
Project Leader Example: *"There was a specific meeting with our customer who pushed very hard between their and our management. Our management then concluded that it would not proceed at that stage; they did not even support it any longer, so we took a step back."*	Project Leader Example: *"It was mainly abandoned because the price of the raw material from country X was too high, so it was not economically viable…. And as it turned out, the figures were not great, and at the same time, we could see problems of automating [the production] on the horizon. Then it was abandoned."* *Information from Mail after the Interview: "The project was cancelled by top management [Bert] in March 2010."*
Team Member 1 Example: *"This [the request of certain key resources for other projects] led to the decision 'Okay, the customer is out,' or more realistically spoken, 'he is not out, but he is ramping it down, and we will then follow this key customer' [as the development was a joint project with this lead customer]."*	Team Member 1 Example: *"Well I just got the messages from Bert [the top manager]. He did not really rely on the ability of people from country X to deliver the amount of material that was needed, and the supply chain was not safe enough, so he was not sure that it could be a business because we had to rely too much on the deliveries from country X. I was told that, and I fully agreed with it."*
Team Member 2 Example: *"I have read the press release of the customer [terminating the activities for the project]…. As I said, the customer has communicated in a very incoherent way. I do not know how much more our management…knew, but it was very, very silent for a long time. But, as I said, this raised some expectations. This was not really a surprise. Such communication channels have been there before as a preparatory action and that a company has to respond to it is completely obvious."*	
Termination decision (examples)	Termination decision (examples)
Project leader Example: *"I was not involved in the decision itself; this happened a few levels above [the middle- and top management took the decision]."*	Project Leader Example: *"It is impressive – it is Bert; his emails decide things."*
Team Member 1 Example: *"This is not a process were we meet one afternoon and then have a clear picture of the world, but this was a process that […] escalated at the end, when a decision had been taken by the entire management hierarchy."*	Team Member 1 Example: *"And [Bert] said 'Well, we do not believe in that [the project] because of these problems, and we will terminate the project'."*
Team Member 2 Example: *"In the end it was first stopped by the management above, far above [the project level]."*	

Table 17 continued

Project Argon	Project Boron
Events leading to termination	Events leading to termination
Project Leader Example: *"We had our financial reviews with him [the CFO], and he saw that we still spent more money on the project. [In this meeting, the CFO] said 'As of today, no single dollar will be invested in this project anymore.' In other words, there was no redesign."*	Project Leader Example: *"And then these political things came up. We started to make an announcement that our project had been postponed but not with a given date. We did this twice, but we did not want to let that happen too often…. But we could end up in a situation where in October, the election is turning out poorly, and then our customer says 'We will not sign anything November 1st.' That means we will not invest and then our project is postponed… closing down"*
Team Member 1 Example: *"Then, after four years, this machine was completed and there was no customer…. I may say it was officially cancelled as an R&D project…. It continued as a customer development project…where we have tried to sell this [specialized] machine in a different market, which has not yielded results either. There were also talks with customers that have 'fallen asleep.' Then there was the information at some point that we would not offer this machine any longer as a specialized machine, and all the activities had to be ended. That was the moment when we officially stopped working."*	Team Member 1 Example: *"…all the political things started to happen here in country B…. The opposition [political party] said that when they come to power – and all the polls said that they will – that they will cancel this project…. Then we said 'We will not put any more money into this project.'"*
Team Member 2 Example: *"We had…made several attempts to find a customer to sell the project to. We have always had difficulties in meeting the requirements set by our management, primarily in terms of profitability. The frustrating thing about this experience is that we had a lot of attempts with different customers and had not made it. The crazy thing was that we finally actually found a client who agreed with the concept and wanted to have the machine, and we had to say to him afterwards that it was no longer possible and that we couldn't do it anymore [due to the termination decision by the CEO during the economic crisis]."*	Team Member 2 Example: *"We were told 'to paddle' – to stop all activities, do not spend money…. It was put on hold by the project manager saying 'Now, we need to go with a stop-and-go strategy, as he has called it. Stop all activities that we can right now…. I think it was the fact that we could not live with the insecurity of not knowing if our customers wanted our products. The customers were asked and when they said 'No, we cannot tell you right now,' then we said 'stop.'"*
Termination decision (examples)	Termination decision (examples)
Project Leader Example: *"The CFO pulled the plug, but ultimately the CEO had to make the decision whether we would sell the machine…. Then it was said that the CEO would not like to hear anything about the project."*	Project Leader Example: *"Our top guy, he is the global head of our products, and he is the steering committee, you can say.... What he says, that is our strategic decision, and he said 'Yes we need [to stop the project].'"*
Team Member 1 Example: *"No, I don't know [who terminated the project]. I have this information [on the termination] from the product manager and the project manager of this offer of the special machine. He said 'There is a decision by the higher management [to terminate it],' indicating that the decision had been made by top management."*	Team Member 1 Example: *"It was the top management…. This was just a decision made high up in the system."*
Team Member 2 Example: *"Ultimately, it was terminated by top management, our overall CEO. He said, the machine would not fit in the market at that moment."*	Team Member 2 Example: *"Mr. K… He is the head of our products, globally.... So for our products, he is the top man. He is the one making these decisions."*

Source: Own illustration, interviews

In contrast to much of the organization decision-making literature, I found that project members did not have a negative emotional reaction to this autocratic decision process; rather, the speedy termination of a failing project (as a consequence of an autocratic process) alleviated, rather than generated, negative emotions. This absence of a negative emotional reaction to an autocratic process is consistent with Eisenhardt (1989b), who proposed that organizational members understand that the top manager ultimately needs to make a decision regardless of whether consensus has been achieved or not. In the current study, the project members were more concerned with creeping death (from a slow or delayed decision to terminate) than with not participating in the termination decision. Although I did not have evidence of reduced decision comprehensiveness resulting from a lack of broader participation in the termination decision, there was evidence that these project team members learned less from their experiences. By not being involved in the evaluation process to determine whether or not to terminate a project, these team members were denied the opportunity to reflect on what represents a successful project, how and why the current project failed to meet these criteria, and what could be done differently in the future. They were denied access to information critical to learning from failure.

The data suggests that it was not only the lack of participation in the termination decision that reduced the opportunity for team members to reflect on their experiences but that an emphasis on a speedy transition to a new project also obstructed learning. That is, the rapid transition of team members from the terminated project to new projects was facilitated by a lack of formalized processes for documenting project failures and formulating lessons learned. The organization theory literature acknowledges that some organizations have capabilities that facilitate learning, while others do not. For example, Edmondson, Bohmer, and Pisano (2001) found that in some hospitals, collective learning processes facilitate the implementation of new cardiac surgery technology, while other hospitals fail to learn and implement this technology successfully. Other learning processes and routines include the (re)structuring of organizational communication processes (Christianson, Farkas, Sutcliffe, & Weick, 2009), adjusting recruitment processes for qualified personnel (Rerup & Feldman, 2011), and evaluating organizational accidents (Haunschild & Sullivan, 2002). Although the importance of organizational processes and routines for learning are well established, less is known about these processes and routines for a specific type of learning – learning from failure.

In Table 18, I report evidence that top managers' mindset toward failure is reflected in the processes and routines that can facilitate 'dealing with' project termination. Subsidiary A has some processes in place to collect, analyze, and store information about how and why projects perform poorly, including for those that are terminated. For example, top manager Arthur noted that: *"We have a process audit, which guarantees a relatively high degree of maturity of our R&D processes compared to the market average…. I believe that we have a distinct culture and I also have the feeling that process-wise, we are well positioned compared to our competitors to ensure that we really make mistakes only once."* Similarly, the leader of project Argon found that: *"In essence, it [their process to capture lessons learned] is about facts that can be written down why something did not work. To document that we have used a specific design for the product, why it didn't work, and what we missed to consider in our design. Thus, in the next design phase, the colleagues can benefit from the learning and do not have to have the same experience themselves."* Indeed, in my field notes for onsite observations, I recorded the fact that in between interviews, two interviewees of project Argon discussed what they entered in their lessons learned database. These statements from the interviews are supported by internal documents of subsidiary A. For example, the documentation of the implemented R&D processes contains a deliberate 'lessons learned' process step within a project review milestone, and a defined 'lessons learned template' ensures the appropriate documentation. Although these processes and routines for learning were not specifically created for gathering and processing information about failed projects, they were adapted to such a task to facilitate learning. This effortful adaption reflects an acknowledgement by the organization's management that it is important to learn from experiences associated with failed projects by providing a mechanism through which project team members can reflect on their experiences and make those reflections available for others.

Table 18: Top managers organizing for failure

Subsidiary A	Subsidiary B
Top Manager Example 1: *"For major projects, there are feedback rounds that summarize what went well, what went less well, and what didn't go well, so 'lessons learned.' Exactly how this is working, especially at the developer level, I cannot say, but as far as I know, there are these rounds, and 'lessons learned' are implemented in certain projects."* Example 2: *"We introduced a number of process improvements just in the last year that should help us to prevent such mistakes or early terminations again."*	Top Manager Example 1: *"Question: How would you like to facilitate the learning experience? I actually did not say that I would like to do it. I am just saying that I informed people and there is no formal process for it."*
Project Alpha	**Project Bravo**
Project Leader Example: *"For project Alpha, we had a meeting to finalize the project closure. Before that, a colleague held a workshop with the core team to capture what went well and what did not go well followed by a prioritization of the results…. If larger mistakes [surpassing a defined US-Dollar value] occur, there is a 'lessons learned' database here at our site. This database is used to follow up on actions after a failure to see whether things are ceased, particularly if they are ceased sustainably…. The process lives in our organization and is very helpful in most cases."*	Project Leader Example: *"I think...the company could learn from failure and does it to some extent. Learning from failures?… I have not heard much about it."*
Team Member 1 Example: *"Actually, we had decided to document at least all our results…. There was at least a rudimentary approach to file it in a really ordered manner."* Team Member 2 Example: *"Otherwise there is the risk that you throw away what you have attained laboriously and expensively. This becomes worthless if you do not pay attention. It starts with the employees, also at the engineering department, filing and documenting the results they achieved reasonably, so that you can use these at a later stage…, and I also got it [the time to prepare the documentation]."*	Team Member 1 Example: *"But I do not think that you should have a sort of website (laughs) for sharing all the failures. No, I do not think that you should make much out of it; just discuss it with the people involved and say 'Ok, now we have learned from this failure.' No one will go back and read a report before starting a new project and say 'They made a mistake.' It should be sort of...personal education for people working there."*

