FACULTY OF SOCIAL SCIENCES AND COMMUNICATION

Department of International Relations

"Managing Global Product Development Teams: A Mixed-Methods Study of (Knowledge) Governance Mechanisms"

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Murcia, 28 of September, 2015

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AUTHORIZATION OF THE DIRECTOR OF THE THESIS
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Dr. Peter Ruhwedel and Dr. Pablo Salvador Blesa Aledo as Directors[1] of the Doctoral Thesis "*Managing Global Product Development Teams: A Mixed-Methods Study of (Knowledge) Governance Mechanisms*" by Ms. Britta Müller in the Departament of Ciencias Sociales, Jurídicas y de la Empresa, **authorizes for submission since it has the conditions necessary for her defense.**

Sign, to comply with the Royal Decrees 99/2011, 1393/2007, 56/2005 y 778/98, in Murcia, 20.9.2015.

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"By itself, specialized knowledge does not yield performance. (…) It is the organization that performs."

Drucker (1994)

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LIST OF ABBREVIATIONS

ACAP   Absorptive capacity (organizational level capability)

AMOS   Analysis of moment structures (software package)

ANOVA   Analysis of variance

AVE   Average variance extracted

B2B   Business-to-business

B2C   Business-to-consumer

CB   Covariance-based

cf.   confer (compare)

CFA   Confirmatory factor analysis

DC   Dynamic Capabilities

e.g.   exempli gratia (for example)

et al.   et alii (and others)

GDP   Gross domestic product

GICS   Global Industry Classification Standard

GLM   General linear model

GLOBE   Global Leadership and Organizational Behavior Effectiveness Research

HRM   Human resource management

iCAP   Individual absorptive capacity

ICT   Information and communication technology

i.e.   id est (that is)

IPMA   Importance-performance matrix

KBV   Knowledge-Based View of the firm

KGA   Knowledge Governance Approach

LISREL   Linear structural relations (software package)

M&A   Mergers and acquisitions

MANCOVA	Multivariate analysis of covariance
MANOVA	Multivariate analysis of variance
MGA	Multi-group analysis
MNC	Multinational corporation
NPD	New product development process
OECD	United Nations Organization for Co-Operation and Economic Development
OLS	Ordinary least squares
QAP	Quadratic assignment procedure
PLS	Partial Least Squares
R&D	Research & development
RBV	Resource-Based View of the firm
RQ	Research Question
sd	Standard deviation
SECI	Socialization, externalization, communication, internalization (elements of Nonaka's knowledge spiral)
SEM	Structural Equation Modeling
TCE	Transaction Cost Economics
UNCTAD	United Nations Conference on Trade and Development
VIF	Variance inflation factor
VAR	Variance
VRIN	Characteristic of strategic resources that are Valuable to the firm, Rare, Imperfectly imitable and Not strategically substitutable by equivalents; concept of the resource-based vies of the firm

1   INTRODUCTION

1.1   RESEARCH PROBLEM, QUESTIONS AND SCOPE

1.1.1   Research problem

The capability to govern knowledge flows across countries is one of the key capabilities of multinational companies (MNCs): "the superiority of MNCs stems from the firms' ability to use multiple mechanisms of knowledge transfer flexibly and simultaneously to move, integrate, and develop new knowledge" (Almeida et al. 2002, p.147). This increasingly holds true for product development, a success critical business process which is knowledge intense and requires social interaction (Eppinger 2001; Kogut & Zander 2003). Product development has been among the last MNC business processes to be internationalized (Gerybadze & Reger 1999; Narula & Zanfei 2005; Belderbos et al. 2011). MNCs from small countries started internationalizing their product development activities in the last quarter of the 20th century in order to access a broader pool of qualified human resources outside their home countries (Boutellier et al. 2008, p.8). Subsequently, MNCs from other countries have followed the trend to internationalize product development, also due to cost advantages derived from low labor cost abroad and advantages from proximity to international suppliers or customers (Granstrand et al. 1993; Gammeltoft 2005). By 2004, the share of product development sites outside MNCs' home countries had reached 66% (Doz et al. 2006), supported by the digitization and network integration of product design processes (Eppinger & Chitkara 2006). The internationalization of product development continues till date, with recent shifts of development locations towards emerging economies, considerably China (UNCTAD 2005a; Veliyath & Sambharya 2011; Laurens et al. 2014).

In order to manage the internationalization of product development, MNCs commonly use global teams consisting of product development experts from central and decentral units of the MNC (Chiesa 2000; Gassmann & Zedtwitz 2003; Eppinger & Chitkara 2006). Such global teams need to be managed effectively to overcome the challenges of physical, cultural and linguistic distance (Ambos & Schlegelmilch 2004). The objective of this dissertation is to identify the most successful governance mechanisms to manage global product development teams.

Product development is a knowledge-based function (Boutellier et al. 2008, p.273; Goffin & Koners 2011), and accordingly this dissertation pays particular attention to the integration of knowledge in global product development teams. Studying the governance of a knowledge-intense activity such as product development, this dissertation contributes to the Knowledge Governance Approach (KGA), an emerging theoretic concept aiming at understanding the relationship between organizational governance mechanisms, knowledge integration and organizational performance (Foss 2007; Foss et al. 2010).

1.1.2   Research questions

To identify the most successful governance mechanisms for global product development teams, this dissertation focuses on the relationships between *governance mechanisms[1]*, *knowledge integration* and *product development performance*. In order to increase the practical applicability of the anticipated findings, this dissertation furthermore aims to identify *context factors* which impact the effectiveness of governance mechanisms for global product development teams. Four research questions are asked to address these research objectives.

---

[1] The terms "control mechanisms", "coordination mechanisms" and "governance mechanisms" are used synonymously in academic literature, as discussed in more detail in section 2.4.1. This dissertation uses the term "governance mechanisms" when discussing tools for achieving integration among different organizational units (Martinez & Jarillo 1989).

A number of governance mechanisms have been thoroughly studied in the context of international collaboration in MNCs (Michailova & Mustaffa 2012). For this dissertation, a holistic overview of these governance mechanisms and the extent to which they are applied in the context of global product development teams is required. Numerous studies have reviewed individual governance mechanisms in the context of international knowledge exchange, a key element in global product development (Björkman et al. 2004; Fey & Furu 2008; Persson 2006; Tsai 2002). However, a holistic study of the extent to which different governance mechanisms are applied in the context of global product development teams is lacking. The first research question (RQ) in this dissertation is thus:

RQ1: Which governance mechanisms are applied to govern global product development teams, and to what extent?

The second research question deals with the relationship between governance mechanisms, knowledge integration and product development performance. Knowledge integration is included since product development scholars agree that

> "The generation of knowledge, its communication to other people, and the cooperative effort to pull different pieces of knowledge together to create new products, are fundamental issues for organizing and managing global [product development]." (Boutellier et al. 2008, p.273)

Consequently, knowledge integration is considered to be a key variable for governing global product development (Birkinshaw 2002). The second research question therefore enquires about the comparative performance of different governance mechanisms on product development performance, considering the indirect impact of knowledge integration:

RQ2: What impact do these governance mechanisms have on successful product development performance, (a) either directly or (b) indirectly via knowledge supporting the integration of team members' knowledge?

Scholars of MNC knowledge flows argue that particular attention needs to be paid to the context in which international knowledge integration takes place (Inkpen & Dinur 1998; Becerra-Fernandez & Sabherwal 2001; Birkinshaw et al. 2002). Likewise, scholars of team performance argue that context factors must be taken into consideration when studying success factors of teams (Guzzo & Dickson 1996; Mathieu et al. 2008). This dissertation therefore takes a contingency approach (Lawrence et al. 1967; Zeithaml et al. 1988) which enables the researcher to assess the relationship between governance mechanisms, knowledge integration and product development performance in different contexts (Ambos & Schlegelmilch 2007). The third research question addresses context factors (contingencies) for governing global product development teams, and seeks to assess their impact on different governance mechanisms:

RQ3: Which context factors influence the governance and performance of global product development teams, and to what extent?

Eventually, this dissertation aims to develop practically relevant advice for managers of global product development, following the call for good research to combine *scientific rigor* with *practical relevance* (Walton 1985; Anderson et al. 2001; Wolf & Rosenberg 2012). Based on the answers to the three previously stated research questions, this dissertation aims to develop practical recommendations on how to increase the performance of global product development team by applying the most effective governance mechanisms. The fourth research question thus asks:

RQ4: How can governance mechanisms be utilized to increase the performance of global product development teams?

Figure 1 visualizes the key variables (boxes) and their assumed relationships (arrows) which are investigated in this dissertation. The circled numbers indicate the associated research questions. RQ4 as an overarching question relating to the overall implications of governance mechanisms is not depicted.
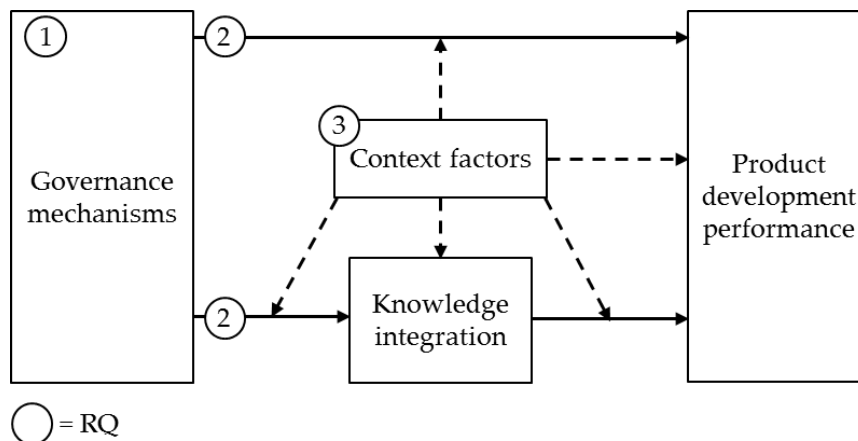
Figure 1: Visualization of research model

1.1.3   Research scope: German-based MNCs in the B2B market

This dissertation seeks to investigate effective governance mechanisms for global product development teams in different *contexts*. *Context* factors can be industry- and firm-specific or country-specific (Ambos 2005; Holtbrügge & Mohr 2011). This study keeps certain context factors constant for all study objects by focusing on German-based MNCs operating in the business-to-business sector.

Geographic focus. When considering coordination mechanisms, the MNC home country has considerable influence, both on organization and managerial style (Egelhoff 1984). In order to keep this important context factor constant and eliminate the "spurious effects stemming from cultural heterogeneity" (Ambos & Schlegelmilch 2007, p.483), this dissertation focuses on MNCs from the same home country: Germany.

Germany ranks fourth in global Research & Development (R&D[2]) budget after the United States, China and Japan (Grueber & Studt 2012)[3]. Germany has the largest R&D budget in Europe, five of Europe's ten leading companies in terms of R&D budgets are based in Germany[4], and experts rank Germany among the top 3 countries in R&D in eight out of ten industry categories (Grueber & Studt 2012).[5]

Despite its prominent global positioning in R&D, empiric research on German MNCs' product development activities is scarce (Ambos 2005; Ambos & Schlegelmilch 2007). The same holds true for empiric research on MNC knowledge integration which plays a particularly important role for product development: Literature on MNC knowledge flows focuses on companies from the US and Scandinavia[6] (Kogut & Zander 1993; Kostova 1999; Minbaeva et al. 2003; Monteiro et al. 2010), whereas only few scholars study German MNCs (Holtbrügge & Berg 2004; Moosdorf 2008; Goffin & Koners 2011) or even specialize on product development in German MNCs in spite of the topic's relevance (Ambos 2005; Goffin & Koners 2011). This dissertation addresses this underrepresentation of German-based MNCs in MNC research.

Industry focus. To further increase the homogeneity of the research object of this dissertation, the focus is additionally narrowed down to the industrial producer or *business-to-business* (B2B) market, as opposed to the *business-to-consumer* (B2C) market. The B2B market is characterized by a higher R&D intensity than the B2C market (EuropeanUnion 2012). Among German MNCs,

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[2] Cf. chapter 2.1.1 for a demarcation of product development vis-à-vis R&D

[3] Cf. Appendix A: Positioning of Germany in global R&D rankings

[4] In 2012, this included Volkswagen, Daimler, Siemens, Robert Bosch and Bayer.

[5] Cf. Appendix A: Positioning of Germany in global R&D rankings

[6] See section 3.2.1 for a detailed overview of recent studies by geographic focus

companies focused on the B2B market outnumber those in the B2C market.[7] Within the B2B market, this dissertation focuses on the development of tangible, non-perishable goods as opposed to services. Developing service products involves mainly incremental changes in processes and procedures (De Brentani & Cooper 1992) whereas developing tangible, non-perishable products involves more investments in fixed assets or human resources (De Jong & Vermeulen 2003), making it a more risky endeavor and thus relevant to study. Figure 2 depicts the industry focus of this dissertation.
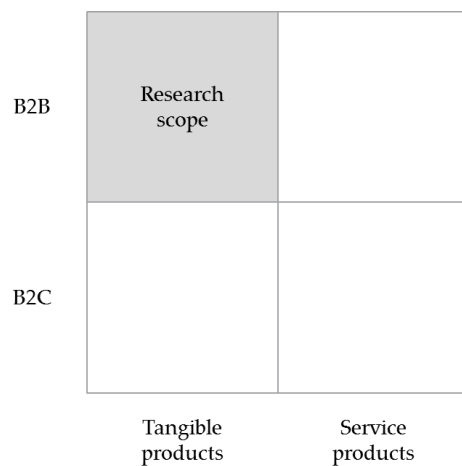
Figure 2: Industry focus

1.2   THEORETICAL AND PRACTICAL CONTRIBUTIONS

1.2.1   Theoretical contributions

This dissertation aims to close the research gap at the interface of three areas of management research: Product development, MNC knowledge integration and (knowledge) governance mechanisms (see figure 3). This chapter depicts the

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[7] Based on own calculations of the German Top 500 companies as published by the newspaper Die Welt (Welt 2012); German-based holding companies without service focus only: ratio of B2B to B2C companies equals 3:2 as measured by number of companies, cf. Appendix B: Leading German-based MNCs in the B2B sector

contribution this dissertation seeks to make to these research areas in order to
further close this gap.
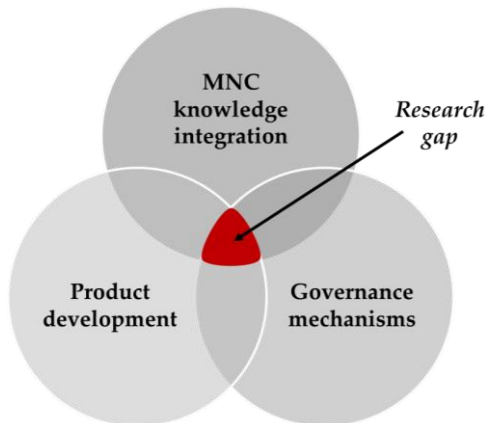
Figure 3: Research gap

Contribution to research on international product development. As
outlined earlier, product development is among the most recently
internationalized business processes. Consequently, the research body on
international product development is still small compared to other functions
(Gassmann & Von Zedtwitz 1999; Ambos & Schlegelmilch 2007; Boutellier et al.
2008). With the internationalization of product development in MNCs, research
focused initially on the organization of international R&D sites in global MNC
networks. Different roles of international R&D sites and their organizational
configuration were discussed (Birkinshaw et al. 2002; Von Zedtwitz et al. 2004)
and supported with empiric research from different countries (Ambos &
Schlegelmilch 2004; Ambos 2005; Kleinschmidt et al. 2007). Research on globally
dispersed development teams as an emerging phenomenon in MNCs started at
the beginning of the 21st century (Gaul 2001; Holmstrom et al. 2006). Several
scholars discussed individual governance mechanisms for global development
teams (Dooley & O'Sullivan 2007; Hoegl et al. 2007; Montoya et al. 2009). While
their recent studies have investigated the impact of individual governance
mechanisms on globally dispersed development teams, a holistic overview of
governance mechanisms for global product development teams, combining

empiric evidence both on their application and impact, is lacking. This dissertation seeks to address this gap.

Contribution to research on MNC knowledge integration. With the evolution of the resource-based view of the firm (Barney 1991) and subsequently the knowledge-based view of the firm (Grant 1996b), organizational theorists have accepted knowledge to be a key source of competitive advantage. As product development is an inherently knowledge-intense business process (Boutellier et al. 2008, p.273; Goffin & Koners 2011), managers of global product development teams need to understand how globally distributed knowledge can be integrated successfully. The research area of MNC knowledge integration has gained considerable scholarly attention throughout the last two decades (Foss et al. 2010; Michailova & Mustaffa 2012). Scholars have long concentrated on the intensity and quantity of MNC knowledge flows without paying particular attention to the outcomes of these knowledge flows (cf. Gupta & Govindarajan 2000). In the 21st century, the research body on *successful* MNC knowledge flows grew considerably but lacked focus on specific functions (Foss et al. 2010; Michailova & Mustaffa 2012) with only few authors focusing on product development (Yamin et al. 2011; D'Agostino & Santangelo 2012). Keupp et al. (2011) argue that "While the beneficial effects of global integration have been highlighted in the literature, little attention has been devoted to the question of how (i.e., by which means) it can actually be achieved" (p.214). Criticizing the lack of knowledge-based empirical studies on global integration, they identify a "persistent knowledge gap" (Keupp et al. 2011, p.214) regarding the mechanisms for knowledge integration. This dissertation seeks to close that gap by identifying governance mechanisms for successful knowledge integration in global product development teams.

Contribution to research on (knowledge) governance mechanisms. Research on governance mechanisms for knowledge-intense processes such as product development has gained momentum in the first decade of this century:

Numerous empiric studies focused on individual knowledge governance processes (Gupta & Govindarajan 1991; Gupta & Govindarajan 1994; Bresman et al. 1999; Gupta & Govindarajan 2000; Hansen 2002; Björkman et al. 2004; Mahnke et al. 2005). As a theoretic framework seeking to explain the applicability of different governance mechanisms, the *Knowledge Governance Approach* (KGA) emerged (Foss 2007; Foss & Michailova 2009b). The KGA

> "begins from a knowledge-related unit of analysis and explains how the efficient deployment of governance mechanisms systematically varies when the unit of analysis varies, given assumptions about agents' knowledge and motivation and given assumptions about the principle (e.g., efficiency) that links the unit of analysis with alternative kinds of governance mechanisms (or combinations thereof)." (Foss & Michailova 2009b, p.285)

While the KGA aims to build a theoretic framework for the application of knowledge governance mechanisms, a significant research gap remains due to the lack of studies with a holistic view on different types of knowledge governance mechanisms, particularly in an international context (Foss et al. 2010; Michailova & Mustaffa 2012). Foss et al. (2010) point out that

> "The relationship between governance issues and knowledge processes remains under-researched, theoretically as well as empirically, at least in comparison with the huge amount of writings concerning the characteristics of knowledge, knowledge taxonomies, how knowledge may be disseminated within and between organizations, and the philosophical foundations of knowledge." (Foss et al. 2010, p.456)

This dissertation attempts to close that gap by taking a holistic view across a broad range of governance mechanisms as they relate to global product development. More specifically, this dissertation seeks to aim the research gap which Foss et al. (2010) describe as

> "a general need for systematic empirical work aimed at uncovering the relative contributions of different organizational antecedents to knowledge sharing behaviours and their organizational ramifications; that is, essentially treat each organizational antecedent as an independent variable in properly specified

regression models, examine which antecedents are and which are not significant,

and compare the direct effects." (Foss et al. 2010, p.469)

This research gap identified by the key contributors to the KGA summarizes this dissertation's research agenda where the effectiveness of a broad range of governance mechanisms (organizational antecedents) is compared against each other to identify the optimal configuration of governance mechanisms for global product development teams in a given context.

Thereby, this dissertation seeks to add to the still small body of research on the KGA as an emerging theory for knowledge management (Andreeva & Kianto 2012; Huang et al. 2013).

1.2.2   Practical contributions

Researching the relationship between governance mechanisms for global product development teams and the performance of these teams, this dissertation provides a study of organizational performance which is often called for in management research to bridge the gap between *scientific rigor* and *practical relevance* (Walton 1985; Anderson et al. 2001; Wolf & Rosenberg 2012).

The research topic of this dissertation is highly relevant to MNCs based on (a) the success criticality of product development, where failure to innovate can have devastating effects on MNC performance (Griffin & Page 1996; McNally et al. 2010), and (b) the rising importance of global product development, as discussed in section 1.1. This pertains particularly to German-based MNCs whose global product development sites recently surged (Ambos 2005). Furthermore, the focus and design of this dissertation responds to the call of Biemans (2003) for more attention to practically relevant studies of the context and success factors of product development in B2B markets. To increase its practical relevance, this dissertation seeks to make recommendations that can be "directly applied to the problems practicing managers and other organizational practitioners face"

(Corley & Gioia 2011). Based on empiric findings, this dissertation seeks to provide practical recommendations for managers to decide on the right governance mechanisms to maximize the performance of their global product development.

In order to ensure the practical applicability and relevance of management research, Wolf & Rosenberg (2012) explicitly call for more qualitative research and for involving practitioners into the study. This dissertation's research design follows this call: Its methodologic approach, as outlined in the subsequent section, involves qualitative practitioner interviews and a quantitative survey of global development projects. The incorporation of practitioners' experience supports the practical applicability of the study's findings.

1.3   STRUCTURE OF THIS DISSERTATION

This dissertation consists of seven chapters. This first chapter introduces the research problem, states the four main research questions and demarcates the scope of the study as part of section 1.1. Section 1.2 discusses the theoretical and practical contributions this dissertation seeks to make. The chapter concludes with this overview of the structure of the dissertation (section 1.3).

Chapter 2 presents key terms and definitions as building blocks for the further course of this dissertation. More specifically, four terms which are key to this study are defined: Product development, global product development teams, knowledge integration and governance mechanisms. Section 2.1 introduces global product development teams as this dissertation's study object: It demarcates the term product development against related terms such as R&D and innovation and defines product development performance as the key endogenous variable of this study. Subsequent section 2.2 outlines the basic concepts relating to global product development teams. Firstly, the concept of a *team* is demarcated in the context of product development. Consequently, global product development

teams are characterized and their role in the internationalization of product development is discussed. Next, the key impact factors for team performance as discussed in organizational science are introduced. A key characteristic of these global teams is the team members' separation by distance. The next sub-section therefore discusses the key challenges associated with distance. Section 2.3 introduces knowledge as a key variable for successful product development. After defining knowledge and characterizing how knowledge is involved in the product development process, the construct and process of knowledge integration is discussed. To end the chapter, section 2.4 provides a general definition, overview and categorization of governance mechanisms to coordinate global product development teams.

This dissertation follows a deductive research strategy, using hypotheses to test theory (Shaffer 1995; Biemann 2007). To develop these hypotheses, this dissertation follows a theoretic-eclectic approach (Flood & Romm 1996; Kornmeier 2011, p.122): Based on a theoretic framework and a review of related empiric findings, a research model is developed. It consists of a set of hypotheses which can be confirmed or falsified empirically, following a post-positivist research epistemology (Creswell 2003; Smith 1996). The third chapter develops this research model which links the key variables of this dissertation: governance mechanisms, knowledge integration and the performance of global product development teams. To develop the research model, firstly a theoretic framework is introduced: Section 3.1 introduces the Knowledge Governance Approach (KGA) as the key theoretic approach applied in this dissertation. The KGA's evolution and links to adjacent theories, the KGA's core propositions and critique are introduced and discussed. Section 3.2 then provides an overview of recent empiric studies on knowledge governance mechanisms related to MNCs and/or product development. This helps answer *RQ1* enquiring about the governance mechanisms applied in practice. Section 3.3 combines the findings of the identified studies with the theoretic propositions of the KGA and derives testable hypotheses concerning the relationships between governance mechanisms,

knowledge integration and product development performance. Testing these hypotheses empirically provides answers to this dissertation's *RQ2* and *RQ3* enquiring about the effectiveness of governance mechanisms and relevant context factors.

Chapter 4 identifies and details the research methodology and design which is applied in the remainder of this dissertation in order to test the derived hypotheses. To start with, section 4.1 discusses the epistemological and methodological basis for this dissertation's empirical research. Section 4.2 then identifies *embedded mixed methods* as a research design which suits the objectives of this dissertation: This design combines a qualitative pre-study which explores the specific context of German-based MNCs in order to refine the research model with a quantitative principal study which tests the hypotheses of the research model (Johnson & Onwuegbuzie 2004; Teddlie & Tashakkori 2006; Johnson et al. 2007). Section 4.3 details the methodology of the qualitative pre-study. More specifically, it introduces expert interviews (Liebold & Trinczek 2009; Pfadenhauer 2009) as the chosen qualitative data gathering instrument and directed qualitative content analysis (Stemler 2001; Mayring 2004; Zhang & Wildemuth 2009) as an applicable analysis procedure. Section 4.4 details the methodology of the quantitative principal study, discussing both how to gather quantitative data in an online survey (Sue & Ritter 2007; Dillman et al. 2009) and how to interpret the data. Partial-least-squares structural equation modeling (PLS-SEM) (Denham 1995; Haenlein & Kaplan 2004; Tenenhaus et al. 2005; Panten & Boßow-Thies 2006) is identified and discussed as a suitable statistical approach to analyze and interpret the quantitative research stream. Furthermore, the approach of assessing the PLS-SEM results is detailed. Lastly, importance-performance analysis is introduced (Martilla & James 1977) and the importance-performance-matrix (IPMA) is presented as an analysis instrument (Ahmad & Bin Wan Afthanorhan 2014). After this methodologic overview, chapters 5 and 6 operationalize the qualitative and quantitative research stream, respectively.

The qualitative pre-study is operationalized in chapter 5: Section 5.1 outlines the sampling approach. Section 5.2 develops the interview guideline. Section 5.3 outlines how the interviews are prepared, conducted and documented. Section 5.4 applies qualitative content analysis to interpret the interviews and discusses the reliability and validity of the findings. Section 5.5 discusses the implications of the qualitative research findings for answering this dissertation's research questions and for designing the subsequent quantitative study. In particular, the expert practitioners' statements regarding the application of governance mechanisms in the context of German-based MNCs help answer *RQ1*. The findings of the qualitative study are furthermore applied to refine the hypotheses of the research model before it is quantitatively tested.

Chapter 6 quantitatively tests the developed hypotheses. Section 6.1 presents in detail how this dissertation's quantitative research relates to answering the research questions. Descriptive statistics are considered to answer *RQ1* which enquires about *the extent* to which governance mechanisms are applied in practice. A basic structural model seeks to answer *RQ2* which enquires about the impact governance mechanisms have on product development performance. Moderated structural models then aim to answer *RQ3* which is concerned with the influence of context factors affecting global product development teams. The IPMA is then operationalized and helps answer *RQ4* which asks how governance mechanisms can be utilized to further enhance the performance of global product development teams. Having detailed this approach, the basic and moderated structural models and their respective measurement models are operationalized. Section 6.2 proceeds to outline the operationalization of the online survey. Section 6.3 characterizes the sample (thus answering *RQ1*) and assesses its validity. Sections 6.4, 6.5 and 6.6 each assess and discuss the findings related to one of the three structural equation models operationalized in section 6.1 and thus answer *RQ2* and *RQ3*. Eventually, section 6.7 presents the importance-performance matrix derived from the data and discusses the results, thus answering *RQ4*.

Chapter 7 concludes this dissertation. Section 7.1 summarizes the answers to this dissertation's research questions. Section 7.2 discusses the limitations of the study and suggests areas for further research. Section 7.3 ends the dissertation by providing an outlook.

Figure 4 illustrates the structure of this dissertation as described above.

1

Introduction

1.1   Research problem, questions and scope
1.2   Theoretical and practical contributions
1.3   Structure of the dissertation

2

Key terms and definitions

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2.2   Global product development teams
2.3   Product development knowledge and knowledge integration
2.4   Governance mechanisms

3

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4.2   Embedded mixed methods research design
4.3   Methodology of the qualitative pre-study
4.4   Methodology of the quantitative principal study

5

Qualitative pre-study

5.1   Identification of the sample
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5.3   Interview preparation, conduct and documentation
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5.5   Discussion of the qualitative findings

6

Quantitative principal study

6.1   Model specification
6.2   Operationalization of the online survey
6.3   Characterization of the sample
6.4   Evaluation and discussion of the basic model
6.5   Evaluation and discussion of the moderated models
6.6   Evaluation and discussion of the multi-group analysis
6.7   Importance-performance matrix

7

Conclusions

7.1   Conclusions and management implications
7.2   Limitations and suggestions for further research
7.3   Outlook

Figure 4: Structure of this dissertation

2   Key terms and definitions

2.1   Product development

2.1.1   Demarcation of product development

The term *product development* is often used interchangeably with related terms such as *research and development* (R&D), *new product develoopment* (NPD) or *innovation* (Boutellier et al. 2008; Trott 2008). The United Nations Organization for Co-Operation and Economic Development (OECD) defines R&D as

> "creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications." (OECD 2002, p.30)

This definition has been suggested and adopted as standard for public surveys and statistics on R&D (OECD 2002; UNCTAD 2005b) and is widely used in academia (Gammeltoft 2005; Boutellier et al. 2008; Belderbos et al. 2011). With this definition, the OECD further distinguishes *basic research*, *applied research* and *development*. The latter is adopted as a demarcation for product development in this dissertation. In detail, the OECD (2002) characterizes (product) development as

> "systematic work, drawing on existing knowledge gained from research and practical experience, that is directed to producing new materials, products and devices: to installing new processes, systems and services: or to improving substantially those already produced or installed." (OECD 2002, p.30)

This definition renders (product) development more concrete than rather experimental or theoretic basic research and more specific than applied research which is mainly undertaken in order to acquire new knowledge (OECD 2002, p.30).

Innovation subsumes research and development activities in a broader context as

> "the process by which individuals, companies and organizations develop, master and use new products, designs, processes and business methods. These can be new to them, if not to their sector, their nation or to the world. The components of innovation include research and development, invention, capital investment and training and development." (STIC 2008, p.v)

Innovation thus includes terms such as R&D and invention. Figure 5 depicts the hierarchical relationships between these terms.
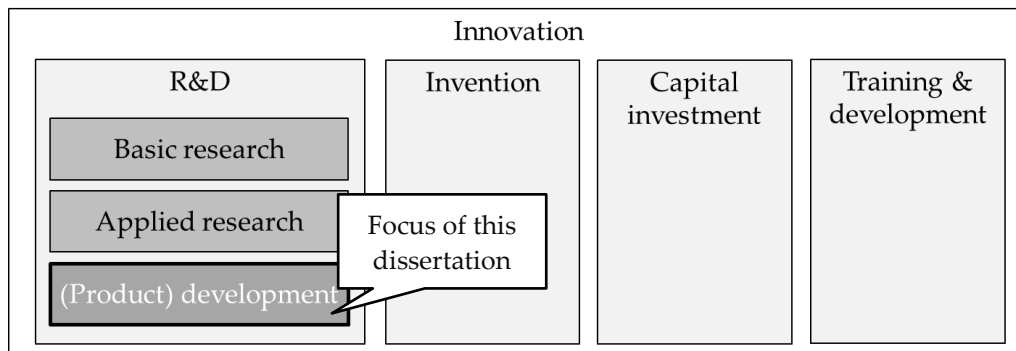
Figure 5: Product development as an element of innovation

Product development can be depicted as a process: the product development process is "a formal blueprint, roadmap template or thought process for driving a new product from the idea stage through to market launch and beyond" (Cooper 1994). This process typically involves (1) an idea phase, (2) a development phase and (3) a launch phase (Boutellier et al. 2008; Thommen & Achleitner 1998). During the *idea phase*, product ideas are generated, evaluated and selected. This "fuzzy front end" (Boutellier et al. 2008) is less structured and systematic than the development and launch phase, and out of the focus of this dissertation. When an idea is accepted, it enters the *development phase* as a project with a clearly defined target, budget and timeframe. This is the core of the new product development process during which the product idea matures. It is also the focus of this dissertation. Donnellan & Fitzgerald (2004) further subdivide the

development phase into four phases: (a) business review, which describes the initial evaluation of the general marketability of an idea for a new product, (b) feasibility studies where basic engineering principles for the new product are established and the product features are conceptualized, (c) implementation when the product design is detailed and the product is actualized for the first time (prototyping), and, finally, (d) validation which deals with developing a reliable and standardized production process before the *launch phase* which marks the product's market introduction. Figure 6 summarizes the activities in each phase and highlights the development phase as the phase on which this dissertation focuses.

Phase	Description
1. Idea phase	Search for ideas, suggest product developments
2. Development phase	Actualize product/project
2.a Business review	Evaluate market potential of suggested development
2.b Feasibility	Specify development (market requirements research basic engineering)
2.c Implementation	Technically realize product/project (detailed engineering, prototyping)
2.d Validation	Set up production, apply technical and market tests, prepare market launch (piloting)
3. Launch phase	Introduce product to market, analyze market response and make corrections as necessary

Focus of this dissertation encompasses phases 2, 2.a, 2.b, 2.c, 2.d.

Figure 6: Phases of the product development process
Source: Author, adapted from Thommen & Achleitner (1998), p.199 and Donnellan & Fitzgerald (2004), p.633

2.1.2 Product development performance

This dissertation studies the impact of governance mechanisms on the *performance* of global product development teams. Product development pursues different objectives which are relevant to define and measure its performance.

Ehrlenspiel et al. (2007) define three objectives of product development performance:

- Developing market-conform products that delight customers and meet (future) market needs
- Developing economic products that can be sold with profit margins; product development therefore also has to take production costs into account
- Creating cost efficient development processes

Other authors add speed to the list of objectives for product development as companies can derive strategic advantage from being the first to offer a product to the market (Griffin 1993).

Due to the various objectives of product development, a large number of metrics for product development exists, and there is little consensus on how to best measure product development performance (Hart 1993; Griffin & Page 1996). Griffin & Page (1996) group performance metrics into three categories:

- Customer-based performance metrics measure the market success of the developed product(s)
- Financial performance metrics deal with the attainment of the related financial targets for the developing company
- Technical or process-based performance metrics consider the achievement of targets related to the development process (time, budget, quality)

Sivasubramaniam et al. (2012) suggest grouping performance measures into measures focusing on effectiveness – "the degree to which goals are attained" (Daft 1998, p.663) and efficiency – "the amount of resources used to produce a unit of output" (Daft 1998, p.663). Another grouping criterion for performance measures of product development which is hardly applied in research relates to the time when performance is measured: This can be either *before* or *after* the launch of the product. Customer-based metrics can only be measured post-launch whereas technical or process-based metrics can be measured pre-launch. Figure 7

categorizes various measures for product development performance by measurement timing (pre-launch as compared to post-launch) and effectiveness as compared to efficiency.

	Effectiveness	Efficiency
Pre-launch	Development time (Griffin 2002) Product quality (Sethi 2000)	Development cost (Ehrlenspiel et al. 2007)
Post-launch	Customer satisfaction, product market share, product sales and profits (Im et al. 2003; Zhang et al. 2009)	Synergies from simultaneous entry into multiple markets (Subramaniam & Venkatraman 2001)

Figure 7: Product performance measures

2.2   GLOBAL PRODUCT DEVELOPMENT TEAMS

2.2.1   Demarcation of teams in product development

Organizational theory defines a team as a special type of group (Katzenbach & Smith 1993; Gemünden & Högl 1998). The ample scholarly work on groups (cf. Guzzo & Shea 1992) characterizes groups by a number of criteria (Guzzo & Shea 1992; Arrow & McGrath 1995; Gemünden & Högl 1998)

- A group is a social entity of three or more individuals.
- Group members recognize each other as such and maintain social contacts over a longer time period.
- The group has a shared purpose.
- Group members are interdependent because of the tasks they perform.
- The group is embedded in a larger social system (e.g., an organization).
- The group uses shared tools, technologies, instruments etc.

While some scholars use the term *group* interchangeably with the term *team* (Guzzo & Dickson 1996), others are more precise in defining teams as a special type of group: Katzenbach & Smith (1993, p.112) point out that a team is *not* "just any group working together. Committees, councils and task forces are not

necessarily teams". What fundamentally differentiates teams from groups, according to the authors, is *accountability*:

> A team is a small number of people with complementary skills who are committed to a common purpose, set of performance goals, and approach for which they hold themselves mutually accountable. (Katzenbach & Smith 1993, p.114)

Mankin et al. (1996, p.24) add that teams are characterized by a higher amount of task interdependence and shared goal or purpose than groups.

Given the ongoing discussion on differences between groups and teams, some authors subscribe to the concept of a "group-team-continuum" (Salas et al. 1992, p.4) with highly structured, interdependent teams on the one extreme and fragmented, minimally interacting groups at the other extreme. For the purpose of this dissertation, it is important however to take the aspect of *accountability* (in this case, accountability for product development performance), task interdependence and interaction (both between functions and disciplines involved in product development) into consideration. Thus this dissertation uses the term team instead of group.

Two main aspects render the application of teams appropriate in organizational contexts (Wiendieck 1992; Schuler 2004): Firstly, assigning holistic tasks to teams rather than assigning specific tasks to individuals improves the collective identification with the task and thus increases motivation, satisfaction and productivity of individuals.[8] Secondly, tasks characterized by complexity and uncertainty require collaboration of individuals. Organizing these individuals in a team aims to increase the level of interaction between team members and their identification with the common purpose. Consequently, the complex and often multifunctional business process of product development provides a typical setting for teamwork (Mankin et al. 1996, p.24).