Table 18 continued

Project Argon	Project Boron
Project leader Example: *"In our R&D organization, we have such a 'lessons learned' process…. Well, ultimately, the moment in which one has learned a lesson, everyone can enter it in a database and make it available for a larger community. However, this is only used very arbitrarily."*	Project Leader Example: *"I would say here at our location, we do not share. There is so much information; you just cannot stand up and say 'Hey now you should know what we have learned.' It is simply an informational overflow."*
Team Member 1 Example: *"I had enough time for this [documenting the lessons learned] because I was appointed to a project team afterwards to initiate process improvements. That was not conducted with 100 percent workload though, but it took a few months during which we regularly discussed what we could do better in the organization in cooperation with our interface partners….Ideas that I have brought in are also reflected in the new organizational structure."*	Team Member 1 Example: *"I have not really met anybody saying 'Well, make sure if something goes wrong that we document it, that we learn from it, and that we somehow inform the others.' I have not seen that…. There is this saying that I have heard: 'If only our company knew what our company knows.'"*
Team Member 2 Example: *"I know that Mr. X started a feedback meeting where he brought together people who were involved in order to identify the lessons."*	Team Member 2 Example: *"It is not about having information sharing in general [outside of the department], I would say. This database would only be one small part; I love the saying 'If our company knew what our company knows.' So there are a lot of possibilities being lost, I think."*

Source: Own illustration, interviews

Subsidiary A's efforts to adapt processes and routines to facilitate organizational members' learning from project failure contrasts with the efforts of subsidiary B. Consider this exchange between top manager Bert (of subsidiary B) and the interviewer: *Interviewer: "And how do you ensure that this information and learning will be available for other people within your organization?" Bert: "I don't, and I will not do that. I will not create a database or anything like that because in the end, it will not be maintained and people will not go in and look at it, and they will not know how to use it. A young person coming in will not want to look at a 10-year-old project. For example, he will feel that information on material A from ten years ago is not relevant to him. If we said to ourselves: 'Oh, we should have this big database of lessons learned from failed projects.' I think the answer is: 'No.' And the way this works is that you cannot systematize your way into that. The way this works is that your people are working with technical excellence, and if somebody has the bright idea that: 'We* *should do a product using material A, as long as I am in the company, that would never ever happen without them first coming and asking me…. It would also not happen without them asking him [project coordinator]. … So, there is not a need to create a database, and I will not do that."*

The project team members offer a similar impression. For example, the project leader of Bravo noted that: *"In the engineering department, there was a handbook that outlined things like that [lessons learned], but it was not applied."* Indeed, my field notes recorded accounts of lessons learned mainly in the form of personal notes, and learning across projects only occurred through individuals' interactions within their personal networks. In the case of subsidiary B, terminated projects generate information, and while the information may be shared through informed channels, there are few – if any – organizational processes or routines that formally encourage members to contribute to organizational learning from project failure.

In sum, consistent with the learning literature, I found few processes and routines dedicated to learning from project failure. However, I did find that in subsidiary A, general processes and routines had been adapted to the task of learning from project failures. Based on the findings presented above, team members of projects Alpha and Argon had the time (based on delayed termination) and information (based on participation) to benefit from the organizational processes and routines that facilitate learning. In contrast, subsidiary B did not appear to use such processes and routines to enhance organizational learning from failure; such processes and routines were dismissed and even actively discouraged. Without 'spending' time on reflection, the team members of projects Bravo and Boron could be immediately redeployed. This was well received by team members; they were anxious to move on to the next project, but they learned little from their experiences.

Although an emphasis on speed could possibly explain these autocratic processes that obstruct learning from failure, another possible explanation is ‘power’. The limited learning that took place in subsidiary B primarily occurred in the top decision maker (not in the subsidiary organization), which made him indispensible. This provided him power, and consistent with the social information-processing perspective (Salancik & Pfeffer, 1978), this could be his motivation for redefining labels of what represents project failure, implementing an autocratic process for termination decisions, and limiting learning from project experiences.

The following chapter consists of relevant implications for research and management. It will summarize the main findings by providing the derived model based on the interview analyses.

6. Summary of results and implications

This section will summarize the results and insights gained in the previously described analysis section of this thesis and present implications for both areas, research and management practice. Furthermore, brief recommendations for managerial approaches to improve the management of project failures are provided.

6.1 Implications for research

This dissertation explores why project team members in some organizational settings learn more from their experiences with a terminated project than team members in other settings. As I noted at the outset, learning from failure is of critical importance given its prevalence (Boulding et al., 1997; Burgelman & Välikangas, 2005; Sminia, 2003) and its informational value (Shepherd et al., 2011; Sitkin, 1992), yet this learning process remains shrouded in mystery. Given uncommon access to sources of information about failed projects, the current study provides various new insights. I offer the model in Figure 11 to summarize these insights.

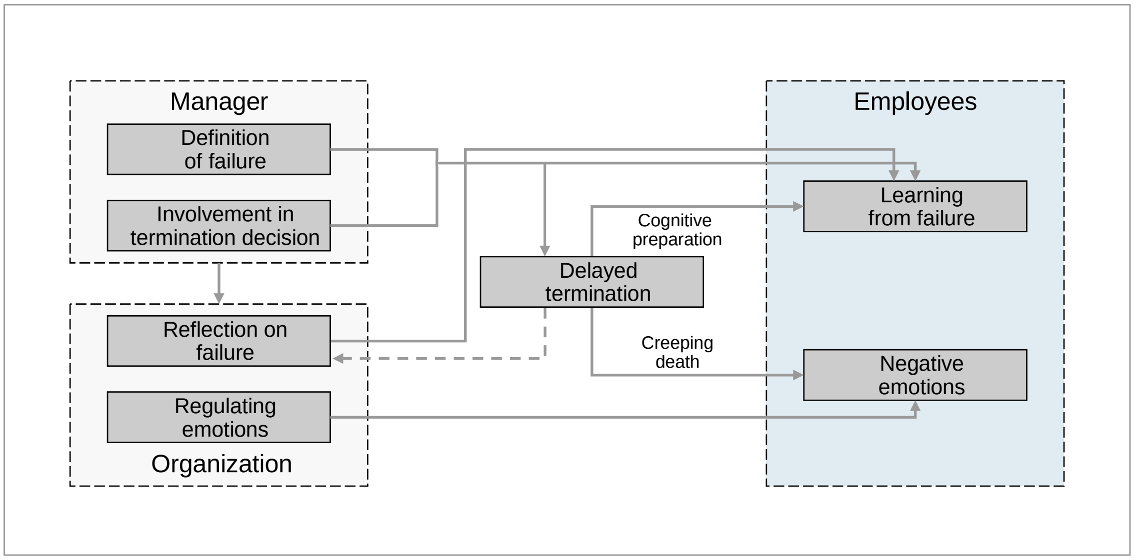

Figure 11: Model for timing of project termination and learning from failing projects

Source: Own illustration

First, delayed termination of a failing project is a double-edged sword: it generates negative emotions in employees from the perception of creeping death, but it provides the time employees need to reflect on the failure and learn from the experience given the rapid redeployment of human resources after project termination. Second, top managers reflected an anti-failure bias that redefined failure from the current project to enable rapid termination but also limited learning from failure. By using non-participative management processes, a top manager was able to accelerate termination and transition but obstructed team members' learning from project failure. Third, top managers' mindsets influence whether or not organizational routines are used to facilitate reflection on project failure (and thus learning).

Overall, these results help resolve some of the mystery surrounding project failure within organizations and contribute to the literature on the timing of and learning from project failure, as well as the emotions of failure, to which I now turn.

6.1.1 Timing of project failure and learning from the experience

In R&D-intensive environments characterized by high levels of uncertainty, projects can be considered as options (McGrath, 1999) or probes (Brown & Eisenhardt, 1997) that explore the unknown. Under these conditions, exploration efforts can help improve overall performance when poorly performing projects are rapidly terminated and resources are rapidly redeployed to projects that show promise and/or to new projects (Brown & Eisenhardt, 1997; McGrath, 1999). From this study emerged two fundamental notions of the role time played in decisions to terminate underperforming projects.

First, delay in project termination was considered costly by the parent firm's management, the subsidiaries' management, and especially those directly involved in the projects' operations. Similarly, delay in resource (particularly human resources) redeployment was resoundingly deplored by those involved in the projects. However, the data show that some delay is a necessary evil. Delay is necessary to provide time for reflection for learning from one's experiences. Specifically, delayed project termination provided team members the time to reflect on and share their lessons learned about failing projects. Similarly, delayed redeployment after termination provided the time necessary to reflect on, document, and share information about and lessons learned from the project failure. An implicit mechanism of managing uncertainty using R&D projects as options or probes is that they reveal information that contributes to new knowledge, including learning from project failure (McGrath, 1999). Consistent with Shepherd's (2003) proposition that learning from failure is not automatic or instantaneous, in this study, I found that some delay (in termination and/or redeployment) was necessary to learn from the failure experience – learning is key to moving forward rather than simply moving on (without reflection and learning).

Second, an anti-failure bias can reduce (or eliminate) a delay in project termination. Although I found that most individuals had an anti-failure bias, the top management for one subsidiary had an anti-failure bias that delayed termination, whereas the top management of the other subsidiary had an anti-failure bias that accelerated termination. The former is consistent with the literature of behavioral economics (e.g., Gimeno et al. 1997; Greve 2002), escalation of commitment (Brockner, 1992; Staw & Ross, 1987; Staw et al., 1981), and procrastination (Anderson, 2003; Lazarus & Folkman, 1984) where the anti-failure bias motivates persistence despite poor performance. In contrast to these established findings, in this study, I found evidence of an anti-failure bias with an opposite effect. With the motivation to avoid failure, top management of one subsidiary (subsidiary B) redefined project failure in a way that did not characterize the current initiative as failing. This allowed him to terminate the current initiative without it being considered (at least by him) a project failure. Without it being considered a project failure, he was able to avoid the negative connotations associated with failure. He was able to maintain (in his own mind) the belief that he had never had a project fail. Indeed, the earlier the initiative was terminated, the less likely it would be considered a project failure (given his definition of the term). This anti-failure bias manifestation had the effect of accelerating termination. However, consistent with the previous insight, this reduced delay and provided little to no time to learn from the experience.