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[8] Schuler (2004, p.231) cites studies going back as far as the 1950s which empirically confirm this aspect.

Teamwork is crucial in product development environment as the integration of new technologies increasingly requires the integration of technical expertise from different technical disciplines (Ehrlenspiel 2008, p.207). Furthermore, product development typically requires collaboration between different organizational functions such as R&D, production, sales and marketing (Brown & Eisenhardt 1995; Gemünden & Högl 1998; Im et al. 2013). Consequently, project teams are a common form of work organization in product development. As Mankin et al. (1996) note,

> "Knowledge workers drawn from different functional units typically make up the project and development team. They are brought together to produce one-time outputs, such as a new product or service to be marketed by the company […]. When their work is complete, project teams usually disband and the individual members either return to their functional units or move on to other projects."

Cross-functional teams have been empirically confirmed as an effective means to increasing product development performance (Hise et al. 1990; Gupta & Wilemon 1996; Loch et al. 1996). This is mainly due to the positive influence such cross-functional product development teams have by enhancing information, communication and project steering (Gemünden & Lechler 1997) and the superior ability of cross-functional teams to integrate specialized functional and technical knowledge (Cross 2000).

2.2.2 Global product development teams

This dissertation focuses on *global* product development teams. These global teams have been identified as a success factor for the internationalization of product development (Snow et al. 1996). This dissertation follows the definition of McDonough et al. (2001, p.111) who characterize global product development teams as "comprised of individuals who work and live in different countries and are culturally diverse." Ambos & Schlegelmilch (2004) further characterize global product development teams as

"international, as they span distances among internationally dispersed R&D units, integrative, as they are established to coordinate work among individual actors, and technology oriented in focus, as they aim to integrate the firms' international R&D efforts." (Ambos & Schlegelmilch 2004, p.38)

Global teams are simultaneously *virtual teams*, characterized as

"a group of people and sub-teams who interact through interdependent tasks guided by common purpose and work across space, time and organizational boundaries with links strengthened by information, communication and transport technologies." (Gassmann & Zedtwitz 2003, p.244)[9, 10]

Global teams have attained a key role in managing international product development due to their suitability to compromise between the forces of centralization and decentralization by combining team members from *central* and *decentral* units (Ambos & Schlegelmilch 2004). The need for *centralization* is based on factors such as the need to protect firm-specific technology, the need to achieve a critical mass in order to achieve economies of scale and ensure high utilization, and the cost of coordination and control to avoid duplication of effort and excessive product differentiation, and to promote cross-fertilization and learning (Granstrand et al. 1993; Ambos 2005). The need for *decentralization* derives from market-seeking and resource-seeking reasons[11] forcing MNCs to set up product development units abroad. Market-seeking foreign product development units adapt products to local market needs, support local production sites abroad or exist for reasons imposed on the MNC from host countries (Håkanson & Nobel

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[9] Another commonly used term in this context is "distributed teams". Anderson et al. (2007) define distributed teams as comprising individuals across the borders of firms, countries, or both. This exceeds the definition pursued by this dissertation which focuses on product development teams who are globally dispersed *within* MNCs.

[10] Not all virtual teams are global, however (McDonough et al. 2001).

[11] Some authors use the terms "home-base augmenting" and "home-base exploiting" synonymously (Kuemmerle 1997).

1993)[12]. Resource-seeking foreign R&D units pursue the motive to "'tap into' a foreign technological infrastructure"(Håkanson & Nobel 1993, p.379), trying to access new knowledge by cooperating with local universities, research organizations, or suppliers. Another resource-seeking motive is to attract local talent based on the highly specialized local knowledge stock or the lower labor costs.[13]

By deploying global product development teams, MNCs attain various advantages (Anderson et al. 2007): Firstly, they gain access to (new) knowledge while minimizing risk as not all international locations need to invest in building the same knowledge stock. Secondly, they can decrease cost by exploiting local labor cost advantages in product development. Thirdly, they can access well qualified resources abroad and eventually increase flexibility by sharing development resources across locations. While these advantages drive the utilization of global product development teams, these teams face two major challenges (Ambos & Schlegelmilch 2004; Cash-Baskett 2011): Intercultural conflicts might negatively impact team productivity and difficulties arise in converting and integrating knowledge across a distance.[14] Cordery & Soo (2008) summarize the challenges of global teams as

> "(a) accessing, storing and capitalizing on team knowledge; (b) developing a sense for collective engagement in respect of the team task and (c) experiencing the sense of collective competence that is often associated with performance." (Cordery & Soo 2008, p.489)

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[12] These reasons include local labor legislation after company acquisitions, or localization regulations set up by local authorities to increase the local knowledge stock (Sun et al. 2007).

[13] Historically, market-seeking units outnumber the resource-seeking foreign R&D units of MNCs (Ambos 2005; Håkanson & Nobel 1993a).

[14] Gassmann & Zedtwitz (2003) furthermore mention the costs of coordination across cultural and geographic distance as a challenge for global product development teams. The relevance of aspect is decreasing however based on the advances in information and communication technology.

In order to better understand the specific challenges global teams are faced with, the next section digresses into general factors impacting team performance. Based on this discussion, the subsequent section 2.2.4 identifies the different facets of distance as key challenges distinguishing global product development teams from co-located teams.

2.2.3   Impact factors for team performance

Before discussing the specific challenges of global product development teams, it is worthwhile digressing to general team performance and its impact factors. The *input-process-output* model developed by McGrath (1964) is perceived as the dominant model in group performance research (Guzzo & Shea 1992; Mathieu et al. 2008). It posits that team members bring an *input* to the team which is *processed* via interaction with other team members in order to generate an *output*. Team performance can accordingly be measured in terms of its impact on the *input*, i.e., the team members' motivation and capability to share their expertise. Likewise, the efficiency of the team *process* can be measured, e.g. in terms of costs and time. Thirdly, team performance measures can be directly related to the team's *output* in terms of e.g. quality, quantity, speed or customer satisfaction (Hackman 1987; Guzzo & Dickson 1996). In the context of this dissertation, many of these team performance criteria, particularly regarding *process* (efficiency) and *output* (effectiveness) overlap with the performance criteria for product development discussed in section 2.1.2. As with product development performance, there is no singular, uniform performance metric for teams (Guzzo & Dickson 1996). Scholars from the fields of organizational and social psychology as well as management scholars have, however, identified a wide range of impact factors for team performance. Based on a synthesis of three widely cited meta-studies summarizing research on team performance since the 1990s (Guzzo & Dickson 1996; Cohen & Bailey 1997; Mathieu et al. 2008), key impact factors for team performance are briefly summarized here to provide a comprehensive foundation for the remainder of this dissertation. As building blocks for team

performance, the impact factors team cohesion, team goals, team motivation, team composition, team leadership and team structure are introduced.

Team cohesion describes in how far the team members are committed to the team's overall task or to each other (Goodman et al. 1987). Cohesion has been studied thoroughly (Webber & Donahue 2001; Gully et al. 2002) and has been confirmed to have an overall positive impact on team performance and to be closely linked to team motivation. Organizations can influence for cohesion by aligning team goals.

Team goals, particularly *specific* and *challenging* goals, raise team performance in the performance dimensions they relate to (Weldon & Weingart 1993). Organization can use this link by aligning incentives with team goals: Teams with challenging goals who are rewarded on goal attainment outperform teams with less challenging goals who receive no goal rewards (Knight et al. 2001). According to a study of Mitchell & Silver (1990), team goals are more effective as an incentive for team members than individual goals.

Team motivation or *collectivistic work motivation* consists of three types (Shamir 1990): (1) Calculative motivation derives from rewards or sanctions associated with team performance. (2) Identification is a source of motivation when a team member's self-concept is influenced by his or her membership in a group. (3) Internalized motivation occurs where a team member identifies the team's beliefs and norms. Employers can influence calculative motivation via team-based incentives and recognitions (Gladstein 1984; Campion et al. 1993). Socialization techniques, particularly team learning, can to some extent positively influence internalized motivation (Zellmer-Bruhn & Gibson 2006). However these types of motivation are hardest to influence and are rather steered through team composition (Mathieu et al. 2008).

Team composition deals with the attributes of team members in terms of e.g. demography (age, gender, education, ethnicity), function and culture. A large body of research in this field has been dedicated to team heterogeneity and has come to different conclusions. Heterogeneity applies to the mix of personalities, gender, attitudes, and background or experience of team members and is generally viewed as positively associated with creativity and decision-making effectiveness (Jackson et al. 1995). This holds true mainly for teams dealing with creative and intellectual tasks (Jackson et al. 1991; Devine & Philips 2001), whereas heterogeneous groups score below average performance in numerous other domains (Mathieu et al. 2008). Several studies find a moderating impact of familiarity on team heterogeneity Watson et al. (1993; 2001). Harrison et al. (1998) find that diverse teams take some time to perform efficiently as compared to homogenous groups. Other research identifies a point in time when team permanence and member familiarity deteriorate team performance (Katz 1982; Katz & Allen 1982), indicating a temporary optimum level of familiarity in teams.

Team leadership has been thoroughly studied as having considerable impact on team performance, particularly as it impacts team management processes such as coordination and knowledge sharing (Mathieu et al. 2008). Eden (1990) finds empiric evidence that the performance expectations set by leaders have positive impact on team performance. The impact team leadership has on team performance however varies with the team structure as outlined below.

Team structure varies with the extent of functional integration of teams. Clark & Wheelwright (1992) differentiate four types of team structures: Functional, lightweight, heavyweight and autonomous teams.

- Functional team structures are specialized and grouped by discipline. In functional teams, the same managers control resources and task performance. This structure works well when tasks can be divided at

the outset into separate, independent work packages allocated to functional subteams, which hardly applies to product development.

- Lightweight team structures are characterized by a team manager who coordinates team members residing in their functional teams. The lightweight project manager has no power on resource allocation. While this approach increases coordination and communication across functions, the functional organization typically has priority over the team. This can drive conflict and friction.

- Heavyweight team structures differ from lightweight team structures in so far as that the project manager outranks functional managers, has primary influence on the resource allocation of the team members and sets and reviews performance targets for the team. Functional managers remain in charge of career development for their team members. While heavyweight teams are reported to be effective, they create conflict with the functional organization more frequently than lightweight team structures.

- Autonomous team structures go one step beyond heavyweight team structures and give the project manager full control over the resources contributed to the project. Team members are typically pulled out of their functions and dedicated full-time to the project and co-located. These teams benefit from task focus and are very efficient in new product development. At the same time, autonomous teams are the most costly, and challenges are often associated in re-integrating the team members into the line organization after the autonomous team has completed its task (Gassmann & Zedtwitz 2003).

Many of these impact factors will be referred to when discussing governance mechanisms for global product development team (cf. section 2.4). Before, one key context factor which is characteristic for global teams is discussed in more detail: distance.

2.2.4   Distance as challenge for global product development teams

Global teams are characterized by *distance* between individuals dispersed across different countries. Different dimensions of distance turn global team work into a more complex task than national, intra-unit collaboration. MNCs "have to be able to transfer (…) knowledge within organizational networks characterized by separation through time, space, culture and language" (Ambos & Ambos 2009, p.15). Berry et al. (2010) provide a concise institutional approach to cross-national distance including economic, financial, political, administrative, cultural, demographic, knowledge, connectedness and geographic distance. International management research further discusses the dimensions of linguistic distance (Marschan-Piekkari et al. 1999), temporal distance (Espinosa & Carmel 2003), institutional distance (Kostova & Roth 2002) and inter-organizational distance (Ghoshal & Bartlett 1990).

Following previous findings of international management scholars (Casey 2009; Ambos & Ambos 2009; Håkanson & Dow 2012), this dissertation focuses on three particularly relevant dimensions of distance for global teams:

- Geographic (and related temporal) distance
- Cultural distance
- Linguistic distance

Table 1 provides an overview of these dimensions of distance, potential measurement approaches and empiric research on intra-MNC cooperation with regard to these dimensions, as discussed in more detail subsequently.

Dimension of distance	Definition: difference between individuals related to…	Potential measurement indicators	Examples for related MNC research
Geographic	Physical distance between countries	Great circle distance between two countries according to the coordinates of their geographic centers	Allen (1977), Hansen & Løvås (2004), Ambos & Ambos (2009), De Rooij (2009), Noll et al. (2010)
Temporal	Time-zones, based on geographical distance on the East-West axis	Hours of time difference	Espinosa & Carmel (2003), Holmstrom et al. (2006) , Noll et al. (2010)
Cultural	Attitudes towards authority, trust, individuality, and importance of work and family	Power distance, uncertainty avoidance, individualism, masculinity	Gomez-Mejia & Palich (1997), Lucas (2006), Casey (2009), Stahl et al. (2009), Taras et al. (2009), Glynn et al. (2010)
Linguistic	Extent to which languages differ from each other	Difficulty of learning each other's language	Welch & Welch (2008), Noll et al. (2010), Welch & Welch (2008), Harzing et al. (2011)

Table 1: Dimensions of distance in MNC research

Geographical distance measures the physical distance between individuals. Actors tend to interact less with increasing geographic distance. In empirical research with R&D teams, Allen (1977) found that collaboration is most effective when the team members are on the same floor and less than 50 meters apart. This is due to the higher intensity of communication between co-workers who are co-located in the same office. The "Allen curve" depicts his empirical findings on the relationship between the distance of separation and frequency of communication among R&D co-workers (see figure 8).

Frequency of
communication
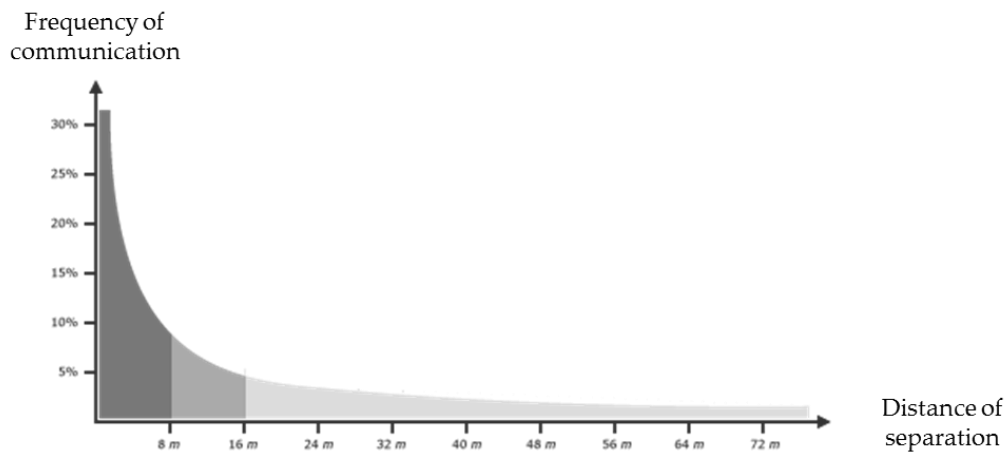
Figure 8: The Allen curve
Source: Allen (1977)

The impact of personal geographic distance holds true also for electronic communication: In 1977, Allen stated that "The more often we see someone face-to-face, the more likely it is that we will telephone the person or communicate in some other medium" (Allen 1977), and while almost forty years later, modern information and communication technology (ICT) offers more possibilities to bridge the distance between individuals, it can still not overcome personal proximity (Ambos & Ambos 2009). ICT-based communication mediates communication as signs of nonverbal communication are not understood (De Rooij 2009; Noll et al. 2010), and "the accuracy and richness of information transfer declines with increasing geographical distance" (Hansen & Løvås 2004, p.803). In an international context, **temporal distance** often reinforces the challenges associated with geographic distance (Noll et al. 2010): The longer the distance between individuals on the East-West axis, the more complex communication gets due to increasing time shifts between the participants. The less their working time overlaps, the harder it becomes for team members to interact synchronously (Holmstrom et al. 2006) and the higher the dependency on less rich communication channels such as email (Espinosa & Carmel 2003, p.64).

Cultural distance is among the most widely discussed aspects of distance in MNC literature (Taras et al. 2009; Stahl et al. 2009) and has been characterized as "a source of strong categorization and stereotyping, so the effects of cultural diversity may be stronger than other sources [of diversity]" (Stahl et al. 2009, p.691). The numerous definitions of culture which have been developed (Koltko-Rivera 2004; Taras et al. 2009) commonly describe culture as a multi-level construct with basic assumptions and beliefs at the core and practices, symbols and artifacts as outer layers (Hofstede 1980; Trompenaars & Hampden-Turner 1998). Culture is shared by the individuals of a society and the construct is relatively stable over time (Taras et al. 2009). Cultural distance describes the extent of difference in culture between individuals from different cultural backgrounds.

Researchers find ambiguous evidence regarding the impact of cultural distance on global teams: One the one hand, cultural distance negatively impacts knowledge exchange, particularly regarding joint identity-building (Lucas 2006) which strongly influences innovation performance (Glynn et al. 2010) and (co-) working practices (Casey 2009). Establishing trust as a key basis for successful cooperation is easier when people share beliefs and values, which is more likely in one culture. On the other hand, the diversity created by cultural distance has positive impacts on creativity and innovation: Combining complementary knowledge based on different beliefs, values and practices can generate innovative new ideas (Vaara et al. 2012). These findings are in line with the findings of heterogeneous team composition discussed in section 2.2.3. Yet other studies suggest that cultural distance is not relevant at all (Gomez-Mejia & Palich 1997).

Linguistic distance relates to the extent to which the mother tongues of individuals differ. It has been neglected by many researchers of international knowledge transfers (Welch & Welch 2008). Communication between MNC members of different national origins oftentimes requires that at least one party

has to switch to another language. In MNCs from non-English-speaking countries that embraced English as a second language, international communication often involves solely non-native speakers. Language, however, is part of the mindscape and individuals typically draw interpretations from their own language system even when communicating in a foreign language. As language skills of individuals differ and particularly informal information is spread in MNC host-country language, knowledge becomes "an informal source of expert power" (Marschan-Piekkari et al. 1999) in MNCs. The "language barrier" slows processes between speakers of different mother tongues down and increases the cost of decision making (Harzing et al. 2011). As Noll et al. (2010) point out with particular regard to global teams:

> "[…] distributed team members [….] may interpret communication in different ways, influenced by their native language and culture; team members with more proficient language skills may lack confidence in their remote counterparts' understanding of communication; less proficient team members may feel inhibited from asking for clarifications due to fear of looking stupid, resulting in incorrect assumptions." Noll et al. (2010, p.73)

Empiric evidence suggests that the dimensions of distance constitute important context factors for global product development teams which have to be considered to answer this dissertation's third research question relating to the context factors which influence the governance and performance of global product development teams.

2.3   PRODUCT DEVELOPMENT KNOWLEDGE AND KNOWLEDGE INTEGRATION

2.3.1   Product development knowledge

Donnellan & Fitzgerald (2004) define product development as "knowledge work" as it is based on a body of knowledge, involves data, requires a deep theoretical understanding and results in an end product for which knowledge is an essential ingredient.

Following the hierarchical demarcation of knowledge (Nonaka 1994; Haghirian 2011), knowledge is more profound than information and data: Data consists of "symbols that represent properties of objects, events and their environment" (Rowley 2007, p.166). Information provides the context to interpret data (Haghirian 2011), and knowledge combines several pieces of information with an interpretation and meaning. Following Davenport & Prusak (2000), knowledge can be defined as

> "a fluid mix of framed experiences, values contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the mind of knowers. In organisations ,it often becomes embedded not only in documents or repositories but also in organisational routines, processes, practices and norms." (Davenport & Prusak 2000, p.5)

Knowledge has many facets. Haghirian (2011) provides a concise overview of five knowledge categories that are distinguished in knowledge research:

- Declarative and procedural knowledge
- Explicit and tacit knowledge
- Formal and informal knowledge
- Strategic, tactical and operational knowledge
- Individual and organizational knowledge

These categories cannot be viewed in isolation – any piece of knowledge can be classified in each of these categories. Knowing the type of knowledge involved in product development helps understand the requirements for knowledge integration between members of (global) product development teams. This section outlines the five aforementioned knowledge categories with practical examples from product development.

Declarative and procedural knowledge. Declarative knowledge is knowledge about facts. Vincenti (1990) names six categories of declarative knowledge for development engineers: criteria and specifications, design

instrumentalities, fundamental design concepts, practical considerations, quantitative data and theoretical tools. Procedural knowledge deals with information about how something occurs or is performed (Zack 1999). Shared procedural knowledge is an important pillar for efficiently coordinating action in an organization (Haghirian 2011). However, without declarative knowledge providing context information or facts, "procedural knowledge sharing will become blind duplication" (Zhao & Luo 2005). Donnellan & Fitzgerald (2004) specify procedural knowledge required in the product development process: *Operational knowledge* is required to detail the specifications of the product ensuring it meets all specified specifications, *process knowledge* is needed to develop a reliable, repeatable, cost effective production process and *causal knowledge* is required to identify the reasons for product performance in the market. In addition to this specific knowledge required for each individual product development phase, Goffin & Koners (2011) mention *project management knowledge*, which includes knowledge on how to deal with project budgets, how to solve technical problems, meet schedules, manage resources and organizational complexity.

Explicit and tacit knowledge. Explicit knowledge can be transmitted into formal, systematic language; it is therefore also termed "codified knowledge". Tacit knowledge, first discussed by Polanyi (1966), is difficult to teach as it requires experiential knowledge. It is hard to formalize and to communicate as it is "deeply rooted in action, commitment, and involvement in a specific context" (Nonaka 1994). Becerra-Fernandez & Sabherwal (2001) call explicit knowledge "know-what" and associate it with "content-oriented tasks" (e.g., knowing about facts and theories). For tacit knowledge, they use the term "know-how" and associate it with "process-oriented tasks".[15] Tacit knowledge is more difficult to transfer than explicit knowledge, since it cannot be communicated without direct

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[15] Michailova & Mustaffa (2012), in their review of literature on MNC knowledge flows, criticize the variety of alternative terms for the tacit/explicit continuum used by different scholars, including "articulability", "demonstrability and teachability.

interaction (Goffin & Koners 2011). Declarative knowledge is mostly explicit as it can be codified, whereas procedural knowledge is mostly tacit and very relevant to product development.

Formal and informal knowledge is differentiated by Haghirian (2011) as follows: Formal knowledge contains knowledge about an organization's objectives, activities and procedures, which is taught and managed actively. Informal knowledge includes knowledge about company members (private/personal information) and, e.g., unpublished information about corporate performance or market developments. Informal knowledge does not necessarily support company goals and can even distract members of the organization, but it can also be a source of power as it is not accessible to everyone. In global teams, team members from the MNC home country are typically more engaged in informal knowledge flows based on their nodal network position and geographic and linguistic proximity to the center of decision making than team members from international subsidiaries (Marschan-Piekkari et al. 1999).

Strategic, tactical and operational knowledge relate to the time and scope for which knowledge is relevant (Hong & Nguyen 2009; Haghirian 2011). As product development projects typically have long-term (product-related) objectives and short-term operational (project-related) goals, all three knowledge categories apply:

- Operational or technical knowledge is know-how of day-to-day operations. It includes technology, languages or basic techniques of how to perform a task.
- Tactical or systemic knowledge involves personal interactions and people management, and is thus more dependent on a specific context. It is required to combine operational and strategic knowledge by means of planning the operations which lead to the achievement of strategic and operational goals.

- Strategic knowledge concerns the long-term positioning, e.g. the knowledge of successful business models or the drivers of competitiveness

Universal and locally embedded knowledge. While some knowledge is universal, containing the same meaning and leading to the same outcomes worldwide, other knowledge is locally embedded and can be applied in a certain local context only. This distinction is important in the context of global teams as certain knowledge loses its meaning and/or needs to be adapted when transferred to another local context. Table 2 provides examples for universal and locally embedded knowledge based on an empiric qualitative study conducted by Hong & Nguyen (2009).

	Technical knowledge	Systemic knowledge	Strategic knowledge
Universal knowledge	• Technology • Languages • Basic selling and marketing techniques	• Quality management and control practices • Planning and management systems • Workplace improvement initiatives	• Successful business models • Strategic mindset • Industry competitiveness
Locally embedded knowledge	• Government regulations • Customer relationship management skills • Communication skills	• Power and politics in organization • Cultural differences • People management skills	• Management of external stakeholders • Local institutions • Local business systems

Table 2: Universal and local embedded knowledge
Source: Adopted from Hong & Nguyen (2009, p.351)

Individual and organizational knowledge. As presented in the introductory definition of knowledge by Davenport and Prusak (2000, p.5), individual knowledge "originates in the mind of the knower". Experience and

rationality can expand individual knowledge. Individual knowledge is typically shaped by individual beliefs and value systems. Organizational knowledge is more than the sum of all individuals' knowledge in an organization (Zhao & Anand 2009). It involves the shared norms, procedures and mechanisms in an organization (Nonaka 1994). Table 3 provides examples for tacit and explicit knowledge on different organizational levels based on the work of Kogut & Zander (1992).

	Individual	**Group**	**Organization**	**Network**
Explicit	• Facts	• Who knows what	• Profits • Accounting data • Formal & informal structure	• Prices • Whom to contact • Who has what
Tacit	• How to communicate • Problem solving	• "Recipes" of organizing such as production methods	• How to coordinate groups • How to transfer knowledge	• How to cooperate • How to sell and buy

Table 3: Explicit and tacit knowledge on different organizational levels
Source: Adapted from Kogut and Zander, 1992

Managing global product development teams requires individual, group and organizational knowledge, and is to a large extent tacit, as outlined by the examples. Global product development teams need to integrate team members' knowledge across geographic, temporal, cultural and linguistic distance. After this section of this dissertation provided an outline of the type of knowledge involved in global product development, the subsequent section discusses the role and process of knowledge integration in global teams.

2.3.2   Knowledge integration

As discussed in section 2.2.2, product development is often performed by cross-functional development teams. In the case of global teams, the individual members of these teams contribute knowledge from different functions and

different geographical and cultural contexts. Sharing and exchanging knowledge in these teams is a key prerequisite to *knowledge creation* which is, in turn, the basis for innovation (Nonaka 1994). Kleinschmidt et al. (2007) empirically confirm the key role of global knowledge integration for product development success. They define knowledge integration as as an organizational capability describing the integration of individual and group knowledge in global product development teams:

> "a capability by which firms access and integrate globally and functionally dispersed information throughout the NPD process for the purpose of developing offers that respond to customers worldwide" (Kleinschmidt et al. 2007, p.426).

According to Grant (1996a, p.380), "the critical source of competitive advantage is knowledge integration rather than knowledge itself". This pertains particularly in the MNC context: Scholars of international management continuously identify the ability to transfer knowledge between countries at a low cost and to transfer the ability to innovate across countries as core capabilities of the MNC (Hymer 1960; Buckley & Casson 1976).

The process of knowledge integration has been conceptualized differently. Two common conceptualizations of knowledge integration which are commonly applied in MNC research are the *knowledge spiral* (Nonaka 1991) and *process model*s of knowledge integration (Cohen & Levinthal 1990; Inkpen & Dinur 1998; Zahra & George 2002). These are outlined in the remainder of this section to provide a basic understanding of how the knowledge of individuals is combined and integrated to create new knowledge.

The *knowledge spiral* was first conceptualized by Ikujiro Nonaka in 1991 and was elaborated by Nonaka and Takeuchi (Nonaka 1991; Nonaka & Takeuchi 1995; Nonaka 1994) based on experience with Japanese organizations which were perceived as performing exceptionally well in the transfer from tacit to explicit and from explicit to tacit knowledge. Nonaka's knowledge spiral is also known as

SECI model, named after the initials of the four types of knowledge exchange he distinguishes (Nonaka 1991):

- Socialization (transfer of tacit knowledge)
- Externalization (making tacit knowledge explicit)
- Combination (transfer of explicit knowledge)
- Internalization (making explicit knowledge tacit)

By means of *socialization* one individual learns from another how to perform a specific task "by doing". *Combination* takes place when one individual combines explicit knowledge from various sources. However, both processes do not lead to the development of new knowledge. Nonaka states that knowledge can be created when tacit knowledge is made explicit by *externalization*, enabling people to share tacit knowledge on a broad base and subsequently to *internalize* new explicit knowledge, thus making it tacit. Figure 9 depicts the concept of the knowledge spiral.
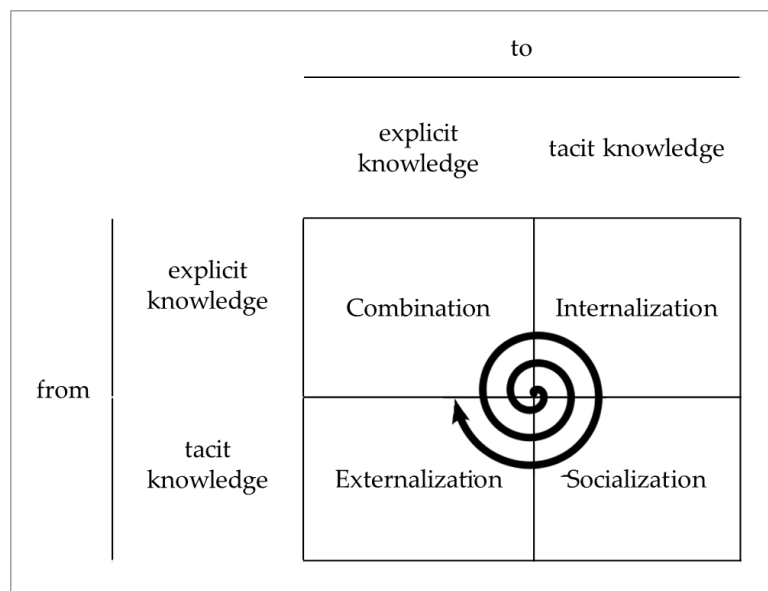
Figure 9: The knowledge spiral
Source: Adapted from Nonaka & Takeuchi 1995, p. 62

Nonaka & Takeuchi (1995) use the same model to explain how individual knowledge becomes group knowledge, and group knowledge becomes organizational knowledge following the four SECI steps. Although Nonaka's SECI model has been criticized for lack of empirical evidence and ambiguousness, it has achieved "paradigmatic status" and is one of the most influential models in knowledge management literature (Gourlay 2006, p.14). It provides a basic framework for the occurrence of knowledge exchange within an organization and its importance for creating new knowledge, while noting the difficulties associated with integrating tacit knowledge. For this dissertation, the SECI model is relevant in order to understand the importance of human interaction to transfer tacit knowledge in an organization. In global product development teams, this interaction is challenged by the distance between team members, as outlined in section 2.2.4.

Process models of knowledge integration help understand why knowledge integration matters to product development in the wider context. They deal with the process of acquiring (external) knowledge, understanding and integrating it with internal knowledge in order to develop new knowledge that can be applied to develop new products. The ability of organizations to do this has been widely discussed by management scholars as a success critical factor coined "absorptive capacity"(Cohen & Levinthal 1990). Absorptive capacity (ACAP) describes "the ability of a firm to recognise the value of new, external information, assimilate it, and apply it to commercial ends" (Cohen & Levinthal 1990, p.128). It is particularly relevant to product development, the context in which it was first discussed (Lane et al. 2006, p.836).

Process models of knowledge integration build on the communication model of Shannon & Wever (1957) which deals with the transmission of a message from a source to a recipient in a given context (Inkpen & Dinur 1998). More specifically, process models of knowledge integration describe the process of transmission by four stages (Inkpen & Dinur 1998; Zahra & George 2002):

Initially, knowledge is recognized or identified. Next, the identified knowledge is adapted or assimilated to the recipient's need. Then, knowledge is translated to the recipients context and combined with existing knowledge. Eventually, the acquired knowledge is applied and internalized by the recipient. Table 4 summarizes two definitions of the four process steps as provided by Inkpen & Dinur (1998) and Zahra & George (2002).

	Process model of knowledge transmission (Inkpen & Dinur 1998)		Process model of absorptive capacity (Zahra & George 2002)	
1	Initiation	Relevant knowledge is recognized	Acquisition	Identification of relevant knowledge
2	Adaptation	Source prepares identified knowledge for recipient's needs	Assimilation	Interpreting the acquired knowledge
3	Translation	Recipient adapts received knowledge for own needs	Transformation	Combination of existing and acquired knowledge
4	Implementation	Acquired knowledge is institutionalized/ internalized by recipient	Exploitation	Application of acquired knowledge (combined with existing knowledge)

Table 4: Process models of knowledge

While the SECI model is a recognized model to explain how organizational learning occurs with particular regard to tacit knowledge, the process models of knowledge are relevant to researching innovation processes such as product development. Developing new products typically requires the identification and interpretation of relevant knowledge, followed by the combination and application of this knowledge to develop new products or solutions which are successful in the market. This dissertation is based on the assumption that governance mechanisms can drive the performance of such knowledge integration and thereby influence product development performance. Before turning to theoretical models on how to link governance mechanisms, knowledge integration and product development performance, the next section provides a general classification of governance mechanisms.

2.4   GOVERNANCE MECHANISMS

2.4.1   Demarcation of governance mechanisms

In management research, the terms "governance mechanisms", "coordination mechanisms" and even "control mechanisms" are used interchangeably (Michailova & Foss 2009, p.8; Harzing 1999 p.8) to describe "the integration, harmonization or linking of different parts of an organization towards a common goal" (Harzing 1999, p.9) based on directing the behavior of individuals. Following Martinez & Jarillo (1989, p.490), a coordination mechanism is "any administrative tool for achieving integration among different units within an organization". This definition of coordination mechanisms applies to this dissertation as it considers *integration* as an objective of coordination. Such integration, particularly *knowledge integration*, has been identified as a key success factor for global product development teams as outlined in the previous sections of this dissertation. Instead of the term *coordination*, this dissertation stresses the term *governance* to discuss these mechanisms, based on the increased popularity and application of the term in the context of managing knowledge-intense processes such as product development (Buckley & Carter 2003; Foss 2007; Gooderham et al. 2011).

2.4.2   Categorization of governance mechanisms

Governance mechanisms have been studied extensively by scholars of international management, and an almost endless list of possible mechanisms to integrate the activities of individuals and entities within MNCs have been explored – some of them very similar, some contrasting each other.[16] A categorization or classification of these mechanisms facilitates the study of effectiveness of different governance mechanisms.

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[16] See Harzing (1999), p. 18-19 for a comprehensive overview of literature contributing to her classification of control (sic!) mechanisms

This section compares two different classifications for governance mechanisms based on the integrating works of Martinez & Jarillo (1989, 1991) and Harzing (1999). Out of the large number of classifications of governance mechanisms, these two approaches are chosen as they have been developed as syntheses based on extensive reviews of previous scholarly work on governance. Both reviewed literature on MNC governance mechanisms developed since the 1950s, and various authors have subsequently based their work on coordination mechanisms in MNCs on their classifications (cf. Tsai 2002, Chini 2004, Ambos and Schlegelmilch 2007, Manopoulos et al. 2008).

Martinez & Jarillo's typology. The classification of governance mechanisms by Martinez & Jarillo (1989, 1991) has been considered "the cornerstone for further developments in the international business field" (Manolopoulos et al. 2008, p.116). Martinez & Jarillo (1989) define two broad categories of governance mechanisms: *Structural and formal* as compared to *informal and subtle* governance.

Structural and formal mechanisms relate to the normative organization as designed by managers. They contain well-defined management systems and structures (Burns & Stalker 1994; Gulati & Puranam 2009). Martinez & Jarillo (1989) distinguish five types of structural and formal governance mechanisms which have dominated scholarly attention in the first decades of international management research:

1. *The formal organizational structure* (grouping of individual tasks and functions into departments and business units)
2. *Centralization and decentralization* (locus of decision making)
3. *Formalization and standardization* (written policies, standard processes and other formalized descriptions for organizational behavior)
4. *Planning* (coordinating the future activities of an organization)
5. *Output and behavior control* (setting and rewarding individual targets)

According to Martinez & Jarillo (1989), structural and formal mechanisms are easier to implement than informal and subtle governance mechanisms.

Informal and subtle governance mechanisms aim at aligning the informal structure of the organization with its strategic objectives (Martinez & Jarillo 1990). The informal organization describes emergent patterns of social interactions within organizations (Gulati & Puranam 2009) and consists of "relationship-based structures that transcend the formal division of labor and coordination of tasks" (Nadler & Gerstein 1992). Informal organization thus involves the communication about issues not directly laid down and governed by management (Burns & Stalker 1994) and ungoverned organic structures which connect groups of individuals who are not related in the formal organization. The informal company structure is more enduring than the formal structure (Chan 2002) and therefore governance mechanisms targeting the informal structure require more management time and are more costly. Martinez & Jarillo (1989) define three categories of informal and subtle governance mechanisms:

6. *Lateral or cross departmental relations* (direct managerial contact parallel to the formal, hierarchical organization)
7. *Informal communication* (establishing personal contact among staff from different units outside the formal hierarchy)
8. *Socialization* (developing a shared vision and culture among staff of different entities)

By applying subtle informal governance mechanisms, organizations can attempt to deliberately influence informal structures by developing social networks and thus creating "social capital"(Adler & Kwon 2002; Kostova & Roth 2003), e.g. by encouraging employee networking via creating expert communities and events, encouraging travel between sites and cross-function training programs. Such attempts aim to improve productivity by enhancing inter-functional communication which is particularly meaningful in the context of product development as a cross-functional business process (cf. section 2.2.1). Cross et al. (2002)mention the importance of informal social networks within product development to disseminate knowledge and information between

individuals. To be effective, these social networks can cross organizational and geographical boundaries and are mentioned by Cross & Parker (2004) as "crucial to the ongoing work of scientific and technical employees and the ability of the firm to innovate".