6.1.2 Emotions of project failure

One of the purposes of this study was to explore the emotions surrounding project failure (if any). I found that project team members in R&D projects were not emotionally invested in the commercial success of their project. That is, they experienced little (if any) negative emotional reaction to the projects' failure. However, they were emotionally invested in the engineering process and experienced a negative emotional reaction to being stuck with a 'declining' technology rather than working on the 'next' technology. This is interesting considering the literatures on emotions related to project failure.

First, the literature on loss in general (Archer, 1999) and specifically on losses associated with business bankruptcy (Shepherd, 2003) and project failure (Shepherd et al., 2011) suggest that an individual will experience a negative emotional reaction to the loss of something important. Complementing this literature, the findings from the current study suggest that what is important to the organization (i.e., commercial success of the project) is generally not of primary importance to project team members. The project team members in my sample were all engineers, and what was important to them was working on cutting-edge technology. The advantage of this engineering mindset is that project team members are unlikely to contribute to persistence (or escalation of commitment) of a poorly performing project, and negative emotions are unlikely to obstruct their ability to learn from their failure experiences. However, consistent with criticisms that small wins may not be large enough to capture sufficient attention (Sitkin, 1992) and that building self-efficacy increases with the magnitude of the experience (Bandura, 1977; Campbell & Hackett, 1986; Gist & Mitchell, 1992), this mindset toward project failure is unlikely to result in sufficient attention being allocated to learning from project failure. Project team members are focused on looking forward rather than looking back and, as a result, 'move on' without necessarily 'moving forward'.

Second, the literature on normalization (Ashforth & Kreiner, 2002; Ashforth, Kreiner, Clark, & Fugate, 2007) suggests that given the appropriate organizational culture, employees can consider project failure as a normal event, which takes emotion out of the process. In a culture that normalizes failure, the meaning of project failure has been reframed, recalibrated, and / or refocused (consistent with Ashforth & Kreiner, 1999; Gusterson, 1998; Palmer, 1978). For example, by reframing project failure as an opportunity to learn, normalization negates some of failure's negative value. Consistent with this literature, I found that failure generated little – if any – negative emotional reaction. However, I extend this literature in two important ways. First, although project failure is a common occurrence in these organizations for these organizational members and generates little negative emotional reaction, project failure is not normalized. There is ample evidence of an anti-failure bias. Indeed, a subsidiary manager claimed that they have ‘no project failures,’ and through a process of redefining labels associated with project failure, this claim became technically correct. These claims and definitions are inconsistent with the notion that failure is considered a normal occurrence. The emotion of project failure has been taken out of the process, not by normalizing failure but by focusing on the engineering challenge.

Second, although failure is not considered normal, transitions from one project to the next are. When these transitions are considered normal, a delayed transition can be considered non-normal and is likely to generate a negative emotional reaction. Indeed, this is what I found in the current study: Project team members were prepared for transition but had a negative emotional reaction when this transition was delayed. So, rather than attribute the lack of negative emotions from project failure to normalization, it could be attributed to an ‘engineering’ mindset of moving from one project to the next even in the presence of a strong anti-failure bias. There is more research required to investigate the negative emotions that result from a lack of (or delayed) expected change, such as the emotions associated with creeping death.

6.2 Implications for management

Apart from the more theoretical implications for research and extensions of existing literature, the practical findings for management that can be derived from this study are manifold. The findings of my study have implications for companies and managers trying to generate the best results and capturing lessons learned from failed R&D projects. Most importantly, the results demonstrate that there is a tension between the emotional well being of R&D employees and learning from failure, influenced by the duration of the termination period. Thus, on the one hand, organizations need to balance between both characteristics: Allowing a delayed termination that generates negative emotions to foster learning but simultaneously preventing extreme negative reactions in situations when projects fail. My research does not suggest that there is a clear optimum in this trade-off situation. In fact, it is important for companies to provide processes that manage the level of negative emotions and / or facilitate the handling of negative feelings (e.g., regulating grief by offering some form of 'funeral' rituals of failure parties [cf. Shepherd et al., 2009]). Having these processes installed, companies provide the basis for a longer termination period (delayed termination) in order to support learning from the experience without too high emotional reactions. In other situations, e.g. when the R&D project represented a lateral initiative outside of the core business, these processes might not be required. Instead, the avoidance of a delayed termination might be preferable in order to protect the project teams from negative emotions and prevent too strong reactions.

Apart from the discussion in which cases a delayed termination is beneficial on a project level, the level of the individual employee bears challenges as well. Not only that there is no objective measure to evaluate the level of negative emotions but – since the R&D projects under consideration are executed by teams – the intensity of negative emotions might vary among team members (please refer to the respective within-case analyses for the detailed assessment of each interviewee). A level of negative emotions that might not harm the learning success for one team member might be already destructive for his or her colleague. In addition to the ability to withstand stress or negative environmental influences, the specific situation and circumstances in the personal environment influence the perception and absorption varies. The fact that perceptions of project failure or terminations and absolute levels of negative emotions vary among different team members was clearly observable when comparing the interviews of my study (e.g., compare the level of negative emotions of project Boron – team member 1 showed ‘Medium-high’ negative emotions as he was especially personally involved as he and his family were in the situation to relocate to a different country. The other two interviewees of Boron, both not having this special personal situation, showed only a ‘Low’ emotional reaction.)

In addition to managing the emotional component, the transition period before moving on to the next project is of importance to facilitate learning from failure in R&D organizations. Companies and managers need to provide their employees with sufficient time to learn after project failure if the content is regarded to be beneficial for future tasks. For a fruitful learning experience, the study has shown that team members need time to reflect on the project, what has happened and to process the occurrences as well as to identify causes and effect. In projects, where team members have been shifted simultaneously to the termination to other research initiatives, mainly driven by resource scarcity and the need to execute several development projects in parallel, team members missed the required time to reflect and digest. Apparently, they learned less compared to their colleagues who had been provided with sufficient time before moving on to the next R&D project. Of course, opportunity costs have to be included in this decision making process of when to assign scarce resources to new projects in management practice. It is hard to assess whether e.g., one urgently needed material specialist should get several weeks of time to generate lessons learned from a recently terminated project while a complete other R&D team is waiting for him or her to be able to move on with their development project. As with the question of having processes in place to balance out the level of negative emotions and a delay in the termination in order to facilitate learning, the question of the right timing before moving on will in everyday practice be a decision driven by the individual case and cannot be answered within this dissertation. Nevertheless, I want to highlight the importance of both decisions for R&D managers.

To provide some suggestions and support on how to further increase the outcome of failed or terminated R&D project in daily practice, I am providing some propositions in the following section. Four mechanisms are in particular applicable to optimize the management of R&D projects with regards to possible failures of initiatives: (1) a regular review of projects based on early warning signs of project failure, (2) a post-mortem review, (3) a social web-like platform to connect experts to consult before a failure or in the case indications for a possible failure are observable, and (4) a deliberate focus on management communication in the event of a failure or project termination.

(1) Early warning signs of R&D project failure

Although not representing an explicit research question of this dissertation, the problem to identify a project that is likely to fail as early as possible is of utmost importance for managing the R&D portfolio in a resource-optimized way (Sánchez & Pérez, 2004). To decide as early as possible whether to continue, change direction, abandon or reach a specific milestone before terminating a failing project is one of the key questions when dealing with project failure from a management perspective. To provide the practitioner with a set of indicators to increase the probability of identifying projects with a high likelihood to fail represents an important tool, since in-depth reviews of every project seem to be impossible or at least inefficient from a resource point of view. Pinto and Mantel (1990) investigated 97 failed projects in order to derive main causes associated with project failure. As a result of their analysis, they found critical factors that are closely linked to project failure. Depending on the measure of success, different causes are prevalent. Overall, missing trouble-shooting mechanisms and adequate staffing (personnel) are found to cause R&D project failure (Pinto

& Mantel, 1990). If implementation and internal efficiency are used as measure of success, missing detailed scheduling and again trouble-shooting mechanisms are found to be key drivers of failure (Pinto & Mantel, 1990). When internal quality is the criterion for failure, a lack of a clear statement of the project objectives is the premier cause associated with failure (Pinto & Mantel, 1990). When measuring success from the client perspective, a lack of project monitoring complements the list of project causes according to Pinto and Mantel (1990).

A starting point to arrive at possible indicators of failing R&D projects is to follow an inverse conclusion and review factors that are critical to achieve and used to determine whether a project is successful or not. In their research, Balachandra and Raelin (1980) showed that this approximation is suitable as their model indicates that success factors of projects could be used as basis to develop an early warning signals model. Pinto and Slevin (1987) provide an overview of critical factors for successful project management, which could be taken into consideration when looking for possible failure indicators to test current projects (see Table 19 for the list).

Table 19: Critical factors to support project success

#	Category	Description
1	Project mission	Initially clearly defined goals and general directions.
2	Top management support	Willingness of top management to provide the necessary resources and authority / power for project success.
3	Project schedule / plan	A detailed specification of the individual action steps for project implementation.
4	Client consultation	Communication, consultation, and active listening to all impacted parties.
5	Personnel	Recruitment, selection, and training of the necessary personnel for the project team.
6	Technical tasks	Availability of the required technology and expertise to accomplish the specific technical action steps.
7	Client acceptance	The act of "selling" the final project to its ultimate intended users.
8	Monitoring and feedback	Timely provision of comprehensive control information at each stage in the implementation process.
9	Communication	The provision of an appropriate network and necessary data to all key actors in the project implementation.
10	Trouble-shooting	Ability to handle unexpected crises and deviations from plan.

Source: Own illustration based on Pinto and Slevin (1987)

Following the approach of Balachandra and Raelin (1980), Sanchez and Perez (2004) extended the perspective in their model of early warning signals to identify failing R&D projects. They defined a set of 14 categories of early warning signs and described for each category in more detail which indications to review in order to identify projects that are likely to fail before very strong signals of failure become clearly evident (please refer to Table 20 for the categories and the descriptions which could serve to develop company-specific failure indicators).