Martinez and Jarillo (1989) is widely cited but can be perceived as ambiguous with blurred distinctions between some of the categories. Harzing (1999) offers a more concise, yet comprehensive classification of governance mechanisms.

Harzing's classification. Harzing (1999) attempts to synthesize the work of Martinez & Jarillo and many other authors who have categorized governance mechanisms since the late 1950s. She argues that most governance mechanisms can be classified along two dimensions: One dimension pertains to the direct as compared to the indirect nature of governance; the other distinguishes personal from impersonal mechanisms. Figure 10 depicts the resulting two-by-two matrix to classify four different categories of governance mechanisms.

	Personal/cultural (founded on social interaction)	Impersonal/bureaucratic/ technocratic (founded on instrumental artifacts)
Direct/ explicit	Personal centralized mechanisms	Bureaucratic formalized mechanisms
Indirect/ implicit	Mechanisms based on socialization and networks	Output-related mechanisms

Figure 10: Classification of MNC coordination mechanisms
Source: Adapted from Harzing 1999, p.21

Personal centralized mechanisms, according to Harzing, include the idea of organizational hierarchy and centralization of decision making. They relate to Martinez & Jarillo's first and second mechanism. With regards to product development teams, these include the prevailing team structures as discussed in section 2.2.3.

Bureaucratic formalized mechanisms, as defined by Harzing aim at "pre-specifying, mostly in a written form, the behavior that is expected from employees" (Harzing 1999, p. 21). They include manuals, rules and regulations. This relates to Martinez & Jarillo's third mechanism, formalization and standardization.

Output control is defined by Harzing as "setting goals that the employee can achieve with a considerable amount of freedom of action" (Harzing 1999, p. 22). This includes both planning and reporting systems, and the measurement of performance against such systems. According to Harzing, this group of mechanisms "bears the largest resemblance to the market way of coordination" (Harzing 1999, p. 21). This category covers Martinez & Jarillo's fourth and fifth mechanism, planning and output control. With regard to global product development teams, this includes team-specific performance goals and reward systems driving calculation motivation (cf. section 2.2.3).

Socialization and networks, according to Harzing, combines three subgroups that relate to Martinez & Jarillo's subtle governance mechanisms: Firstly, formalized lateral or cross-departmental relations, secondly, informal, lateral or horizontal exchange of information, and thirdly, socialization. Harzing (1999, p.22) notes that this last category "resembles a garbage can", combining a number of diverse mechanisms. It is clear, however, that none of them fits into one of the other categories as neither involves hierarchy, formalization or fixed targets. Her categorization of informal, socialization-based mechanisms has been applied by other authors (Jaussaud & Schaaper 2006). Socialization-based coordination is

strongly centered on the construct of trust which, in economic sociology, is deemed a "lubricant" for social systems and a general coordination mechanism for network-type organizations, such as MNCs (Tuunainen & Miettinen 2012). Trust is often discussed in the context of global teams for whom establishing trust is typically a challenge based on the lack of personal interaction (Cash-Baskett 2011, p.45) and differences in basic beliefs and attitudes which relate from cultural distance (cf. section 2.2.4). Relating to the earlier discussion on team performance (cf. section 2.2.3), socialization creates familiarity between team members and thus increases the efficiency of heterogeneous teams.

To answer this dissertation' first research question, the specific governance mechanisms which are applied to govern global product development teams must be identified. This identification process takes place in chapter 3 based on an extensive review of existing literature (see section 3.2) and continues in chapter 5 where previous scholarly findings are tested in expert interviews. In order to ensure that the broad range of governance mechanisms is covered and to guide the reader, Harzing's two-by-two classification scheme of governance mechanisms will be applied throughout this dissertation. Before turning to empiric evidence on applicable governance mechanisms for global product development teams (section 3.2), this dissertation now proceeds to exploring the theoretic foundations of governing global product development teams.

3 THEORETIC AND EMPIRIC FOUNDATIONS AND RESEARCH MODEL

3.1 THEORETIC FOUNDATION: KNOWLEDGE GOVERNANCE APPROACH

3.1.1 Knowledge governance approach: Definition and positioning

Chapter 2 points out the role of knowledge and knowledge integration as key success factors for (global) product development teams. Based on this finding, the knowledge governance approach (KGA) is considered a relevant theoretic framework to study governance mechanisms for global product development teams. Coined by Nicolai Foss (Foss 2007), the KGA has been previously applied as a theoretic concept in the context of technology and innovation management (Grandori & Kogut 2002; Keupp et al. 2011) and MNCs (Foss & Pedersen 2004; Foss 2007). The KGA subscribes to the assumption that "knowledge processes can be governed" (Michailova & Foss 2009, p.9) in so far as managers can design governance mechanisms to optimally support knowledge integration and creation. Michailova & Foss (2009) define knowledge governance as

> "choosing governance structures (e.g., markets, hybrids, hierarchies) and governance and coordination mechanisms (contracts, directives, reward schemes, incentives, trust, management styles, organizational culture, etc.) so as to favorably influence processes of transferring, sharing, integrating, using, and creating knowledge." (Michailova & Foss 2009, p.8)

The KGA applies as a theoretic framework to this dissertation as is attempts to answer some this research's key questions:

> "What combinations of governance mechanisms are best suited for promoting knowledge sharing, integration, and creation within and between firms?" (Foss 2007, p.15)

Rather than representing a clear-cut theory of the firm, the KGA constitutes a network of connected ideas (Grandori 1997; Prencipe 2006; Foss 2007; Foss &

Michailova 2009a). At the same time, the KGA "goes beyond the overall and by now somewhat exhausted argument that the management of knowledge has become a critical issue" for multiple management tasks (Foss & Michailova 2009b, p.272). The major proponent of the KGA, Nicolai Foss, defines the approach as follows:

> "The 'knowledge governance approach' is characterized as a distinctive, emerging approach that cuts across the fields of knowledge management, organisation studies, strategy, and human resource management. Knowledge governance is taken up with how the deployment of governance mechanisms influences knowledge processes, such as sharing, retaining and creating knowledge. It insists on clear micro (behavioural) foundations, adopts an economizing perspective, and examines the links between knowledge-based units of analysis with diverse characteristics and governance mechanisms with diverse capabilities of handling these transactions." (Foss 2007, p.1)

The KGA is positioned in the broad knowledge movement (Eisenhardt & Santos 2002; Grandori & Kogut 2002). It is concerned with the identification of governance mechanisms that are applicable to govern knowledge-intense processes and stresses the micro-foundations of knowledge which is possessed by individuals and needs to be integrated in the firm in order to create value (Foss & Michailova 2009b). The KGA draws mainly from three theories (Foss 2007, Felin & Spender 2009, Michailova & Foss 2009):

(1)   Transaction cost economics, which characterizes organizations as governance structures for transactions which are characterized by uncertainty (Coase 1937; Williamson 1981)

(2)   Agency theory which addresses conflicts of interests between principals and agents, and advises incentives to solve these (Jensen & Meckling 1976)

(3)   The knowledge-based view of the firm which stresses knowledge as the source for competitive advantage and stresses the task of integrating individual knowledge (Grant 1996a)

The subsequent section 3.1.2 discusses these three contributing theories in more detail, providing a review of their respective main propositions, critique and contribution to this dissertation's research interest.

3.1.2   Theoretical foundations of the knowledge governance approach

3.1.2.1   Contributions of transaction cost economics

Fundamentals of transaction cost economics (TCE). The fundamental assumptions of TCE can be traced back to Coase (1937) who stated that firms exist if their internal transactions outperform the price mechanisms of the market, i.e. if transactions can be transformed less costly within an organization than between different participants of the market (Klein et al. 1978). TCE is an interdisciplinary approach that combines (institutional) economics with organization theory and overlaps with contract law (Williamson 1979, 1998). Three central constructs of TCE are outlined hereafter: *Transactions*, *opportunism* and *bounded rationality* (Williamson 1979).

TCE defines *transactions* as activities that contain the principles of conflict, mutuality, and order (Commons (1932, p.4). Such transactions exist extra- and intra-organizational (Verbeke & Yuan 2005). Williamson (1981) states that all transactions incur a certain cost, and that organizations must seek to minimize these costs in order to maximize their efficiency. To assess whether to insource transactions or perform them in the market, they have to be assessed in three dimensions: (1) the degree of *uncertainty* associated with the transaction's outcomes which derives either from market parameters or from opportunistic behavior, (2) the *frequency* with which transactions recur, and (3) the *specificity* of (not otherwise required) investments related with the transaction (Williamson 1979, 1981). Spot contracting is suggested for transactions that are standardized, frequent and involve little uncertainty. Transactions that are not fully standardized but frequent and involve uncertainty require a longer-term contract

between the provider and the user. This contract can contain risks due to human opportunism.

TCE views *opportunism*, defined as "self-interest seeking behavior with guile" (Verbeke & Yuan 2005, p.45), as part of human nature. Guided by opportunistic behavior, both buyer and seller are likely to bargain over incremental gains in a contract, leading to the contractual risk of behavioral uncertainty (Williamson 1979). Teece (1976) states that "Even when all of the relevant contingencies can be specified in a contract, contracts are still open to serious risks since they are not always honored." TCE thus proponents accept that the rationality of individuals is limited ("bounded") by the information to which these individuals can access and process in due time to make a decision (Simon 1972). This *bounded rationality* influences contracts which, in a complex world, will never cover all eventualities. Therefore one requires "Governance structures which attenuate opportunism and otherwise infuse confidence are evidently needed" (Williamson 1979, p.242). Confidence or *trust* is an important construct in this regard, as it applies not only to inter-organizational but also to inter-personal interactions when faced with bounded rationality.

Governance, according to TCE, is "the institutional matrix within which transactions are negotiated and executed" (Williamson 1979, p.239), thus leaning towards organizational mechanisms.[17] Organizations replace the market as a governance structure when asset specificity is high, (behavioral) uncertainty prevails and the values expected from the transaction are significant. Drawing contracts for such situations is costly and time-consuming, and thus organizations, by insourcing these transactions, decrease their transaction cost (Klein et al. 1978). Williamson (1999) summarizes that

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[17] In this regard, TCE departs from neo-classical economics which describe the firm as a production function (Bain 1968). Rather than by economies of scale and scope, TCE derives the boundaries of the firm from the alignment of its governance structures (firm or market) (Williamson 1998).

"(…) governance is an economizing response to the Commons triple, in that governance is a means by which to infuse order in a relation where potential conflict threatens to undo or upset opportunities to realize mutual gains."[18] (Williamson 1999, p.1090)

TCE critique. Initially criticized for the "suspicion that almost anything can be rationalized by invoking suitably specified transaction costs" (Fischer 1977), TCE received ample empiric evidence since the 1970s. TCE has been mostly applied and empirically tested and confirmed in the context of economics, where it was applied to explain vertical integration, regulation and natural monopolies. In managerial studies, TCE is applied to explain innovation, corporate governance and corporate finance (Williamson 1989). In strategic management where the fundamental question is how to achieve and sustain competitive advantage (Teece et al. 1997), TCE cannot be applied as a stand-alone theory. It can be combined, however, with the resource-based view (RBV)[19] to apprehend how firms, given their resources (assets, capabilities and disabilities), should react in the market (Williamson 1998).

Strategic management scholars have criticized TCE for its view of mankind as opportunistic, and for regarding self-interest as the limiting case of human motivation (Kogut & Zander 1996, p.504). TCE has is also questioned in non-western organizational contexts: Boisot & Child (1988) argue that in the Chinese context, for example, TCE is not fully applicable as the Chinese collectivist society puts individual interests behind societal or group interests. Even Western societies have been found to move away from the grassroots opportunism assumed by TCE (Doz & Prahalad 1991). These arguments need further empiric grounding, however.

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[18] The term "Commons triple" relates to the aforementioned definition of Commons (1932) of a transaction containing the principles of conflict, mutuality and order.

[19] See section 3.1.2.3 for a more complete discussion of the RBV.

Another criticism to TCE deals with the overstatement of contracts as an organizational tool. Contracts may undermine trust and therefore bring about the risk to encourage opportunistic behavior (Poppo & Zenger 2002, p.707). Gulati (1995) argues that

> "trust avoids contracting costs, lowers the need for monitoring, and facilitates contractual adaptation. Trust counteracts fears of opportunistic behavior and as a result, is likely to limit the transaction costs associated with an exchange. (...) In other words, trust can substitute for hierarchical contracts in many exchanges (...)".
> Gulati (1995, p.93)

While TCE considers trust as an important element, it offers little guidance on how to establish trust via e.g. informal organization (Williamson 1998). More recent theories such as the relational view (Dyer & Singh 1998) seek to integrate contractual and relational governance and view them as complimentary (Poppo & Zenger 2002).

TCE and the governance of global product development teams. TCE can be applied to global product development teams as they are characterized by the specificity related to R&D investments, the uncertainty related to the market success of the product, and the risk of opportunistic behavior among team members to act in the interest of their own entity rather than those of the global team or MNC. A global product development team thus resembles a risky transaction and requires some form of governance in order to minimize transaction costs. Intra-MNC collaboration is widely discussed in international management literature from a TCE lens due to the hazards of opportunistic behavior by MNC subsidiary managers and bounded rationality of corporate managers (Rugman & Verbeke 2003). Internal market tools (rewards), bureaucratic tools (formalization) and socialization have been suggested as remedies (Verbeke & Yuan 2005).

The TCE maxim of cost efficiency has however been criticized in studies of international knowledge management for being "driven by its consideration of

cost-minimization but, actually, the decision to engage in (…) knowledge transfer may represent a more costly, though ultimately more profitable, alternative" (Ding et al. 2009, p.49).[20] Taking into consideration the potential friction losses caused by geographical, cultural, linguistic and inter-organizational distance, more costly governance mechanisms including informal organization which has been underexplored by TCE, have to be considered in the context of global teams.

3.1.2.2   *Contributions of agency theory*

Fundamentals of agency theory. Agency theory draws from TCE and behavioral science (Jensen & Meckling 1976; Williamson 1999). While TCE focuses on the organizational level and concentrates on aligning governance structures with transactions, agency theory is occupied with the relationships between and behavior of individuals within the firm, and turns to incentive alignment (Wiliamson 1998). In this regard, agency theory and TCE can be viewed as complimentary (Williamson 1998). Agency theory focuses on the relationships between principals (typically, an organization's owners) and agents (managers). Like TCE, agency theories subscribes to the belief that individuals tend to act opportunistically:

> "Agency theory postulates that because people are, in the end, self-interested they will have conflicts of interests over some issue any time they engage in cooperative endeavours." (Jensen & Meckling 1994, p.43)

Instead of contractual or institutional governance structures, agency theory devises managerial control and incentives to avoid opportunistic behavior:

> "The central proposition of agency theory is that rational self-interested people always have incentives to reduce the losses these conflicts engender." (Jensen & Meckling 1994, p.43)

In the context of firm owners and managers, incentives include profit sharing incentives, stock options, and other, mostly financial tools to motivate managers to act in the owners' interest.

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[20] For a further discussion of critiques associated with the TCE and the TCE's response, see Williamson 1999, pp.1098

Eisenhardt (1989) distinguishes two complementary streams of agency theory: The positivist stream almost exclusively focuses on the relationship between firm owners and managers, and discusses remedies to the moral hazards associated to opportunistic behavior of managers. The principal-agent stream applies agency theory to other relationships (e.g., employer-employee) and seeks to identify the most efficient contracts under varying levels of outcome uncertainty, risk aversion, and information, taking a very mathematical approach (Eisenhardt 1989, p.60). Originating in the context of corporate finance (Jensen & Meckling 1976), agency theory, has been extended to economics, political science, sociology and organizational behavior– basically all fields in which principles and agents exist who have (partly) different goals and risk preferences. These include many organizational functions such as accounting, marketing and human resource management (HRM) (Eisenhardt 1989).

The latter is most relevant in the context of this study, as HRM applies agency theory to design the physical and psychological contracts between firms and employees (Armstrong 2014, p.207). The TCE assumption that contracts are incomplete due to bounded rationality is thus expanded to employment contracts which do not specify all expectations between employer and employee upfront (Rousseau & Greller 1994). Psychological contracts refer to the beliefs that employees and employers hold regarding promises made, accepted and relied on between each other and deal with assumptions, expectations, promises and mutual obligations. In the context of agency theory, managers thus have to clarify expectations and related (financial or non-financial) compensations or rewards for employees to meet these expectations, and must control how employees meet such expectations.

Critique of agency theory. Like TCE, agency theory faces criticism for its view of mankind as opportunistic. Furthermore, the assumption that managers (in the principal-agent relationship) do not perform without incentives is fiercely debated (Brennan 1994). Armstrong (1996) argues that agency theory simplifies

the view of employees as "objects to be motivated by the carrot and stick. It is a dismal theory, which suggests that people cannot be trusted." Proponents of agency theory defend this argument by ample empiric evidence for the theory[21] and the argument that the

> "central proposition [of agency theory] is not that people are self-interested, or that conflicts exist. The central proposition of agency theory is that rational self-interested people always have incentives to reduce or control conflicts of interest so as to reduce the losses these conflicts engender. They can then share the gains."
> (Jensen & Meckling 1994, p.45)

Joining this debate, Osterloh & Frey (2000) stress the need to distinguish between incentives directed at extrinsic and intrinsic employee motivation: Employers can drive employees' extrinsic motivation via (financial) incentives. Intrinsic motivation lies within the individuals and can be fulfilled by satisfactory and fulfilling work (Osterloh & Frey 2000, p.539). To prevent "crowding out" of intrinsic mechanisms, Osterloh & Frey (2000) suggest mechanisms such as participation to raise employees' self-determination and strengthen their personal relationships and identification with their employer.

Agency theory and the governance of global product development teams. In the MNC context, scholars typically regard MNC headquarters as the principal and subsidiary managers as agents. Their interests need to be aligned by incentives which provide additional motivation for the agents to participate in internal knowledge exchange (Fey & Furu 2008). Among the four categories of governance mechanisms introduced in section 2.4.2, this relates to personal, output-related governance. Several authors have drawn from agency theory when discussing governance mechanisms for knowledge-intense MNC processes (Osterloh & Frey 2000; Minbaeva et al. 2003; Andriessen 2006; Persson 2006; Fey & Furu 2008). Andriessen (2006) explores that tangible incentives (e.g., money, gifts,

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[21] Eisenhardt (1989, pp.66–67) provide a comprehensive overview of articles providing empirical evidence for agency theory mostly related to managerial compensation and Mergers & Acquisitions (M&A).

promotion, access to information) and intangible incentives (e.g., reputation, public praise) are applied to reward employees for knowledge sharing. Empiric evidence supports the positive relationship between financial bonuses and knowledge sharing in the MNC context (Persson 2006; Fey & Furu 2008) and of HRM tools and corporate socialization directed at intrinsic motivation (Minbaeva et al. 2003; Gooderham et al. 2011). Osterloh & Frey (2000) argue that tacit knowledge cannot be transferred by contracting, and that employees cannot be sanctioned for not sharing tacit knowledge. Incentives can thus add to, but not exclusively drive motivation and can therefore be conceptualized as one coordination mechanism to support knowledge sharing which is, however, not sufficient and must be accompanied by socialization mechanisms. While applicable to governing global product development teams, agency theory is thus not sufficient to compare the performance of the various governance mechanisms available to govern global product development.

3.1.2.3   *Contributions of the knowledge-based view*

Fundamentals of the knowledge-based view (KBV). The KBV focuses on knowledge as the key resource from which to draw competitive advantage. It has evolved from the resource-based view (RBV) of the firm but borrows the assumption that transactions can be performed more effectively within an organization than in the market from TCE (Kaplan et al. 2001).

The RBV, the broader perspective in which the KBV is set, was the first strong theory to draw the attention of strategic management scholars away from industry dynamics toward resources residing within the firm as a main source for competitive advantage. RBV justifies superior firm performance by the firm's resource base, more specifically by the management and combination of resources to create innovation and derive economic value (Penrose 1959; Wernerfelt 1984; Peteraf 1993; Kor & Mahoney 2004). A key proponent of the RBV, Barney (1991, p.110) defines firm resources as "all assets, capabilities, organizational processes,

firm attributes, information, knowledge etc. controlled by a firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness". Barney (1991) further specifies the nature of *strategic resources* by four attributes: They must be <u>v</u>aluable to the firm, <u>r</u>are, <u>i</u>mperfectly imitable and <u>n</u>ot strategically substitutable by equivalents. Resources that possess these "VRIN" attributes offer an organization the opportunity to develop value-creating strategies that cannot be easily copied by rivals. They provide differentiation advantage which creates long-term competitiveness (Grant 1991). The RBV thus establishes the resource-conduct-performance paradigm as a contrast to the previously prevailing structure-conduct-performance paradigm which links competitive advantage to market structure and positioning (Porter 1980). The RBV paves the way for the KBV which focuses on knowledge as a success-critical resource (Eisenhardt & Santos 2002).

Typically attributed to the work of Kogut & Zander (1992; 1993), Nonaka (1991) and Grant (1996b), the KBV stresses the application of knowledge as the source of sustainable competitive advantage. While the KBV emerged before the post-industrial digital economy (Grant 2002), it has become increasingly popular in the light of the fundamental changes in the economy from tangible to intangible assets and the transition from the industrial to the knowledge- and information-based society (Poppo & Zenger 1998; Strietzel 2005; Kyläheiko et al. 2011).

The KBV embraces TCE by assuming that the efficient exchange of, particularly, tacit knowledge, is basically a transaction which is among the key reasons for the existence of the firm:

> "Firms grow on their ability to create new knowledge and to replicate this knowledge so as to expand their market. Their advantage lies in being able to understand and carry out this transfer more effectively than other firms." (Kogut & Zander 1993, p.639)

TCE views the reduced risk of opportunism as a driver of transaction costs and the key reason why firms insource transactions. The KBV, in comparison, posits that transaction costs can additionally arise for knowledge-based reasons: The KBV assumes it is more cost efficient for a firm to insource knowledge via employment contracts and gain authority over the application of this knowledge than to contract such knowledge from the market (Conner & Prahalad 1996, p.383). While KBV proponents basically accept opportunism as a motive, they do not make it their central argument and do not view the associated moral hazards as critical as TCE: In the KBV, organizations are viewed as "social communities in which individual and social expertise is transformed into economically useful products and services by the application of higher order organizing principles". (Kogut & Zander 1992, p.384)

KBV proponents suggest that knowledge resides in the individual, and knowledge integration is thus crucial for the firm (Kogut & Zander 1992; Grant 1996b). Accordingly, the purpose of organizations is to combine and integrate the highly specialized and often tacit knowledge of individuals more effectively than markets would do: Knowledge resides "within the individual, and the primary role of the organization is knowledge application rather than knowledge creation" (Grant 1996b, p.109).[22]

KBV critique. The KBV has been criticized for not being a theory of the firm because it provides possible reasons for strategic advantage but does not sufficiently address why firms actually exist (Foss 1996a; Foss 1996b). Grant (2002), a key proponent of the KBV, argues that it is more a framework than a theory:

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[22] Along the same lines, the positivist KBV is often discussed jointly with concepts of knowledge exchange such as the SECI model and the process models of knowledge, including absorptive capacity (cf. section 2.2.2) which provides insights into how to transfer and integrate the individual knowledge.

"the real contribution of the knowledge-based approaches to management and the firm is not so much in offering a new theory that can revolutionize our thinking about the existing and management of companies; it is more in providing a perspective that can augment and extend, possibly even transform, existing theory and management techniques". (Grant 2002, p.135)

While the KGA draws considerably from the KBV by making knowledge governance its explanandum and stressing the role of integrating individual knowledge, KGA proponents criticize the KBV for the fact that

"it leaves completely in the dark, for example whether knowledge-based competitive advantage is primarily caused by ex ante highly efficient, knowledgeable, etc. individuals self-selecting into certain organizational environments, or by superior interaction among employees that ex ante did not arrive with much human capital (or some mix between the two extremes)." (Foss & Michailova 2009b, p.283)

The KBV thus provides a framework to understand the vitality of knowledge but fails to provide sufficient "micro-level" explanations which are utmost relevant to KGA proponents (Volberda et al. 2010; Foss 2011).

KBV and the governance of global product development teams. The KBV helps understand how to govern global product development teams by highlighting the key role of integrating the knowledge of individuals, a matter which has been discussed in relation to product development performance earlier. The KBV further adds to the understanding of governance mechanisms for knowledge integration and compares the effectiveness of different governance mechanisms. In this context, Grant (1996a) identifies *directions* and *routines* as coordination mechanisms which support the integration of individuals' knowledge into the organization. Directions consist of written rules and directives. Organizational routines rely "upon informal procedures in the form of commonly-understood roles and interactions established through training and constant repetition, supported by a series of explicit and implicit signals" (Grant 1996a, p.379). These routines thus evolve from socialization-based governance

rather than from formal governance. Grant (1996a) states that routines are superior to directions as they require less communication and offer more flexibility to adapt actions to contexts and more applicable when knowledge is tacit, thus reducing transaction costs.

Grant (1996b, p.118; 2002) furthermore states that hierarchy is the least effective coordination mechanism: Hierarchy is typically based on the intensity of interaction where employees whose tasks and skills (and, consequently, knowledge) are interdependent and pooled in one group. Knowledge integration, however, requires the combination of heterogeneous knowledge which is most probably not found in one group. Instead of rigid organizational hierarchies, proponents of the KBV call for *fluid teams* that enable the involvement of individual specialists as and when they are needed (Gardner et al. 2012, p.306).

The KBV thus contributes to knowledge governance research by ranking governance mechanisms by effectiveness, starting with socialization-based mechanisms, followed by formal-bureaucratic and hierarchical governance mechanisms.

3.1.3   Propositions of the knowledge governance approach

KGA proponents criticize the KBV for its lack to connect individuals and their interactions to the macro-level of capabilities, and offer a complementary view between TCE and the KBV (Foss 2011; Williamson 1999) which also integrates agency concerns (Foss 2007). Williamson's summary of the complementarity between governance and competence theories (such as (TCE and KBV) describes the differences between the two approaches which are taken into account by the KGA:

"Governance [TCE] is more microanalytic (the transaction is the basic unit of analysis) and adopts an economizing approach to assessing comparative economic organization, whereas competence [KBV] is more composite (the routine is the unit

of analysis?) and is more concerned with processes (especially learning) and the lessons for strategy. Healthy tensions are posed between them. Both are needed in our efforts to understand complex economic phenomena as we build towards a science of organization." (Williamson 1999, p.1106)

The KGA is still a fragmented approach at the time of writing this dissertation. So far, KGA proponents agree on a number of basic principles and views (Osterloh & Frey 2000; Foss 2007; Foss & Michailova 2009a):

- The *explanandum* is knowledge governance, which management must design to facilitate the creation, sharing, transfer, integration and application of the success critical resource knowledge.
- Explanations start with the individual agent (*micro-foundation*) and seek to understand the causal links between organizational (macro) governance mechanisms, and individual (micro) knowledge-related behaviors and organizational (macro) knowledge-related outcomes.
- Besides the informal mechanisms of socialization widely discussed in the KBV literature, *formal (organizational) governance mechanisms* are revived. Personal, output-related mechanisms (incentives) are considered likewise.
- Knowledge governance mechanisms must account for the distinct *taxonomy* of the knowledge involved.

Table 5 summarizes and contrasts the cornerstones of the KGA and the aforementioned contributing theories.

	Knowledge governance approach	Transaction cost economics	Agency theory	Knowledge-based view
Explanandum	Governance mechanisms	Existence / boundaries of the firm	Contract between principals and agents	Competitive advantage
Explanans	Micro-foundations of individual behavior	Transaction costs	Agency-related moral hazard	Knowledge integration
Context factors	Knowledge taxonomy	Transaction characteristics, industry dynamics	-	Knowledge taxonomy, industry dynamics
Human assumptions	Opportunism, bounded rationality	Opportunism, bounded rationality	Opportunism, bounded rationality, risk aversion	Bounded rationality

Table 5: Cornerstones of the KGA and its contributing theories
Sources: Author, based on Eisenhardt (1989), Williamson (1998), Grant (2002), Foss (2007), Foss & Michailova (2009)

The need to understand the *micro-foundations* of knowledge governance is derived from what KGA proponents perceive to be underexplored in management science[23]:

> "Important constructs, such as capabilities, dynamic capabilities, absorptive capacity, communities of practice, etc are macro-level constructs, usually firm-level ones. (…) these constructs are not clearly rooted in (micro-) foundations, which, among other things, means that their origin and nature remain unclear. Micro-foundations involve a quest for theorizing explanatory mechanisms that are located at levels of analysis lower than those of the phenomena that one seeks to explain (…). While teams, groups, projects, etc may be invoked as micro-foundations for the above macro-constructs, and are entirely legitimate components of explanation, ultimately micro-foundations mean theorizing in terms of the actions and interactions of individuals." (Foss et al. 2010, p.457)

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[23] Foss et al. (2010) find empiric evidence for the lack of consideration of micro-foundations in a literature review of articles on knowledge sharing published between 1996 and 2006.

Earlier models of knowledge integration such as absorptive capacity (ACAP) point out the capability of individuals: "The firm's absorptive capacity depends on the individuals who stand at the interface of either the firm and the external environment or at the interface between subunits within the firm" (Cohen & Levinthal 1990, p.132). Individual absorptive capacity is thus identified as a root cause for organizational knowledge (Volberda et al. 2010; Foss 2011), coined *iCAP* (short for individual absorptive capacity) by some researchers to describe "the level of effort that individuals undertake to identify external knowledge, assimilate it and utilize it to commercial ends" (ter Wal et al. 2011, p.4).

In the tradition of TCE, KGA proponents characterize the individual by opportunism and bounded rationality (Williamson 1999; Felin & Spender 2009). The KGA's subscription to TCE partly explains its proponents' call to extend the focus of knowledge governance beyond informal organization and to include *formal mechanisms* such as organizational structures and incentive mechanisms as governance tools. Foss (2007) argues that literature on knowledge processes focuses on informal organization (i.e. socialization via networks, culture, communities of practice etc.) rather than on formal organization. Foss & Michailova (2009b, p.283) add that "Organization itself seems almost conspicuous by its absence in [the KBV]." While an empiric literature review demonstrates that, in fact, both formal and informal organization are investigated in empiric studies related to knowledge governance, this literature review also illustrates that both types of organization are rarely studied jointly in spite of assumed linkages (Foss et al. 2010). This leads KGA proponents to call for more comparative studies of different knowledge governance mechanisms, as pursued in this dissertation.

KGA proponents' suggestion to understand the *taxonomy* of the knowledge involved relates to the view of knowledge as a contingency factor: The characteristics of knowledge, such as its tacitness, complexity and specialization,

impact on the configuration of the governance mechanisms applied (Birkinshaw 2002; Grandori & Kogut 2002).

Based on these principles, the KGA develops general propositions regarding the interaction of micro- and macro-level relationships to explain governance. Drawing from social theory (Coleman 1990, p.8), Foss et al. (2010) summarize the KGA's general propositions as follows:

(1) Governance mechanisms[24] influence the conditions of individual knowledge sharing behavior (micro).

(2) The conditions of individual knowledge sharing behavior influence individual knowledge sharing behavior (micro).

(3) Individual knowledge sharing behavior influences knowledge sharing outcomes (macro).

(4) Thus, governance mechanisms influence knowledge sharing outcomes (macro).

Before relating the KGA's propositions to this dissertation, the subsequent section 3.1.4 reviews criticisms of this theoretic approach.

3.1.4   KGA critique and required extensions

Due to its relative newness and remaining state of being frayed across many disciplines, there is limited formal critique of the KGA. That itself renders the KGA difficult as a theoretic framework, and more contributions and empiric evidence are required to determine whether it exceeds the status of just another approach on knowledge as "a fashionable research topic" (Haghirian 2011). Foss et al. (2010) argue that knowledge governance remains

"a concept that has not yet been well explored and understood, and is arguably not yet on the relative level of conceptual development and acceptance that

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[24] Foss et al. (2010) use the term "organizational antecedents" synonymously with the term "governance mechanisms", which is used here for reasons of consistency.

characterize constructs such as absorptive capacity (…).The relationship between governance issues and knowledge processes remains under-researched, theoretically as well as empirically (…)." (Foss et al. 2010, p.456)

The lack of empiric evidence which contributes to the KGA is a challenge addressed by this dissertation which seeks to empirically test hypotheses on knowledge governance.

Among the few existing critiques of the KGA, JC Spender challenges the approach for being too focused on organizational economics and neglecting theories from sociology, psychology or philosophy (Felin & Spender 2009). While this criticism is valid in an epistemological discussion, it pertains only marginally to this dissertation which, in fact, deals with the integration of individuals' knowledge into teams and its impact on performance. In this context, the individual motivations of team members, which are discussed in psychology, would burst the research scope. Sociology, on the other hand, is considered to a large extent in the KGA due to its linkage with agency theory, a theory drawing largely from sociology (Archer 1995, p.65). Nicolai Foss as a main proponent of the KGA indeed bases most of his scholarly work on transaction cost theory and transaction-cost minimizing formal governance mechanisms. Other contributors to the KGA, however, do take into account mechanisms such as socialization (Husted & Michailova 2009) which is broadly discussed in literature on organizational learning (Levitt & March 1988)[25], as well as drivers for individual motivation (Osterloh & Frey 2000).

A third criticism is the notion that, while the KGA does recognize the importance of context factors for knowledge governance, it fails to provide examples and implications of context factors other than tacitness (Winter 1998, p.168). Notably, the KGA hitherto provides no concise propositions regarding

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[25] Argyres et al. (2012) argue that learning as a contractual relation reduces transaction costs, and thus transactions are a learned capability. In that regard, there is a place for socialization as a governance mechanisms in transaction cost economics.

knowledge governance in different industries albeit the impact of industry dynamics is commonly discussed as impactful parameter in management theory[26]: The implications derived from markets dynamics have been recognized in the KBV and TCE, and even spurred the development of another, distinct, hybrid theory: the Dynamic Capabilities (DC) approach (Grant 1996a; Eisenhardt & Martin 2000; Christensen & Knudsen 2008). DC focus on *high-velocity markets* characterized by a turbulent competitive environment. In high-velocity markets, "the strategic challenge is maintaining competitive advantage when the duration of that advantage is inherently unpredictable, (and) where time is an essential aspect of strategy" (Eisenhardt & Martin 2000, p.1106). These conditions require firms to adapt their governance mechanisms and to allow for a high degree of flexibility. TCE proponents address this phenomenon by integrating "dynamic transaction costs" which have been defined as the costs of not having the required capabilities when needed (Langlois 1992). The KBV discusses the success-critical capability to apply knowledge that resides in the firm to new contexts in dynamic markets. DC more specifically applies this to governance mechanisms: Based on their evolutionary paths, firms in moderately dynamic markets establish "detailed, analytic routines that rely extensively on existing knowledge" while firms in high-velocity markets use "simple, experimental routines that rely on newly created knowledge specific to the situation" (Eisenhardt & Martin 2000, p.115). Analytic routines refer to bureaucratic-formalized mechanisms whereas experimental routines refer to socialization-based mechanisms. Similar propositions have not been integrated in the KGA.

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[26] Christensen & Knudsen (2008) are among the few KGA contributors discussing turbulent markets. They suggest flexible (team) organization structures to cope with their dynamics by putting the individuals with the most applicable knowledge in the right place at the right time. They fail, however, to offer either empiric evidence or pragmatic ideas for pursuing this idea in practice.