Table 20: Model of early warning signals to identify failing R&D projects

Early Warning Signal	Description
Achievement of Technological Goals	Successive failures to obtain partial technological objectives. Increasing disagreement and discussion among R&D staff about technological advancements.
Personnel Commitment	A mood of dissatisfaction among the personnel. Conflictive situations. Talking behind the back (unnecessary criticism). Lack of trust expressed in no uncertain terms. Various non-verbal messages observed in meetings. No sense of camaraderie in the group. People are not willing to stay after closing time to work on the project. There is not occasional horseplay in the group. Staff members are not willing to take on additional assignments related to the project.
Communication between Departments	Messages lost along the way. The tone of messages, especially when it changes, suggests that something has happened. Conflictive Information. Many problems detected due to insinuation; people are not willing to say things straight out. The same things come up again and again in meetings. Lack of initial Information for planning. Slow initiation of work and/or poor turnout at the site.
Client interface	Lack of contact with the client. Delayed decisions caused by the client. No support from the client company's CEO for the project.
Cost and Time Deviations	Unexpected costs and delays during the project development. Tendencies to change the budget without proper reason.
Quality of Documents	Bad quality, tone and lateness of reports. Slow delivery of schedules by a contractor after reaching an agreement. Lots of changes in plans. Incorrect revisions. Responsibilities unclear. Inadequacies in project plans. A contract drawn up unprofessionally or unambiguously. A contract consciously drawn up to have little room for changes.
Number of Expected End Uses	More applications discovered during the project development stage. New specifications keep changing to accommodate the new applications, which create unnecessary delays.
Government Regulations	Regulations based on scientific experiments or political considerations, which have negative impacts on the sale and distribution of the new products.
Lack of Talented People	A lack of working staff noticed.
Project Matching to Company's Strategy	Results that deviate from the company's strategy.
Number of Projects in Portfolio	The size of the portfolio and the amount of resources committed to each project grows inconsistently with the size and strategy of the company.
Pressure on Project Leader	Increasing inquisitions about the perceived slow progress of a project. Deadlines missed or ignored. Meetings where management is exerting pressure to get the product out of R&D.
Project Champion	Change of project champion to another position. Loss of interest by the project champion.
Top Management Support	Delays in the approval of equipment requests. Less frequency of meetings between the project leader and the top managers. Fewer meetings of top managers of the project location. Poor accessibility of top management personnel to the project leader.

Source: Sanchez and Perez (2004)

Of course, the introduced failure signals above cannot be seen as a generalizable, complete or final list, nevertheless, it improves the better understanding of what could cause project failure in the sense of failure indicator categories. The list represents a practical resource and possible starting point to develop own sets of early warning signals of R&D

project failure and to guide project reviews. Evidently, this list needs to be complemented with additional factors based on own experience.

(2) Post-mortem review

Executing post-mortem reviews to learn from past experience has been part of several projects covered in this study. For example, team member 2 of project Argon stated: *"I know that Mr. X started a feedback meeting where he brought together people who were involved in order to identify the lessons."* His colleague, the project leader of project Delta described the process in his department as follows: *"We have processes in the development department. We hold a post-mortem meeting for each development project, in which the input of the team along the categories 'What was good? What was less good? What would you recommend to other upcoming projects?' is collected."* Literature as well favors post-mortem reviews to analyze, digest and process experience from failed projects and ventures to support learning from the experience (Birk, Dingsoyr, & Stalhane, 2002; Collier, DeMarco, & Fearey, 1996; Glass, 2001; Reel, 1999; von Zedtwitz, 2002). The rationale is quite obvious – if no (post-mortem) reviews for terminated projects are executed, it is unlikely that an understanding why exactly the project failed and what to change in order to prevent doing the same mistake twice will be established (von Zedtwitz, 2002). Although it is obvious that reviews are highly useful, according to Glass (2002) they rarely happen in reality. Von Zedtwitz states that 80% of all – successful and unsuccessful – R&D projects have not been reviewed after all after completion (von Zedtwitz, 2002). Furthermore, Ahonen and Savolainen (2010) found that in four out of five cases the reason for the termination of projects could not be identified from the regular project documentation. Thus, performing a post-mortem, which can be defined as *"a formal review of the project examining the lessons that may be learned and used to the benefit of future projects"* (von Zedtwitz, 2002, p. 255), seems to be a vital process to be formalized and established in R&D organizations. Moreover, it is assumed that the projects for which no post-mortem has been executed are the ones that are likely to represent the ones with highest learning potential (Collier et al., 1996).

Collier et al. (1996) suggest a structured process for post-mortem reviews. They designed a process based on the experience of post-mortem reviews in more than a dozen organizations comprising more than 1,300 team members in total. Please refer to Figure 12 for process steps and key elements to consider as one possible way to structure a post-mortem review in organizations.

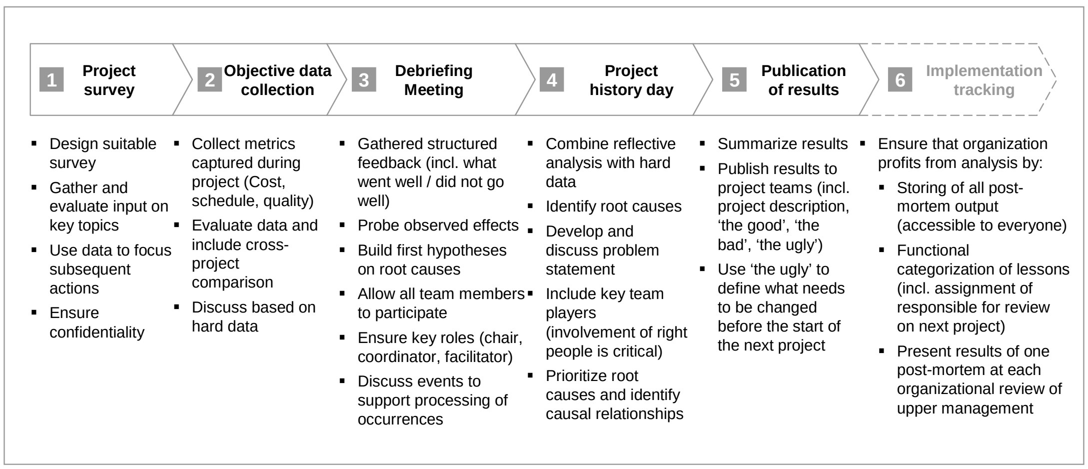

Figure 12: Defined process for post-mortem reviews

Source: Own illustration based on Collier et al. (1996)

Implementing post-mortem reviews in the regular R&D process ensures that the experience is processed and analyzed again to filter important information and gather insights. These insights might exceed what seemed to be the reason for the termination at first sight – and encourage to generate deeper insights. For example, a post-mortem that a person died because not enough oxygen got to the brain is not useful because all people die for this reason – the key question is to identify what caused that oxygen did not to get to the brain. This requires some work but is the source of information from which the organization can learn.

However, having achieved the lessons learned is only half of the journey. It is important to follow up and implement the insights learned from the experience. Here, some problems might arise, as indicated by the interviews. In some cases, it was a challenge to identify and get access to the critical lessons learned from terminated projects. Take for example team member 2 of project Chrome: *"If you have a failure, reports that are written and go into the system labeled as 'confidential'. So, if you want to look at it, you cannot just go into the system and look at it. You cannot find out. So the project documentation, I am sure, was ok. I have never looked at the project documentation. But this was just the formal documentation, within the engineering world, it just kind of stopped. For example, these diagnostic tests, we still got partly completed reports on our desks [but not available to others]. […] But the learning is too isolated."* Another challenge is to ensure a consequent implementation, especially of radical changes, as team member 1 of project Delta mentioned: *"In any case it [the lessons-learned process] is lived in the sense that the process requires to create and provide these [lessons-learned] documents, that a meeting takes place, in which this is done. Whether or not consequences are drawn out of it, I do not know. I may say it, the more difficult a subject is to tackle, the more likely it is in my view not tackled."* Nevertheless, lessons from project reviews often are able to drive significant change, as the project leader of project Argon described: "*We have learned a lesson from this and consequently have set up a new organization which focuses on the cost management of our products, which together with experts from other departments tackles the whole issue of product cost. Unfortunately, it was too late for this project, but nevertheless our project initiated the change."* Thus, when the process is designed and implemented properly, both, team members and the organization, learn from failed or terminated projects. To conclude, instead of having a large database only that stores the project documentation, hence at best records learning, post-mortem reviews foster the learning process itself.

(3) Internal social web platform to connect the R&D community

People do not like to talk about failures; they prefer to focus on successes. Thus, if not well-managed and lessons learned are not shared and proactively announced / distributed within the company, it is likely that failures occur twice or at least similar situations arise in which these lessons would have been beneficial. The interviews indicated that project documentation reports often are not actively used; take the quote of team member 1 of project Delta as an example: *"So far, I have actually the feeling that this project analysis is executed and this is documented and stored somewhere on the server afterwards. But, that this knowledge is used, somehow distributed or applied, I do not have this feeling."*

Instead of having a large database with records on lessons learned, which might not be user-friendly do to its sheer complexity, it might be beneficial to create a – comparable to a social network – company-internal community with key experts on critical topics. Such a company-wide, subsidiary-overarching 'facebook for engineers' could foster the easy-to-use knowledge exchange and establish contact to experts and experienced R&D employees on demand for the respective topic. For example, when starting a new development project that centers around the use of a new material or the solution of a specific thermo-dynamical problem, a key word search or posting of the relevant question on a blackboard could open the discussion with experts from other subsidiaries outside of the own personal network. A quick telephone call as follow up, could easily clarify, if the experience of the expert is of use in the specific situation. In a positive case, the direct contact could transfer lessons learned better than a complicated and time-consuming retrieval of information from a large documentation document or database. Of course, the success of such a network thrives or fails based on its user-friendliness, ease of use and the time required to keep the information updated most importantly. A possible solution might be to keep it short and simple, which means to only include keywords and contact information of the respective member.

Fundamental is to put intelligence into the definition of the key words by each user. Ideally, the update of the own keyword library should happen directly after a completed – or more importantly terminated – project and not take more than 30 minutes.

Although the idea of having an enterprise social network is not new (e.g., the company Yammer was launched in 2008, originally as an enterprise micro-blogging service but turned into a 'facebook for the enterprise' and was recently acquired by Microsoft (Israel, 2012; Nakano, 2012), it has not been mentioned by the interviewees as means of exchanging lessons learned. However, when actively being asked about a solution as described above, interviewees indicated positive interest. The manager of subsidiary B, for example, answered when being asked whether it would make sense to implement an expert database connecting the experts within the company among each other: *"That would be a very good idea. You could have experts and then you could have key words for the fields that these people are experts in. And then you could do a search. That would be fine."* Team member 2 of project Delta as well underlines the importance of having access to person who already experienced similar situations: *"But at least it is important to know, who has the knowledge. This would be a starting point. To know when a problem occurs whom to contact and to discuss the situation with and to implement the lessons learned, this is the way we handle it today as well."* Nevertheless, it needs to be easy to use and may only require little time and effort as the project leader of Caesar points out: *"Yes, absolutely [that it makes sense to have an expert network]. As long as it does not take too much time to fill in. I mean we have a lot of reporting everywhere..."*

(4) Management communication on project termination and failure

As seen in the interviews, communication seems to be a very important issue when project failures occur or are likely to happen. Although being a simple and not costly process at first sight, internal communication seems to be a weak point when analyzing the interviews. Within the interviews, several improvement opportunities have been highlighted. On management level, the manager of subsidiary A mentioned for example: *"It is important to establish a short line of communication. I do not really see this realized as of today. But a great achievement would be, if the decision-makers would explain to the affected persons why the respective project needs to be terminated. In an ideal world, and here we come back to a quality feature, the criteria for a termination are defined and part of the project agreement at the project start."* On project level, team member 2 of project Delta stated: *"I think communication is the key to the story. [The problem was] That it was not communicated in time: 'Listen, there are problems with time and budget.', or 'We are going in the wrong direction.' There have been rumors about a stop of the project, but management only communicated: 'No, there is nothing.'."* The project leader of Dexter added on improvement opportunities in project communication: *"Mr. X has done it [the communication of the reasons for the stop] in this communication meeting. But I think it would have been important that this would have come from a higher level because Mr. X was in the same boat as the simple developer or the ordinary engineer. He also had a very good relationship to the people. Therefore one believed Mr. X, but it would have had a quite different quality, if a higher management level would have come to our R&D department communication meeting – and not in an larger meeting of the complete subsidiary – and would have said: 'The project did not work out due to this and that reason, there are many reasons for this and each has contributed its part to the termination.'. That would have had a very different quality to me as if my line manager tells me, whom I am familiar with. We knew it for months, when we talked to each other privately or in small circles."* Team member 2 of Dexter still does not know the exact reasons for the termination and also sees an improvement potential with respect to project communication: *"Well, the rumor mill on the corridors was always slightly faster than* *the actual, official meeting. There is always a kind of communication meeting in the canteen, in which things are discussed and communicated. Prior to it, we already knew a little more [than what was officially communicated]. But until today, I do not know the exact reason [for the termination]: 'Have we been too bad, have we been too slow or have there been completely other reasons?'."*

A possible solution to the identified weaknesses might be a deliberate and planned communication strategy as cornerstone for each R&D project. To communicate important milestones of the project or in situations with high relevance, several actions could be implemented. For example, a tone from the top presented in communication meetings of top management with the project teams complemented by smaller bi-directional communication meetings could be used to achieve a more transparent project situation. The bi-directional meetings, where one member of the management meets a smaller group of team members should be designed to act as a question and answer opportunity. IT should provide team members with a platform to communicate their issues, address and clarify their concerns as well as to present important findings after projects (e.g., after a debriefing or wrap-up meeting of a failed project).

7 Limitations and conclusion

The final chapter of this dissertation concludes by highlighting the entailed limitations of the research and provides concluding remarks.

7.1 Limitations and opportunities for future research

In line with other qualitative studies and inductive research approaches, several limitations apply to my study. Due to its exploratory, theory-building character, it needs to be regarded as initial research and a starting point to understand processes and events around project failure in R&D organizations of firms. Although the mentioned limitations need to be borne in mind when evaluating the results of this study, they also provide opportunities for future research to broaden the theory and increase the knowledge of this field of research. Overall, three main categories of limitations need to be addressed.

(1) Sampling:

As with many case study research projects, I theoretically sampled to select cases that facilitated theory building. This theoretical sampling also provides some boundary conditions for my model.

First, I focused on the termination of R&D projects. It is unclear whether the model will extend to other projects such as joint venture projects, service-related projects, or projects focused on the implementation of a new product launch (or the implementation of other strategic imperatives). As introduced earlier, R&D employees in general show a high degree of passion and commitment for their projects. Moreover, the likelihood to experience project failure is inherently higher as to the implicit uncertainty involved in R&D activities. Thus, future research should broaden the perspective and investigate the model in other environments where project failure is less common and employees have less experience with failure.

Second, project sizes vary (e.g., very large projects in subsidiary A, mixed (large and a very small) projects of subsidiary B) and thus might be part of the explanation of different behaviors and significance. However, due to the limited availability of project candidates for this research, an equalized level of project sizes (project budget, number of team members, etc.) could not be realized when selecting the projects for this research. Future research could follow this avenue and try to achieve a sample with more equalized project sizes to exclude possible variations due to project size. Moreover, homogenous samples (e.g., large and small projects in terms of resources or investment) could be used to explore whether the magnitude of the failure in terms of size has an impact on how employees deal with project failure (e.g., whether the project scale has an impact on the magnitude of emotional reactions and learning as larger projects and more invested time in a project might lead to stronger reactions).

Third, my cases involved engineers within subsidiaries within a parent organization that had an ‘engineering’ mindset. There is some doubt that my model would extend to all individuals with different (non-engineering) backgrounds or organizational cultures. For example, would a team of lawyers working on a death penalty case have such little emotional reaction to project failure? Indeed, it remains an open question as why engineers (at least in this study) have a greater emotional reaction to an obstruction to the process across projects than to the termination of a project itself. Do biochemists, architects, and academics have similar emphases as these engineers do?

Fourth, the individuals in the current study had alternative, attractive opportunities to ‘move on to’ after a project was terminated. Perhaps their reactions to delayed termination and project failure would be different if alternate projects were unattractive or non-existent. Moreover, in most cases there was only a very short period of time of uncertainty on their subsequent position (i.e., from literally a few hours to a few days). The few interviewees with longer transition periods, for example the project leader of Dexter, indicated that this situation represented a challenge for him.

Fifth, I focused on the investigation of projects failures within two subsidiaries of one multinational corporation. It is unclear how the comparison between the two organizations (subsidiaries) would be different without the parent umbrella. Perhaps, for example, the cultural differences between organizations would be greater. However, the detached subsidiaries can be regarded as relatively autonomous businesses with own management styles, culture and processes. The businesses where the interviews for this research have been conducted in do neither share the same technologies nor do any joint guidelines or rules imposed by corporate management prevail, rather the subsidiaries are managed separately, endowed with own, distinct business target agreements. Subsidiary management hence bases strategic decisions on their own and independent rationales and estimations. Thus, I am positive that my findings are suitable as basis for future research to understand project terminations, associated learning from failure and negative emotions.

Sixth, my research comprises a comparatively small sample size of eight projects and 28 interviews in total. For the more detailed cross-case analysis, I focused on four projects representing the polar types of the sample. As explained before, this limitation was a consequence of the projects available for investigation. While the approach represented an ideal setting to understand the processes in detail, a larger scale empirical study is required to validate the findings.

Seventh, although both subsidiaries were in the same sector – energy – they were in different industries and perhaps because of these industry differences, the size and length of the projects differed. However, I did not explore industry differences (largely because they did not ‘come out of the data’) nor was I able to explore sector effects due to the operational limitations of this dissertation.

The limitations induced by theoretical sampling prevail in other similar studies as well, e.g., a limited sample size of six to ten cases seems to be a common size (cf. Eisenhardt, 1989a for an overview of the sample size of several qualitative studies). Moreover and as described above, the unique data and setting that I was given access to limited the cases and interviews to available projects and interview persons. In addition, my setting represents an ideal background to understand the relevant processes in detail as the purpose of this study was to understand the processes first before starting a large-scale empirical research. Further research should continue this avenue to test and validate my model in large-scale empirical investigations, covering other industries and extending the analysis to other project types. It also can extend the boundary conditions of the current model by exploring environmental influences such as industry velocity and / or hostility. Corroborating my findings with different samples will allow generalizing the results and thus broadening the applicability of the results.

(2) Post-hoc bias

My research primarily relies on self-reports of learning as evidence of learning (consistent with the sensemaking perspective’s emphasis on individuals constructing plausible stories of events). Although I asked the interviewees about specific results or changed behavior and respective examples, my theorizing does not necessarily extend to learning that results in increased accuracy or improved performance but certainly future research could do so. Moreover, due to operative limitations, I could not personally observe the learning results as well as the emotional reactions to the termination of the projects. Using an experiment / longitudinal approach could solve this limitation. In the context of failure, this would require a huge research setup – as it is impossible to predict which projects will fail, all projects would have to be observed representing a stretch to resources as a large number of projects would have to be investigated in parallel. Another question concerning the operative implementation is the question of when to start collecting the data as a failure is not an event but a gradual process. I am looking forward to new research approaches to tackle this issue and following longitudinal research approaches.

(3) Level of analysis of emotional reactions

Finally, I took a relatively coarse-grained (macro) perspective of emotions. I asked the interviewees about their emotional reaction and their assessment of their reaction to the failure event. As I did for their learning result, I again asked for specific situations and experiences induced by the termination event. The reason why I chose this approach was to achieve an unbiased overview of the emotional reactions that followed the termination event and to capture the whole spectrum without preconceived constructs. Future research can extend this boundary condition with a finer-grained exploration of the antecedents and consequences of specific emotions, such as, frustration over delayed failure and relief when a project is eventually terminated.

Taking these limitations into consideration, I conclude in the following chapter with a brief summary.