3.1.5   Application of the KGA to global product development teams

The KGA contributes to this dissertation as an overarching framework which draws from different theories to devise knowledge governance strategies. This dissertation follows the KGA's approach in considering the individual agent and the team as micro-foundations for product development performance. Like the KGA, this dissertation aims to understand the link between governance mechanisms and knowledge-related behaviors (team knowledge integration; micro-level) and organizational outcomes (product development performance, macro-level). Figure 11 presents the KGA propositions regarding the relationships between the micro and macro levels, and translates them to the context of this study. Arrow 1 represents the relationship between governance mechanisms and individual knowledge sharing conditions, translated in the context of this study into iCAP, which can be expressed as the motivation and ability (Minbaeva et al. 2003) of the members of a global product development team to contribute to the project. Arrow 2 represents the relationship between knowledge sharing conditions and knowledge sharing behavior, the latter translating into knowledge integration, i.e. the extent to which the globally and functionally dispersed knowledge of individuals is combined. Arrow 3 links this knowledge sharing behavior with the knowledge sharing outcomes which, in the context of this study, relates to product development performance. Arrow 4 depicts the direct relationship between governance and results. Context factors are not (yet) considered in this simplified illustration.
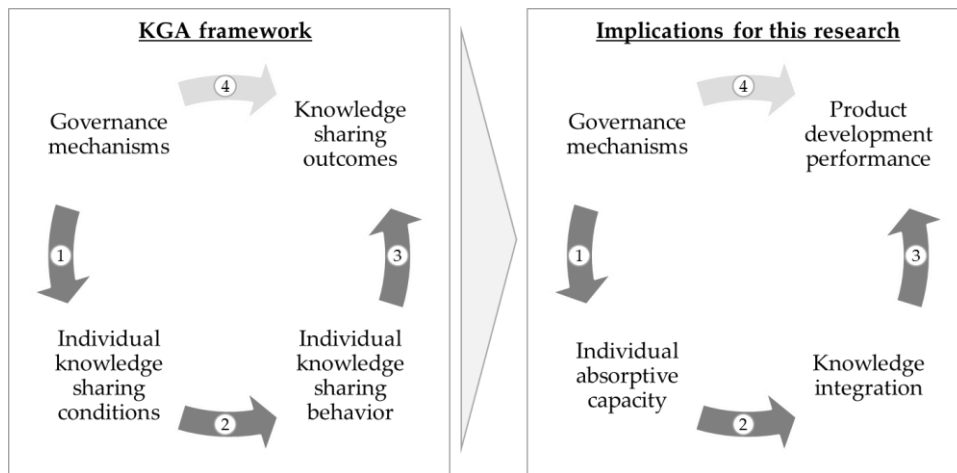
Figure 11: KGA levels of analysis and links
Source: Author, adapted from Foss et al. (2010)

The KGA contributes to answering this dissertation's research questions in multiple ways while requiring further empirical testing. *RQ1* asks which governance mechanisms are applied to coordinate global product development teams. The KGA discusses hierarchical governance (organization), output-based governance (incentives) and socialization-based governance (organizational learning, informal organization). While authors subscribing to the KGA do not explicitly discuss bureaucratic-formalized governance mechanisms, the KBV as a main contributing theory mentions these mechanisms, such as procedures and directives (Grant 1996a). All four categories of governance mechanisms introduced in section 2.4.2 are thus relevant to consider when studying the governance of global product development teams.

RQ2 inquires about the direct and indirect impact of these governance mechanisms on product development performance. KGA proponents point out that hierarchical and output-based governance impact on individual absorptive capacity whereas informal socialization tactics help to develop organizational absorptive capacity (Volberda et al. 2010). Some proponents particularly stress reward-based mechanisms (Foss 2007; Osterloh & Weibel 2009) to motivate individuals to contribute their knowledge, others focus on organizational

structures (Christensen & Knudsen 2008) or socialization (Husted & Michailova 2009).

RQ3 seeks to understand the context factors influencing the governance and performance of global product development teams. The KGA focuses on knowledge taxonomy as a context factor. Bureaucratic-formalized mechanisms are applicable to integrate explicit, codifiable, e.g. technical knowledge. However, as discussed in section 2.3.1, product development knowledge is only partly explicit and requires to a large extent tacit knowledge. Therefore, the impact of bureaucratic-formalized governance mechanisms is likely to be lower than the impact of the three remaining categories of governance mechanisms. The KGA suggests that socialization-based coordination might be more applicable when dealing with particularly tacit knowledge, thus suggesting this mechanism to be most applicable in the context of product development knowledge (Volberda et al. 2010; Argyres et al. 2012).

RQ4 enquires about management recommendations on how to best govern global product development. Rooted in TCE, the KGA offers a main criterion according to which to rank the performance of governance mechanisms, that is cost efficiency, or the input-output-relation of their application. Thus, those governance mechanisms with the highest total effect on the desired outcome – product development, in the context of this dissertation – should be those that are applied most, pointing at the guiding principle to answer the fourth research question.

This dissertation however needs to make two contributions to the KGA in order to answer the research questions: Firstly, to fully address *RQ2*, it needs to empirically test the relative impact of the four categories of governance mechanisms and thus add to the body of empiric evidence related to the KGA. This will be addressed by the empiric research design of this study. Secondly, this dissertation needs to cover a broader scope of context factors beyond tacitness, to

answer *RQ3*. Based on what has been discussed thus far, two further context factors should be included in the study of knowledge governance mechanisms for global product development teams:

- *Distance* must be incorporated due to the previously discussed challenges it raises for global teams (see section 2.2.4).

- Industry velocity is neglected in the KGA literature but is recognized as a relevant impact factor for knowledge governance in other knowledge-based theories such as DC.

Before translating the implications of the KGA into testable hypotheses for this dissertation, the subsequent section provides an overview of empiric evidence on knowledge governance mechanisms as a basis for developing differentiated hypotheses for consecutive empiric testing.

3.2   EMPIRIC CONTRIBUTIONS: EVIDENCE ON KNOWLEDGE GOVERNANCE

3.2.1   Identification of relevant literature

To ensure that existing findings on knowledge governance mechanisms are incorporated into this dissertation, a review of recent literature is conducted.

Selection process and criteria. Michailova & Mustaffa (2012) review on empiric articles on MNC knowledge flows between 1996 and 2009 as published in fifteen top-ranked management journals.[27] Their list of journals is reviewed against the highest ranked journals[28] from the 2011 JourQual 2.1 ranking of academic journal quality in business administration (Hennig-Thurau & Sattler 2012). To further expand the empiric basis to product development, the same rating categories of the 2011 JourQual 2.1 list are screened for journals on product

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[27] Michailova & Mustaffa's (2012) selection of journals is based on lists of top-tier management journals collated and cited by renowned scholars.

[28] Thirteen journals achieving top three rating categories (A+, A and B) are reviewed.

development. Two journals are added. Figure 12 presents the fifteen journals selected according to this procedure, grouped into the categories (1) international management, (2) general management and (3) innovation management.

- Journal of International Business Studies (A)
- International Business Review (B)
- Journal of International Management (B)
- Journal of World Business (B)

- Journal of Product Innovation Management (A)
- International Journal of Innovation Management (B)

International management journals

Innovation management journals

General management journals

- Academy of Management Journal (A+)
- Academy of Management Review (A+)
- Administrative Science Quarterly (A+)
- Management Science (A+)
- Organization Science (A)
- Strategic Management Journal (A)
- Journal of Management (B)
- Journal of Management Studies (B)
- Journal of Organizational Behavior (B)

Figure 12: Overview of reviewed journals and rankings

These fifteen journals are reviewed for articles published between January 2000 and March 2013[29] which meet all of the following criteria:

1) Coverage of governance of global knowledge flows and/or product-development related knowledge flows

2) Qualitative or quantitative empiric findings using

   a. At least one governance mechanism as independent variable

   b. Knowledge integration[30] and/or product development[31] performance as a dependent variable

Table 6 provides an overview identified articles following the described selection process.

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[29] The literature review ends in 2013 before the launch of this dissertation's empiric survey which is based on this literature review. The review period of 13 years parallels that of Michailova & Mustaffa (2012).

[30] In addition to knowledge integration, the search includes related terms such as knowledge flows, knowledge sharing and knowledge transfers.

[31] In addition to product development, the search includes related terms such as innovation, R&D and technology management.

Author (Year)	Title	Considered coordination mechanisms[32]	Consideration of NPD and/ or MNCs	Methodology	Sample characteristics (regional/ functional/ industry focus)
Gupta & Govindarajan (2000)	Knowledge flows within multinational corporations	O, S	NPD: - MNC: ✔	OLS regression	MNCs based in the US, Europe and Japan
Subramaniam & Venkatraman (2001)	Determinants of transnational product development capability: Testing the influence of transferring and deploying tacit overseas knowledge	S	NPD: ✔ MNC: -	Multiple regression analysis	US-based MNCs
Bonner et al. (2002)	Upper management control of new product development projects and project performance	H, B, O	NPD: ✔ MNC: -	Multiple regression analysis	US-based companies
Kostova & Roth (2002)	Adoption of an organizational practice by subsidiaries of multinational corporations: Institutional and relational effects	H	NPD: - MNC: ✔	Multiple regression analysis, ANOVA, MANOVA	Quality management, US agricultural MNC
Leenders & Wierenga (2002)	The effectiveness of different mechanisms for integrating marketing and R&D	S	NPD: ✔ MNC: -	SEM	Pharmaceutical industry

[32] H = Hierarchical, B = Bureaucratic-formalized, O = Output-based, S = Socialization-based

Author (Year)	Title	Considered coordination mechanisms	Consideration of NPD and/ or MNCs	Methodology	Sample characteristics (regional/ functional/ industry focus)
Tsai (2002)	Social structure of "coopetition" within a multiunit organization: Coordination, competition, and intraorganizational knowledge sharing	H, S	NPD: - MNC: ✓	QAP multiple regression	One multi-unit petrochemical MNC
Minbaeva et al. (2003)	MNC knowledge transfer, subsidiary absorptive capacity, and HRM	O	NPD: - MNC: ✓	OLS regression	MNCs based in Europe, USA and Japan
van der Bij et al. (2003)	An empirical investigation into the antecedents of knowledge dissemination at the strategic business unit level	O, S	NPD: ✓ MNC: -	Factor analysis and OLS regression	US-based high-technology companies
de Brentani & Kleinschmidt (2004)	Corporate culture and commitment: impact on performance of international new product development programs	H	NPD: ✓ MNC: ✓	Factor analysis	North-American B2B companies
Björkman et al. (2004)	Managing knowledge transfer in MNCs: the impact of headquarters control mechanisms	O, S	NPD: - MNC: ✓	OLS regression	Finnish and Chinese MNC subsidiaries
Holtbrügge & Berg (2004)	Knowledge transfer in multinational corporations: Evidence from German firms	B, S	NPD: - MNC: ✓	Correlation analysis	German-based MNCs

Author (Year)	Title	Considered coordination mechanisms	Consideration of NPD and/ or MNCs	Methodology	Sample characteristics (regional/ functional/ industry focus)
Hansen & Løvås (2004)	How do multinational companies leverage technological competencies? Moving from single to interdependent explanations	H, S	NPD: ✓ MNC: ✓	Logit model	Product development projects in US-based MNCs
Wang et al. (2004)	Determinants and outcomes of knowledge transfer: A study of MNCs in China	O, S	NPD: - MNC: ✓	Multiple regression analysis	MNC subsidiaries in China
Mahnke et al. (2005)	The impact of knowledge management on MNC subsidiary performance: the role of absorptive capacity	O, S	NPD: - MNC: ✓	OLS regression	Cement industry
Sherman et al. (2005)	New Product Development Performance and the Interaction of Cross-Functional Integration and Knowledge Management	B	NPD: ✓ MNC: -	SEM	NPD projects
Song et al. (2005)	Determinants of the Level of Knowledge Application: A Knowledge-Based and Information-Processing Perspective	O, S	NPD: ✓ MNC: -	SEM	US-based high-technology companies

Author (Year)	Title	Considered coordination mechanisms	Consideration of NPD and/ or MNCs	Methodology	Sample characteristics (regional/ functional/ industry focus)
Ambos et al. (2006)	Learning from foreign subsidiaries: An empirical investigation of headquarters' benefits from reverse knowledge transfers	H	NPD: - MNC: ✓	Multiple regression analysis	European-based MNCs
Landsperger et al. (2006)	How Network Managers Contribute To Innovation Network Performance	H	NPD: ✓ MNC: -	SEM	German mechanical engineering industry
Persson (2006)	The impact of operational structure, lateral integrative mechanisms and control mechanisms on intra-MNE knowledge transfer	H, O, S	NPD: - MNC: ✓	OLS regression	Swedish MNCs
Subramaniam (2006)	Integrating Cross-Border Knowledge for Transnational New Product Development	H, S	NPD: ✓ MNC: ✓	Multiple regression analysis	Transnational NPD teams of MNCs
Zellmer-Bruhn & Gibson (2006)	Multinational organization context: Implications for team learning and performance	H, B, S	NPD: - MNC: ✓	ANOVA, GLM regression	Pharmaceutical industry
Hoegl et al. (2007)	How Teamwork Matters More as Team Member Dispersion Increases	S	NPD: ✓ MNC: -	Multiple regression analysis	Software development teams from German laboratories of German and US-based MNCs

Author (Year)	Title	Considered coordination mechanisms	Consideration of NPD and/ or MNCs	Methodology	Sample characteristics (regional/ functional/ industry focus)
Kleinschmidt et al. (2007)	Performance of Global New Product Development Programs: A Resource-Based View	H	NPD: ✓ MNC: ✓	SEM	Global NPD programs of North-American and European B2B firms
Salomo et al. (2007)	NPD planning activities and innovation performance: the mediating role of process management and the moderating effect of product innovativeness	B	NPD: ✓ MNC: -	SEM	NPD projects, mainly by German companies
Song et al. (2007)	The Effect of IT and Co-location on Knowledge Dissemination	S	NPD: ✓ MNC: ✓	ANOVA and GLM regression	Dutch and US-based, dispersed NPD teams
Barczak et al. (2008)	Antecedents and Consequences of Information Technology Usage in NPD: A Comparison of Dutch and US Companies	B	NPD: ✓ MNC: -	Confirmatory factor analysis	NPD projects of Dutch and US companies
Fey & Furu (2008)	Top management incentive compensation and knowledge sharing in multinational corporations	O	NPD: - MNC: ✓	OLS regression	Finnish and Chinese MNC subsidiaries
Ambos & Ambos (2009)	The impact of distance on knowledge transfer effectiveness in multinational corporations	B, S	NPD: - MNC: ✓	Moderated multiple regression	European-based MNCs

Author (Year)	Title	Considered coordination mechanisms	Consideration of NPD and/ or MNCs	Methodology	Sample characteristics (regional/ functional/ industry focus)
Christiansen & Varnes (2009)	Formal Rules in Product Development: Sensemaking of Structured Approaches	B	NPD: ✓ MNC: -	Qualitative research (case studies)	Danish industrial companies
Montoya et al. (2009)	Can You Hear Me Now? Communication in Virtual Product Development Teams	S	NPD: ✓ MNC: ✓	MANCOVA	US-based MNCs (equipment, computing, materials)
Sarin & O'Connor (2009)	First among Equals: The Effect of Team Leader Characteristics on the Internal Dynamics of Cross-Functional Product Development Teams	H, B, O	NPD: ✓ MNC: -	Hierarchical linear modeling	NPD projects in high-technology companies
Zhao & Anand (2009)	A multilevel perspective on knowledge transfer: evidence from the Chinese automotive industry	S	NPD: - MNC: ✓	SEM	Chinese auto industry
Lawson et al. (2009)	Knowledge Sharing in Interorganizational Product Development Teams: The Effect of Formal and Informal Socialization Mechanisms	S	NPD: ✓ MNC: -	SEM	UK manufacturing companies

Author (Year)	Title	Considered coordination mechanisms	Consideration of NPD and/ or MNCs	Methodology	Sample characteristics (regional/ functional/ industry focus)
Bstieler & Hemmert (2010)	Increasing Learning and Time Efficiency in Interorganizational New Product Development Teams	H, S	NPD: - MNC: ✓	Multiple regression analysis	Inter-organizational NPD projects
Ciabuschi et al. (2010)	Headquarters' influence on knowledge transfer performance	H	NPD: - MNC: ✓	PLS-SEM	Innovation transfer projects
Fang et al. (2010)	Multinational firm knowledge, use of expatriates, and foreign subsidiary performance	S	NPD: - MNC: ✓	Logistic regression	Foreign subsidiaries of Japanese MNCs
Gooderham et al. (2011)	Governance mechanisms for the promotion of social capital for knowledge transfer in multinational corporations	O, S	NPD: - MNC: ✓	SEM	Danish MNCs
Monteiro et al. (2010)	Knowledge flows within multinational corporations: explaining subsidiary isolation and its performance implications	S	NPD: - MNC: ✓	CFA, OLS regression	Swedish-based MNCs
Salomo et al. (2010)	Managing New Product Development Teams in a Globally Dispersed NPD Program	H, B	NPD: ✓ MNC: ✓	SEM	Global NPD programs of North-American and European B2B firms

Author (Year)	Title	Considered coordination mechanisms	Consideration of NPD and/ or MNCs	Methodology	Sample characteristics (regional/ functional/ industry focus)
De Clercq et al. (2011)	A Closer Look at Cross-Functional Collaboration and Product Innovativeness: Contingency Effects of Structural and Relational Context	H, S	NPD: ✓ MNC: -	Moderated hierarchical regression analysis	Canadian firms
Keupp et al. (2011)	Achieving Subsidiary Integration in International Innovation by Managerial "Tools"	H	NPD: - MNC: ✓	Tobit model	German and Swiss-based MNCs
Landsperger & Spieth (2011)	Managing innovation networks in the industrial goods sector	H, S	NPD: ✓ MNC: -	SEM	German innovation networks in the industrial goods sector
Niedergassel et al. (2011)	Cross-cultural Perceptions on Knowledge Sharing in Heterogeneous Collaborations	S	NPD: ✓ MNC: ✓	Qualitative (focus-group based)	Focus groups of scientists in Germany and China
Rabbiosi (2011)	The Impact of Subsidiary Autonomy on Reverse Knowledge Transfer: Moving from Single to Interdependent Explanations	B, S	NPD: - MNC: ✓	Probit models	Italian-based manufacturing MNCs

Author (Year)	Title	Considered coordination mechanisms	Consideration of NPD and/ or MNCs	Methodology	Sample characteristics (regional/ functional/ industry focus)
Rijsdijk & van den Ende (2011)	Control Combinations in New Product Development Projects	B, O, S	NPD: ✔ MNC: -	Hierarchical moderated regression analysis	Industrial, commercial machinery and computer equipment companies in the Netherlands
Yamin et al. (2011)	The Performance Effects of Headquarters' Involvement in Lateral Innovation Transfers in Multinational Corporations	H, S	NPD: ✔ MNC: ✔	Multiple regression analyses	Innovation transfer projects
Chang et al. (2012)	Expatriate Knowledge Transfer, Subsidiary Absorptive Capacity, and Subsidiary Performance	S	NPD: - MNC: ✔	Moderated regression analysis and path analysis	British subsidiaries of Taiwanese MNCs
Choi & Johanson (2012)	Knowledge translation through expatriates in international knowledge transfer	S	NPD: - MNC: ✔	Multiple regression analyses	Korean conglomerates
Najafi-Tavani et al. (2012)	Mediating Effects in Reverse Knowledge Transfer Processes: The Case of Knowledge-Intensive Services in the UK	S	NPD: - MNC: ✔	SEM	UK subsidiaries in the business service industry

Author (Year)	Title	Considered coordination mechanisms	Consideration of NPD and/ or MNCs	Methodology	Sample characteristics (regional/ functional/ industry focus)
Rundquist (2012)	The ability to integrate different types of knowledge and its effect on innovation performance	B	NPD: ✓ MNC: -	Multiple regression analysis	Swedish manufacturing firms
Sivasubramani-am et al. (2012)	Determinants of New Product Development Team Performance: A Meta-analytic Review	S	NPD: ✓ MNC: -	Hunter-Schmidt procedure for meta-analysis and SEM	Empiric research focusing on NPD and teams
Vaara et al. (2012)	The impact of organizational and national cultural differences on social conflict and knowledge transfer in international acquisitions	B	NPD: - MNC: ✓	SEM	Foreign acquisitions of Finnish MNCs
Im et al. (2013)	Antecedents and consequences of creativity in product innovation teams	B, S	NPD: ✓ MNC: -	SEM	High-tech manufacturing firms in the United States

Table 6: Literature overview on coordination mechanisms for MNC knowledge transfers

3.2.2   Characteristics of the literature sample

Before analyzing the empiric contributions provided in the literature, the sample of articles is characterized.