7.2 Conclusion

This thesis explored project failures in the context of R&D-intensive subsidiaries of a multinational organization. The mystery of project failure persists despite its frequent occurrence and can be attributed to an anti-failure bias among managers and scholars (McGrath, 1999). Provided uncommon access to multiple sources of data on project failure, I was able to remove some of the mystery surrounding this important topic. The within- and cross-case analysis demonstrated how R&D project terminations were managed, which emotional consequences occurred related to the termination and how learning from failure took place in the respective settings. Especially the methodology of cross-case comparison has identified several common patterns, which subsequently have been contrasted with extant literature. As a consequence, I identified several propositions to extend existing knowledge and theory on R&D project failure, which I tied together in the proposed model for timing of project termination and learning from failing projects.

To conclude, although scholars have acknowledged that issues related to the timing, emotions, and learning surrounding project failure are likely to be important, this study offers a number of new insights in this area. Specifically, team members learned from project failure when there was a delay in both the termination of the project and the redeployment of personnel to the next project. Despite more learning resulting from of delayed termination, the delay generated a negative emotional reaction to what was considered the creeping death of the project; team members believed that their progress in terms of the engineering process was obstructed by being required to remain with the failing project. I also found that anti-failure biases were prevalent. One manifestation of an anti-failure bias was the (re)definition of project failure so it did not apply to the current initiative, which subsequently enabled a rapid termination. Termination of a failing project was also accelerated by a process that restricted boarder participation in the decision to terminate and gather information critical to learning, which also obstructed learning. Due to the exploratory nature of this study, I do not claim to offer the only, ultimate explanation of project termination processes and consequences. Nevertheless, it enables us to understand this phenomenon better, building on real life cases of terminated R&D projects. As there is a clear need for further studies, I look forward to future research that empirically explores the model proposed in this dissertation and to further theorizing on project failure within organizations.

Appendix

Appendix 1: Interviewee overview

#	Company	Position	Years in company	Years in industry	Interview date	Interview location	Interview duration [1)]
1	Corporate	CTO	18	18	July 20th, 2011	Office	45:24
2	Subsidiary A	Mgmt: Mkt. director	20	22	July 26th, 2011	Office	67:50
3	Subsidiary A – Project Alpha	Project manager	13	13	May 23rd, 2011	Office	67:32
4	Subsidiary A – Project Alpha	Project team member 1	21	21	May 23rd, 2011	Office	66:31
5	Subsidiary A – Project Alpha	Project team member 2	15	20	May 23rd, 2011	Office	63:39
6	Subsidiary A – Project Argon	Project manager	19	19	July 19th, 2011	Office	83:47
7	Subsidiary A – Project Argon	Project team member 1	10	10	July 19th, 2011	Office	68:46
8	Subsidiary A – Project Argon	Project team member 2	14	15	July 26th, 2011	Office	99:52
9	Subsidiary B	Mgmt: CTO	7	38	June 24th, 2011	Telephone	37:49
10	Subsidiary B – Project Bravo	Project manager	4	34	June 22nd, 2011	Office	108:42
11	Subsidiary B – Project Bravo	Project team member 1	0 [2)]	36	July 6th, 2011	Telephone	53:54
12	Subsidiary B – Project Boron	Project manager	6	6	June 21st, 2011	Office	107:48
13	Subsidiary B – Project Boron	Project team member 1	3	3	June 23rd, 2011	Office	66:23
14	Subsidiary B – Project Boron	Project team member 2	3	18	July 15th, 2011	Telephone	98:11
15	Subsidiary C	Mgmt: CTO	7	16	May 16th, 2011	Office	51:29
16	Subsidiary C – Project Caesar	Project manager	11	11	Aug 16th, 2011	Telephone	54:26
17	Subsidiary C – Project Caesar	Project team member 1	6	30	June 29th, 2011	Telephone	42:29
18	Subsidiary C – Project Caesar	Project team member 2	6	16	July 6th, 2011	Telephone	64:18
19	Subsidiary C – Project Chrome	Project manager	8	44	June 15th, 2011	Office	91:00
20	Subsidiary C – Project Chrome	Project team member 1	25	25	June 14th, 2011	Office	73:13
21	Subsidiary C – Project Chrome	Project team member 2	8	34	June 5th, 2011	Office	122:28

Appendix 1 continued

22	Subsidiary D	Mgmt: CTO	25	25	Aug 2nd, 2011	Office	55:40
23	Subsidiary D – Project Delta	Project manager	24	30	May 9th, 2011	Office	105:50
24	Subsidiary D – Project Delta	Project team member 1	5	5	May 9th, 2011	Office	69:51
25	Subsidiary D – Project Delta	Project team member 2	5	5	May 9th, 2011	Office	80:54
26	Subsidiary D – Project Dexter	Project manager	11	16	June 27th, 2011	Office	113:41
27	Subsidiary D – Project Dexter	Project team member 1	4	19	June 27th, 2011	Office	87:39
28	Subsidiary D – Project Dexter	Project team member 2	9	9	June 27th, 2011	Office	59:18

Note: Main interviews only, without preparatory discussions and follow-up interviews
1) Taped core interview only 2) Employee of external research partner

Source: Own illustration

Appendix 2: Case study protocol

Source of data	Implemented procedures
Pre-interviews	• Identify and contact suitable candidate with overview on R&D project portfolio • Explain research objective and ensure anonymization and confidentiality upfront • Clarify questions on details with regards to research questions • Ask for contact persons of identified projects and notification of upcoming contact by researcher • Ask for upfront information / material to prepare interviews
Interviews	**Preparation:** • Conduct pre-call to explain study, approach and research questions; highlight and ensure anonymization and confidentiality upfront (refer to pre-calls with company representatives if necessary) • Ask for documentary information to better understand specific project situation and prepare interviews • Define interview date and location • Send information package (incl. research approach and key questions to be answered by study) upfront and offer opportunity to clarify further questions in advance **During the interview:** • Introduce yourself and establish open, trustful atmosphere ('break the ice') • Explain research questions, scope of interview and interview sequence(clearly state what is out of scope) • Ask for permission to tape the interview • Follow semi-structured interview guideline, start with open questions and keep flexibility of sequence according to the course of the interview • Ask for permission to contact interviewee for follow-up questions to clarify open issues if required • Take field notes before / during / after the interviews **After the interview:** • Write down important insights / notes / ideas immediately after the interview (what were key insights / interesting facts) • Record information on interview situation and specifics in interview report • Transcribe interview within 48 hours and perform anonymization
Archival data	• Ask for permission to review additional documentary material before / after the interview (try to get similar documents / types of information) • Search databases (e.g., Factiva) and company press releases for additional public information on projects • Search internal documents for relevant information • Gather confirming and disconfirming evidence from all sources
Data triangulation	• Triangulate information from all sources for respective project

Source: Own illustration

Appendix 3: Coding scheme

#	Category	Sub-category	Exemplary quote from the study
1	Blame for failure	---	In my opinion, I do not think that we make individual developers responsible for the failure of the project and accordingly no longer provide subsequent tasks to these developers. This is not the case. Therefore, the next task is actually the greatest sign of confidence.
2	Primary cause of failure	---	The first stage [of the product] was working okay, the second stage was not. There was a lot of discussion about what we needed to do. Basically it came down to… I really think it was a fundamental flaw within the theory and the concept of the design of component A we were putting forward.
3	Champion	Exit	I have not initiated the termination. I have only supplied the numbers in the end. Based on my experience with other projects of similar dimensions, I could estimate how much it would cost. We then had also meetings with the respective specialists to back the numbers again. Ultimately, it was decided on the basis of my estimations.
4	Champion	Project	The head of the business segment - it was actually evident that he wanted to have this machine and that he supported the project.
5	Commitment	Employees	I think at times, we set targets very challenging, because we simply thought, "This can be done, it must be done". And we even defined targets ourselves that the individual components needed to reach, so we set corresponding cost targets for their designs.
6	Commitment	Organization	And finally, the commitment from the management level above and below was absent. So from both, the solution side and the product side as well, there was no clear commitment to this machine.
7	Commitment	Project	In the milestone two review, we have already noticed that there was no one in this project, who pushed for the introduction or the implementation of this machine in a real customer project.
8	Communica-tion	Project	There were very different views on some topics in the extended project team because of the language barrier. Due to the fact that only few people of the customer spoke English, direct contact was only very rarely possible. This has made the communication in the project very, very difficult.
9	Communica-tion	Termination	I have been very open with the team, even all the time before the termination. […] I did closely inform the core team about things happening with the customer. Simply, as I said earlier, this issue of 'efficiency', what does the customer want, where does the customer stand at the moment, what are our concerns, I have just very closely communicated and to talk about this as prompt and open as possible. I also said relatively open that we have to take the decision as it is, even if I could not quite understand things. Of course you try to explain to give them a new perspective. Within the extended team, it was not possible to make it that prompt as I was not able to launch a meeting with 70 people spontaneously. But first of all we informed the key people by a written notice so they will not hear about this indirectly. Then we organized a management meeting, where our management was able to communicate it directly face to face and could answer questions.
10	Creeping death	---	I guess, a point was, it was at some point good that there is a definitive decision. This arouses still a shaking of the head today, because it has been just such a creeping death.
11	Dealing with failure	Organizing for failure	*Which organizational processes or routines are in place to help you getting over failure?* ... I do not know of any. I know we, of course, have our HR department to handle people who get stressed out by a termination - which could be the case in this situation as well. We have a process for that but... a process or routine directly managing project failure - to my knowledge; we do not have procedures to support getting over failure.
12	Dealing with failure	Support	Originally in such an important new development I expected the management to say: "I made a business decision and I am looking for

			someone who can execute the task. Someone who is responsible for it, who has to do this but, of course, I support and enable him so that he can do it". And in fact it is not like this. De facto the 'company' says: "I made this decision and transferred the responsibility for the project and he should handle it. But now it is your problem; if you'll get into troubles - I do not care, it is not my problem, it is yours...". This is very astonishing, but it is like that.
13	Emotional response to failure	Development of emotions over time	Probably, the trough lasted a week or two. And then you come out slowly, but you are still left with all the negative feelings, do I get my CV together, do I look for another job and all those things. You know, to try to see where your future is.
14	Emotional response to failure	Estimation of perception on higher org. levels	I think at that level it is just a part of daily business. It is a fact of business life that some projects fail and some do not. They look at the entire portfolio... Whereas we, as projects managers, only look at the projects that we are working on. So from their point of view I think for other project X it was somewhere frustrating because it had by far higher costs. But closing down R&D projects I think this is just another decision.
15	Emotional response to failure	Estimation of perception on lower org. levels	Well... Disappointment... Lack of understanding and... Yes, disappointment and incomprehension - actually the two essentials... so disappointment that the project was terminated and lack of understanding about the 'why'. And I think this is the critical pair and this can then be seen very differently. People handle this differently. There are introverted ones that get depressed and then there are the extroverted, which abound it. I believe the basics patterns are always the two. The reaction then always depends on the personality.
16	Emotional response to failure	Negative emotions / neutral reactions	On the one hand, there was a big disappointment about the stop, we did not succeeded with the whole topic that has been very, very exciting from the technical perspective and we had a lot of external contacts. Now it was gone.
17	Emotional response to failure	Physical reaction	Not meaningful, not lasting, I had sleepless nights and was actually struggling to concentrate on other things. At home I just felt pretty miserable at the time but not seriously ill. The sleepless nights... The only thing I could mention is that sort of feeling sick, that was probably the most physical symptom. Yes. Feeling sick, in the same sort of way, I guess, if you are going to do a major presentation and you do not feel capable. It is that sort of feeling that you have deep in your stomach in these situations.
18	Emotional response to failure	Positive emotions (incl. relief)	At some point, certainly a little bit of relief because, as I said, we permanently had high pressure three years earlier. Therefore we had too little time for the development in terms of the customer project. That meant also to show the customer that we were the right partner, we would make it, we keep your schedule. At the same time, we actually needed more time according to our regular process. Then this was just gone. Therefore I felt a relief.
19	Emotional response to failure	Regret	I always said: "A technological window opens here; it is appropriate and important that we do not just only play along with the others, but also really try to be the driver of the technology." If we afterwards find out that it doesn't work, then we also know that others cannot control it. But it's very bad, when suddenly nations such as A and also B are on the market and say "Here you go, here is the first realized project of this new technology, customers can actually buy it" and we missed it.
20	Escalation of commitment	---	Yes. What is also interesting is that no one has said, "We don't do that" in all the official meetings, so if we had reviews or gates. We have had gate meetings where the top management was present and where no one has said: "We don't do that, no release". In every decision makers meetings, the project has received a green light.
21	Expectations	Performance	My experience is, that in larger industrial projects basically, let's call it, an unrestrained optimism on all sides. Whether it is technically 'Will we get it done? - Sure, we will work it out.' And concerning time? Well. Challenging… Will work. And commercially in the sense of budget? First

			of all: Do we have sufficient money? – We need to see, but it should work. There is always a merciless optimism.
22	Expectations	Termination	It was also completely clear to everyone that this is even economically a very, let's say, challenging project. It could always happen that something like “At the end of the day it's not worth it” might be said. It was clear to everyone that such a situation could occur.
23	Expectations	After the failure (dealing with failure)	It is important how it is communicated and that you are reasonably able to understand why it is like this. If I there is no market then there is no market. Full stop. Finish. End. If I did trust in the product then it is good. If there is not currently anything or if there is not anything available at the moment I have just to accept this.
24	Identity	---	These R&D persons. These projects really, really are their babies.
25	Learning from failure	Lessons on org. level (incl. changes in org. after event)	Yes. I think in the past you went on trust on a person’s experience. I think today we analyze that deeper by more structured reviews.
26	Learning from failure	Lessons on personal level (incl. changes in own approach)	I believe that I personally learned simply to avoid letting things come closer to you. I notice this in the daily business - some colleagues get really all upset in such situations. I say in these situations “Folks, keep calm”. First try to understand, to assess the facts, are the consequences really that drastic? I personally think that everybody needs to make these experiences in his professional life and, figure out how to deal with it.
27	Learning from failure	Organizing to learn from failure (incl. belief in learning)	Yes, absolutely. It depends on the type of the project manager. Some project managers keep their notes for every day and they write down how the project is performing, so they can collect these to a lessons learned report. Other ones just do a lessons learned workshop and then write the lessons learned document.
28	Redeployment	---	I may say, ultimately project management involves continuous motivation of the team. Setbacks or downs just require special motivation. I may say, when the time came that the project was almost dead, it was announced that we won’t continue to work on it, I think everyone involved somewhere in this project team already worked on other projects again. So I can state that no boredom came up, but everyone was again fully loaded with tasks. It just went on.
29	Re-motivation	Implemented measures	I conducted a small workshop with focus on ‘motivation’ and ‘recognition’ in my organization, simply to make clear to everyone what motivation is at all and what options I have as manager. The most obvious to everybody is a bonus payment, but there are very banal things like simple saying “Thank you”, expressing recognition or using the opportunity to e.g., let the team present the results. To make this aware within our team. But this is nothing the company did, but what I did out of my own initiative.
30	Termination	Organizing for termination	I think in general it is because of any of our KPIs. It could be financial, it could be time-schedule, and it could be product-KPIs. And maybe a fourth one is some type of quality assessment. If any of those four categories does not fulfill its target, it goes to the gate. There we need to consider if we should continue with the project or if we official stop it.
31	Termination	Clarity of failure definition [1)]	On the one hand an economic loss - that is quite clear. Investment in R&D that delivers no return... Sometimes it is also a motivation issue, sometimes also a reorientation in the organization because you have to change certain processes and in general as well a learning opportunity... The question, what went wrong, what can we do differently next time?
32	Termination	Project failure percentage [1)]	I think only a very low percentage is terminated. It depends on what you measure. If you measure it in number of projects or if you measure it in invested money. But I think it is probably less than ten percent. We have a few terminations, only very few. Not reaching the target is probably a higher percentage, due to different circumstances. One is maybe that the project idea was not really suitable when we analyzed the market, what is really needed out there. And the other one is that we set a quite stretched

			target but we cannot fully fulfill it. I think that is more common than completely stopping a project.
33	Termination	Decision on termination	These decisions are always crossing the management level. It depends on the size and importance of the project, but in the end it goes up to the top-management. Usually, there is a graded decision-making process: on operational level, issue are elaborated, evaluated and submitted for decision-making and then it crosses the different hierarchy levels as they are established in the project, up to top-management.
34	Termination	Right or wrong?	The way they did it at that time was a consistent and right decision. Also if it came across differently, I would say that it was not communicated that bad. Many followed it and thought about it. Certainly it was my task to say, wait a moment and take the team with you. Then we had several discussions. I think overall, it was not managed that bad. I think the decision was the right one.
35	Time	Anticipation of failure	Yes. There was then a short phase where you realized: “Oh, something is happening now.” They did not want to talk any longer with us for the moment, they said: “We need to make up our minds ourselves first.” Then you could note already, there is something happening now.
36	Time	Emotional recovery	I think once we got a few months to get this ‘wrap up’ done. And then I heard that there was another project coming along. Then you start to pick up a bit. And I said: “Oh, there is another one”, and they asked me to come on board and another design leader, product manager, came along and we started again.
37	Time	Right timing to terminate?	Sure, you should have done it sooner. One should have perhaps talked about the goals and expectations much earlier. They have already not been defined correctly in the specifications.
38	Time	Transition	I cannot say the exact number of days, it depended on the situation and the workload of the people, but it should have been several weeks. I think that is the optimal way because it is impossible to find other tasks immediately. But after one month without a new task, of course the feeling of the people will be quite bad. If the decision, on which new project they will be staffed on happens within several weeks, it will be good.
39	Tolerance for failure	Individual	So basically because in the R&D business, it is quite a common situation that a project is stopped. There is sometimes also a complete change of the project direction because it is investigative and if you find that there is no way to reach the project objective, you need to stop and go in another direction. Therefore, it is more or less an obvious situation for us.
40	Tolerance for failure	Manager	At some point, it became very emotional at the upper management level, following the motto “I don’t want to hear the name of project Argon any longer”. That was very emotionally charged.
41	Tolerance for failure	Organization	The way I hear them in the R&D community is that we are trying to learn from it, why it happened. I would not call it either positive or negative; one simply tries to learn from it. This is how I experience it. Why is it gone wrong? Why does a product not succeed in the market? You have mentioned some of them. And you have to approach this in a cool or cold blooded manner.
42	Uncertainty / instability	Project	It was between life and death. It was not yet dead, but it was also not fully alive.
43	Uncertainty / instability	Role	It was a problem at least at that time, yes. Now, I cannot trace it back to this mistake, but rather to the current atmosphere at the department. But it has been a problem that they did not know what their next task will be for at least four to six months after the so called quick ramp-down at that time.
44	Uncertainty / instability	Strategy	No doubt. We have to provide prospects or with other words present a long-term strategy. Where do we want to go as a company? What does it mean for us as a development department and how is my personal task included? This is something we always say. […] But, in my view, we are not sufficiently stable. What we call a long-term strategy is not stable.

Note: 1) Only on subsidiary / corporate level

Source: Own illustration

Appendix 4: Semi-structured interview guideline – Corporate level

No.	Question
1.	What percentage of your projects fails? (failure: aborted R&D projects, projects with negative EBIT margin)
2.	Do you think this is rather high or low?
3.	Do you know the terminated projects in detail? Who reports them to you?
4.	How do you identify interesting / important projects that you follow in more detail?
5.	How do you feel about project failures?
6.	What do you think do the subsidiary managers feel?
7.	What about the employee on the project?
8.	Do you think that the organization can learn from its failures? (Failure is often recognized as negative – nevertheless, it offers the opportunity to learn from it. What do you think about it?)
9.	Does the corporation do anything to facilitate this?
10.	Which organizational processes / routines have been in place to
a)	to help you getting over the failure?
b)	learn from failure within the subsidiary / from Corporate (e.g. a formal/informal post-mortem) / has your behavior changed?
c).	re-motivate for the next project?
11.	How do you learn from failure?
12.	If you can think of a subsidiary that is particularly good at learning from project failures and one that is not particularly good. Why is the good one good? Why is the bad one bad?
13.	Can you imagine to initiate action that the less-good subsidiaries learn from the good ones?

Source: Own illustration

Appendix 5: Semi-structured interview guideline – Subsidiary level

No.	Question
1.	What percentage of your projects fails? (failure: aborted R&D projects, projects with negative EBIT margin)
2.	What does failure mean to you?
3.	How do you recognize that a project is likely to fail?
4.	Whose decision is it to terminate a project?
5.	How is the termination of a project decided upon? (How do you determine the optimal point to terminate a project?)
6.	Do you have any formal or informal procedures for terminating a project?
7.	Who delivers the news to those involved in the project and how is this done?
8.	How do you feel when a project is terminated – e.g. during the most recent failure?
9.	Should the terminated projects investigated (a) Project Alpha b) Project Argon) have been stopped earlier? Why did it not happen? (What would have facilitated the termination?)
10.	What do you think do those who were actively involved in a failed project feel?
11.	Is there anything you do about these negative reactions?
12.	How did the team members feel during the last project failure?
13.	How are they reallocated?
14.	How do you identify the ones responsible for the failure?
15.	What do you do with those responsible for the failure?
16.	Which organizational processes / routines have been in place to
a)	*to help you getting over the failure?*
b)	*learn from failure within your subsidiary / from Corporate (e.g. a formal/informal post-mortem) / has your behavior changed?*
c)	*re-motivate yourself for the next project?*
17.	What do you think the Corporate organization thinks when they hear a project has failed?

Source: Own illustration

Appendix 6: Semi-structured interview guideline – Project level

Category	No.	Question
Project basics	1. 2. 3. 4.	Tell me a little about the project. (Criteria: when, topic/objective, budget, work only this project only or parallel on others, …) What was the purpose of the project? What was the size and composition of the team (age structure, gender, disciplines)? How much time and effort did you invest in the project?
Process of termination	5. 6. 7. 8. 9. 10. 11. 12.	How was the project terminated? What were the events leading up to it? Who made the decision? How were you informed? How have you handled the termination within the team? Did you anticipate that it would be terminated? Should it have been terminated? (sooner or later than it was?) Have you still had hope to achieve the targeted result?
Emotional reaction	13. a) b) c) d) e) 14. 15.	How did you feel (Scale 1-10 / right after decision, today) the moment that project was terminated? later that night? the next day? one month later? now? (How long ago did it fail?) Have you had a physical reaction to the termination (e.g. sleeplessness)? Would somebody within your environment have realized / observed your situation? Why?
Organizational processes	16. 17. 18. 19. a) b) c) 20. 21.	When you said you felt bad, what did the organization do to make you feel better? What could they have done to make you not feel so bad? And / or make you feel better more quickly? Which organizational processes / routines have been in place to to help you getting over the failure? learn from failure within your subsidiary /from Corporate (e.g. a formal / informal post-mortem) / has your behavior changed? get re-motivated for the next project? Did something change in the organization after the termination? As the result of this experience do you feel any different about the organization? How?
Learnings / going forward	22. 23. 24. 25. 26. 27. 28. 29. 30.	Has something changed in the way you work on projects? What? Do you think, you have learned a lot? (Scale 1-10) What were your key learnings (what would you do different – would it fail with your knowledge of today as well? When the project failed were you immediately reassigned? Did the team stay together? If not, do you still have contact? Starting the first project after the termination, did feel any influence (e.g. behavior) on how you started the work? How did you immediately feel about this new project your have just been assigned to? How do you feel about it today? What do you think the subsidiary manager feels when projects fail? Why?

Source: Own illustration

Appendix 7: Assessment matrix – Project level

Categories (coded items)			Subsidiary A		Subsidiary B		Subsidiary C		Subsidiary D	
#	Category	Sub-category	Project Alpha	Project Argon	Project Bravo	Project Boron	Project Caesar	Project Chrome	Project Delta	Project Dexter
1	**Blame for failure**	---	L	L	L	L	Mixed	Mixed	L	L
2	**Primary cause of failure**	---	Market	Cost	Partnering	Market	Cost	Technical	Organization	Organization
3	**Champion**	Exit	No	No	No	No	Mixed	No	Mixed	No
4	**Champion**	Project	No	Yes	No	No	Mixed	No	Mixed	No
5	**Commitment**	Employees	L	H	M	M	L	M	M-L	M-H
6	**Commitment**	Organization	L	L	L	L	L	L	L	L
7	**Commitment**	Project	L (M-L)	L	M	L	L	L	L	M
8	**Communication**	Project	L	L	L	M	L (M-L)	L	L	L
9	**Communication**	Termination	M-H	L	M-L	H	Mixed	H	L	L
10	**Creeping death**	---	H	H	L	L	L	L	H	M (M-L)
11	**Dealing with failure**	Organizing for failure	L	L	L	L	L	L	L	L
12	**Dealing with failure**	Support	L	L	Mixed	Mixed	L	L	L	L
13	**Emotional response to failure**	Development of emotions over time	Decreasd - quickly	Decreased - mixed	Decreased - mixed	Decreased - mixed	Decreased - mixed	Decreased - mixed	Decreased - mixed	Decreased
14	**Emotional response to failure**	Estimation of perception on higher levels	Mixed	Do not care	Care	Do not care	Mixed	Care	Do not care	Mixed
15	**Emotional response to failure**	Estimation of perception on lower levels	n/a							
16	**Emotional response to failure**	Negative emotions / Neutral reaction	H	H	L	L	L	H	M	M
17	**Emotional response to failure**	Physical reaction	L	L	L	L	L	L	L	M
18	**Emotional response to failure**	Positive emotions (incl. relief)	H (mixed)	H (mixed)	L	H	Mixed	L	M	L
19	**Emotional response to failure**	Regret	H	L	L	L	L	L	Mixed	M
20	**Escalation of commitment**	---	M	H	L	L	L	L (mixed)	H	L
21	**Expectations**	Performance	M	H	L	L	L	H (mixed)	M (mixed)	L
22	**Expectations**	Termination	M	L	L	L	L	L	L	L
23	**Expectations**	After the failure (dealing with failure)	M	M	M	L	M	L	L (mixed)	M (mixed)
24	**Identity**	---	Strong	Mixed	Strong (mixed)	Strong (mixed)	Strong	Strong (mixed)	Weak	Weak
25	**Learning from failure**	Lessons - Org. level (incl. changes in org after event)	L	H (mixed)	L	L	L	M (mixed)	M	M-L
26	**Learning from failure**	Lessons - Personal level (incl. changes in approach after)	H	H	M-L	M-L	M	M	M (mixed)	M (mixed)
27	**Learning from failure**	Organizing to learn from failure (incl. belief in learning)	L	H	M-L	H (mixed)	M	M	M-H	M-H
28	**Redeployment**	---	Good	Good	Good	Good	M (mixed)	Good	Mixed	M (mixed)
29	**Remotivation**	Implemented measures	M	M (mixed)	M	H (mixed)	M	Mixed	M	M (mixed)
30	**Termination**	Organizing for termination	No	Mixed	No	No	No	No	No	No
31	**Termination**	Clarity of failure definition	n/a							
32	**Termination**	Project failure percentage	n/a							
33	**Termination**	Decision on termination	BU mgmt	BU mgmt	BU CTO	BU mgmt	BU CTO	Mixed	Mixed	BU mgmt
34	**Termination**	Right or wrong?	Right	Wrong	Right	Right (mixed)	Right (mixed)	Right	Mixed	Wrong
35	**Time**	Anticipation of failure	Long	Long	Short	Mixed (L)	Long	Long (mixed)	Long (mixed)	Short (Mixed)
36	**Time**	Emotional recovery	Long	Long (mixed)	Short	Short (Mixed)	Short	Long	Long (mixed)	Short (mixed)
37	**Time**	Right timing to terminate	Just right	Too late	Just right	Just right	Too early	Just right (mixed)	Too late (mixed)	Too late
38	**Time**	Transition	Short	Short	No answer	No answer	Short	Long	Short	Long
39	**Tolerance for failure**	Individual	M-H (mixed)	L	M (mixed)	H (mixed)	H (mixed)	M (mixed)	Low	Low
40	**Tolerance for failure**	Manager	M (mixed)	L	L	L	L	L	L	L
41	**Tolerance for failure**	Organization	M-H (mixed)	L	L	L	H (mixed)	L	L	L
42	**Uncertainty/ Unstability**	Project	H	H	L	H	L	L	H (mixed)	H
43	**Uncertainty/ Unstability**	Role	H (mixed)	L	L	L	L	L	L	M (mixed)
44	**Uncertainty/ Unstability**	Strategy	H (mixed)	L	L	L	L	L	L	H

Source: Own illustration

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Eidesstattliche Erklärung

Ich erkläre an Eides statt, dass ich die bei der promotionsführenden Einrichtung, der Fakultät für Wirtschaftswissenschaften der Technischen Universität München, zur Promotionsprüfung vorgelegte Arbeit mit dem Titel:

Emotions and learning from terminated R&D projects –
A multiple-case study research

am Lehrstuhl für Betriebswirtschaftslehre – Entrepreneurship unter der Anleitung und Betreuung durch Prof. Dr. Dr. Patzelt ohne sonstige Hilfe erstellt und bei der Abfassung nur die gemäß § 6 Abs. 6 und 7 Satz 2 angegebenen Hilfsmittel benutzt habe.

- Ich habe keine Organisation eingeschaltet, die gegen Entgelt Betreuerinnen und Betreuer für die Anfertigung von Dissertationen sucht, oder die mir obliegenden Pflichten hinsichtlich der Prüfungsleistungen für mich ganz oder teilweise erledigt.
- Ich habe die Dissertation in dieser oder ähnlicher Form in keinem anderen Prüfungsverfahren als Prüfungsleistung vorgelegt.
- Die vollständige Dissertation wurde nicht veröffentlicht.
- Ich habe den angestrebten Doktorgrad **noch nicht** erworben und bin **nicht** in einem früheren Promotionsverfahren für den angestrebten Doktorgrad endgültig gescheitert.

Die öffentlich zugängliche Promotionsordnung der Technischen Universität München ist mir bekannt, insbesondere habe ich die Bedeutung von §28 (Nichtigkeit der Promotion) und §29 (Entzug des Doktorgrades) zur Kenntnis genommen. Ich bin mir der Konsequenzen einer falschen Eidesstattlichen Erklärung bewusst.
Mit der Aufnahme meiner personenbezogenen Daten in die Alumni-Datei der TUM bin ich einverstanden.

München, den 23. Oktober 2012 ……………………………………

Dennis Warnecke