Time of publishing. Figure 13 shows the distribution of articles by publishing date.[33] This shows the continuous and increasing interest in the knowledge governance and suggests its popularity as a research topic was relatively low at the beginning of the century (between one and three articles published annually between 2000 and 2003) and increased continuously till the 2010s (six to seven articles annually between 2010 and 2012).
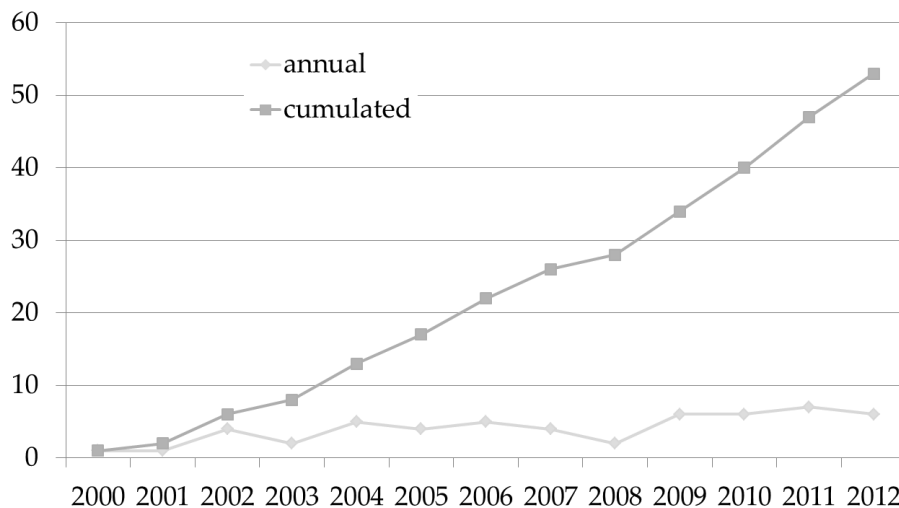
Figure 13: Articles on knowledge governance by year of publishing (2000-2012)

Focus topics. The sample includes 26 articles focusing on knowledge flows in MNCs, 19 articles focusing on the inter- or intra-organizational exchange of product development knowledge, and 9 articles considering both. The most frequently discussed category of governance mechanisms in the sample is socialization (35 articles), followed by hierarchical governance (19 articles),

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[33] The year 2013 is not included as only three months were considered in the literature review.

bureaucratic-formalized governance (16 articles) and lastly output-based governance (14 articles). The same ranking order applies when considering only articles related to product development. Articles which focus on MNCs but not on product development cover output-based governance considerably more often (second-most discussed category of governance mechanisms in this sub-sample). Figure 14 presents the distribution of categories of governance mechanisms covered in the different types of articles.
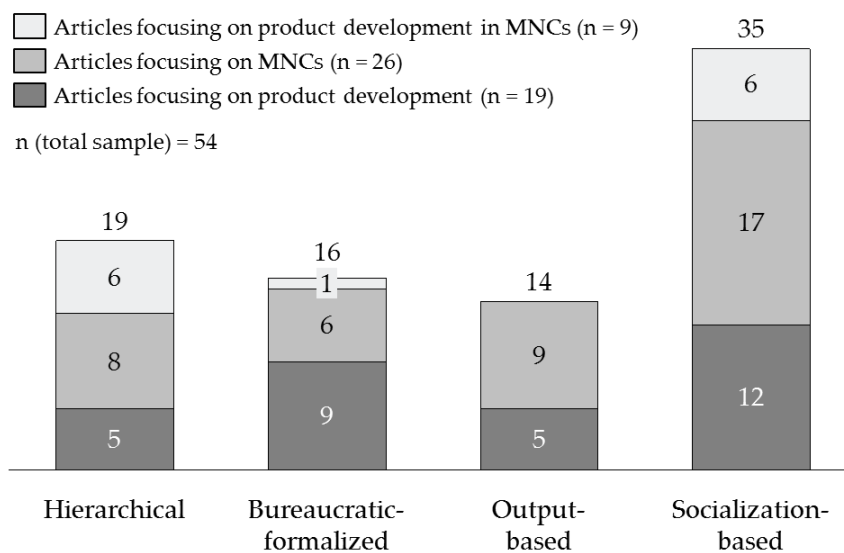
Figure 14: Number of articles treating each coordination mechanism

No article covers all four categories of governance mechanisms. 24 articles cover only one category of governance mechanisms, 16 articles cover governance mechanisms from two categories, and four articles discuss three categories of governance mechanisms.

Of the three identified context variables, tacitness is discussed as a context variable in 6 articles, distance in 3 articles, and industry velocity in 2 articles within the sample.

Regional/industry focus. Most of the sampled articles have a regional focus: 26 articles focus on MNCs in Europe, thereof 7 articles each on Germany and Scandinavia (Finland, Denmark, Sweden).[34] 15 articles study North American companies, primarily from the United States (14 articles). 11 articles discuss findings from an Asian context, thereof six related to China and three to Japan. 15 articles in the sample mention an industry focus, most notably in the B2B sector (11 articles), including high-technology industries, cement and petrochemicals.

Methodological approach. From a methodological viewpoint, 2 articles are based on qualitative research. The remaining 52 articles apply quantitative research techniques. The most commonly applied statistical method in the sample is multiple regression analysis (31 articles), including moderated, hierarchical and logistical regressions, probit and logit models. Structural equation modeling is the second-most applied statistical method (17 articles), followed by (confirmatory) factor analysis (4 articles).

This quantitative assessment of the reviewed literature confirms that this dissertation treats a contemporary topic and that this dissertation's scope is unique as it aims to cover all four categories of governance mechanisms. It confirms that studies on German-based MNCs are underrepresented compared to Germany's role in global economics. The three context factors distance, tacitness and industry velocity which appear relevant for the study of global product development are not broadly covered in the literature sample, which stresses the need for further research. Lastly, the literature overview identifies a range of proven methodological approaches for this field of research which are reviewed in chapter 4.

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[34] Scandinavia's overrepresentation in this sample as related to its countries' economic power reflects the dominant role of Scandinavian-based research in the study of MNCs and internationalization (Kutschker & Schmid 2008, pp.464–470).

3.2.3 Empiric evidence on knowledge governance mechanisms

3.2.3.1 *Hierarchical governance mechanisms*

Hierarchy is conceptualized in the MNC context as the degree of centralization of decision-making at MNC headquarters (Ciabuschi et al. 2010). Several authors find that hierarchical dependency of MNC subsidiaries on headquarters hinders knowledge flows whereas autonomy among MNC entities supports efficient and effective knowledge flows (Kostova & Roth 2002; Tsai 2002; Zellmer-Bruhn & Gibson 2006; Ciabuschi et al. 2011; Yamin et al. 2011). This finding is justified by the notion that imposed hierarchies hinder an entity to engage in knowledge transfers with other entities unless it is explicitly asked to do so (Tsai 2002), in line with the KBV argument that formal organization hinders the exchange and creation of knowledge (Grant 2002). Scholars of hierarchical governance in MNCs distinguish *operational headquarter involvement* and *strategic top management attention*. Additionally, they study team structure.

Operational headquarter involvement. Keupp et al. (2011) test overall subsidiary performance and find that it increases with the amount of operational autonomy. Bonner et al. (2002) find strong and significant support for their hypothesis that management intervention in the project operations of product development teams is negatively related with project performance.

Strategic top management attention. Bstieler & Hemmert (2010, p.492) investigate the impact of management guidance, and find a significant impact of "clear, challenging, targeted and goal-oriented" management direction both on knowledge integration and time efficiency of global product development teams. Likewise, Kleinschmidt et al. (2007) find evidence that top management attention has a positive impact on knowledge integration in global NPD teams, and that the provision of sufficient resources (people, time and money) by top management is highly positively associated with both knowledge integration and product development performance.

Team structure. A third type of hierarchical governance discussed in the sample of articles relates to the structure of product development project teams. Contrary to the approach of Lawson et al. (2009) who classify teams as a formal socialization mechanism, this dissertation classifies teams as hierarchical form of governance following Harzing's (1999) classification. Being both "formal" and "personal", teams represent temporary hierarchical organizations with a team leader who leads the project hierarchy. Subramaniam (2006) and Salomo et al. (2010) confirm the positive association between global product development teams and global product development performance. De Clercq et al. (2011) find evidence that hierarchical governance hinders product development teams: Cross-functional team composition creates competition between the hierarchies of the line organization and the project organization. Similarly, Persson (2006) finds that permanent team structures resemble the hierarchy in the line organization and have a negative impact on knowledge flows between international MNC units, while temporary team structures support knowledge flows. This is in line with the KBV's proposition of fluid teams (Gardner et al. 2012, p.306).

The degree of hierarchical coordination within a team differs with the decision-making authority held by the project manager. This definition goes back to the definition of "heavyweight team structures" which has been introduced in section 2.2.3. In heavyweight team structures, project managers "have primary influence over the people working on the development effort and supervise their work directly" (Clark & Wheelwright 1992, p.13). The work of Landsperger et al. (2006) provides strong evidence that the installation of a heavyweight project manager adds to team performance.[35, 36] Niedergassel et al. (2011) conduct a qualitative study with German and Chinese scientists and find that team

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[35] Landsperger et al. (2006) discusses this in the context of inter-firm networks and uses the term "network manager" instead of "project manager". The comparison of the two terms is legitimate based on the earlier discussion on the comparability of MNCs to inter-organizational networks.

[36] The findings are confirmed in a subsequent study (Landsperger & Spieth 2011).

expectations towards aspects such as communication style differ considerably, and therefore cross-cultural teams should be "enhanced by promotors (sic!), dedicated individuals that establish connections and advance the interaction between persons." – in global teams, these tasks can be effectively fulfilled by a strong team manager. The project manager's impact diminishes in organizations with a strong line hierarchy (Sarin & O'Connor 2009).[37]

Interaction with other governance mechanisms. De Brentani & Kleinschmidt (2004) confirm the positive relationship between management attention and project performance in global product development and explore an interrelation with other governance mechanisms: Top management attention is no stand-alone solution, and companies with high management involvement not flanked by other governance mechanisms achieve inferior product development results than others. Rabbiosi (2011) explores an interaction effect between organization and impersonal governance: The successful application of impersonal governance requires a certain degree of central power by which headquarters can force subsidiaries to codify and capture knowledge systematically so that it can be accessed by other MNC units. These findings suggest that management attention increases the effectiveness of other coordination mechanisms but is no successful stand-alone coordination, neither for successful knowledge exchange nor for product development performance.

3.2.3.2 *Bureaucratic-formalized governance mechanisms*

Bureaucratic-formalized knowledge governance is based on formal guidelines and standards. The application of such mechanisms requires that tacit knowledge is made explicit so that it can be captured in writing. Identified bureaucratic-formalized approaches include *knowledge management systems* and *standard processes*.

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[37] Similarly, Denti & Hemlin (2012) find that team leaders can make a strong impact in decentralized, less formalized organizations.

Knowledge management systems (KMS) are a cost efficient approach (Holtbrügge & Berg 2004, p.136) to make tacit knowledge explicit based on the concept of *knowledge encapsulation*:

> "Knowledge encapsulation refers to a mechanical procedure to store and document knowledge and information for subsequent use and exchange" (Zhao & Luo 2005, p.80).

Zellmer-Bruhn & Gibson (2006) discuss KMS as viable tools for MNCs to capture and share know-how and improve learning results. Sherman et al. (2005) likewise report higher performance for product development teams who systematically record, retrieve and utilize information from past related development projects. Focusing on product development, Rundquist (2012) explores a positive association between the application of systems and methods to acquire and re-use domain-specific and general knowledge with innovation performance.

Zhao & Luo (2005) find empiric support for the association between knowledge encapsulation and the frequency of knowledge flows, yet the authors have concerns about potential effects of reverse causality as frequent knowledge sharing might increase the documentation of knowledge.

Standard processes. While KMS typically capture declarative information, standard processes are applied to formalize procedural knowledge and streamline processes throughout the organization to facilitate and control collaboration. They involve stage gates at process points where a decision must be taken whether to continue with the development project or not, depending on the current probability of success due to technical, budgetary or other unexpected challenges (Bradfield & Gao 2007).

Vaara et al. (2012) test the general impact of standardized practices on MNC knowledge transfers and find that this aspect has a significant, highly positive impact on knowledge transfers.

Authors focusing on product development processes arrive at less supportive results for standard processes: Rundquist (2012) explores that the methods to acquire and re-use procedural knowledge are not associated with innovation performance. Im et al. (2013) confirm that formal planning hampers creativity and thus product competitive advantage. Sarin & O'Connor (2009) find that the extent to which leaders of product development teams structure development processes is not associated with team performance. Similarly, Bonner et al. (2002) empirically prove that product development projects that rely on high formal process control are associated with lower performance. Rijsdijk & van den Ende (2011) confirm that process control has no significant effects on product development project outcomes. A potential explanation for the low or even negative impact of standard processes on product development performance relates to the nature of product development knowledge: It is characterized as mostly tacit (see section 2.3.1), and standard processes depend on codification of tacit knowledge to explicit knowledge, which is the harder the more tacit the knowledge is.

Among the reviewed articles dealing with product development, only Kleinschmidt et al. (2007) find a positive (and significant) path relationship: They confirm a positive relationship between NPD process formality and knowledge integration in global NPD programs. The qualitative analysis of Christiansen & Varnes (2009) suggests a potential reason for the disparity in the findings: While many companies report to have adopted a standardized development process, the actual application differs widely. Thus studies testing the influence of standard processes on performance need to investigate the adherence to a standard process rather than its general adoption.

Interaction with other governance mechanisms. Rijsdijk & van den Ende (2011) find that the impact of process control on performance turns from neutral to negative at high levels of socialization. They assume that this derives from

socialization's capacity to spur flexibility to interact, which is restricted by formal process control.

3.2.3.3 Output-related coordination mechanisms

Output-related coordination mechanisms view the relationship between MNC headquarters and subsidiaries as a principle-agent relationship (Björkman et al. 2004; Fey & Furu 2008). Contrary to the previously discussed mechanisms, incentives focus on the individual rather than the team. In an MNC context, rewards help to overcome the "Not-Invented-Here" (NIH) syndrome (Gupta & Govindadrajan 2000) which is driven by individuals' ego-defense mechanisms or by power struggles within organizations. The NIH syndrome hinders members of MNC entities to adopt practices whose success can be attributed to (members of) other entities. To increase the *motivational disposition* of MNC entities and individuals to overcome the NIH syndrome and engage in knowledge exchange, MNCs can install reward mechanisms combining financial and non-financial incentives (Björkman et al. 2004, p.445).

Gupta & Govindarajan (2000) test the influence of incentives for entity managers "to focus on system-wide optimization" rather than on entity optimization. Their empirical results, however, display that financial incentives based on overall MNC performance do not influence the amount of knowledge inflows or outflows.[38] Mahnke et al. (2005) come to similar conclusions. Fey & Furu (2008) test the same concept and arrive at contrary results: General managers' compensation based on MNC performance has a positive influence on knowledge sharing. All of these studies have in common that they measure the effects of performance-based pay related to MNC performance, whereas specific rewards for knowledge integration are neglected. The cause-and-effect

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[38] Note that Gupta and Govindarajan (2000) test the *amount* but *not the quality* of knowledge flows within the MNC.

relationship between incentives and knowledge sharing is thus not necessarily given.

Minbaeva et al. (2003) test the link between different financial and non-financial incentives with international knowledge transfer. Their empirical findings support their hypotheses that performance appraisals, merit-based promotion, performance-based compensation and internal communication positively impact employees' motivation and ability which, in turn, positively influences international knowledge transfers. Other studies confirm the positive influence of reward mechanisms: According to Wang et al. (2004), linking rewards and learning positively impacts on the acquisition of *management knowledge* in international MNC subsidiaries. Persson (2006) identifies the use of knowledge transfers as a criterion for performance evaluation as the most impactful, yet least applied mechanism to support knowledge flows.

With particular regard to product development teams, Song et al. (2005) confirm a strong correlation between reward mechanisms and knowledge application. Similarly, van der Bij et al. (2003) confirm the appropriateness of rewards for knowledge dissemination. Sarin & O'Connor (2009) explore that goal setting for individual team members has a strong influence on team dynamics, and is among the most powerful tools for a product development team leader. Rijsdijk & van den Ende (2011) confirm the significant positive impact of output-control mechanisms on product development performance, more specifically on project timeliness and technical product quality. These results confirm earlier findings from organizational science relating to the strength of motivational goals as discussed in section 2.2.3.

Interaction effects between coordination mechanisms. Rijsdijk & van den Ende (2011) explore a positive interaction effect between "clan control" (socialization-based coordination) and output-based coordination: The higher the

socialization among team members, the higher the impact of output-based control.

3.2.3.4   *Socialization-based coordination mechanisms*

Scholars widely accept socialization as an appropriate mechanism to foster the transnational flow of tacit knowledge (Holtbrügge & Berg 2004) due to their ability to influence the informal organization. Many empiric studies confirm the hypothesis that knowledge flows between MNC entities increase with the application of socialization mechanisms (Gupta & Govindarajan 2000; Tsai 2002; Björkman et al. 2004; Mahnke et al. 2005; Persson 2006; Najafi-Tavani et al. 2012; Najafi-Tavani et al. 2012).

Tsai (2002, p.181) argues that "interunit social interactions blur the boundaries between organizational units" and thus facilitate knowledge sharing. Socialization-based coordination creates trust among individuals, which is an influential driver for the performance of product development networks (Bstieler & Hemmert 2010; Landsperger & Spieth 2011; Tuunainen & Miettinen 2012). It has been furthermore reported to indirectly impact on cost performance and technical product quality in product development projects (Rijsdijk & van den Ende (2011).

Im et al. (2013) find empiric support for their hypotheses that product development teams displaying a high level of social cohesion are more creative and thus drive product competitive advantage. As socialization-based mechanisms are among the costliest to maintain due to travel costs, time limits, and the higher exposure to cultural and linguistic differences (Holtbrügge & Berg 2004), it is viable to explore which socialization mechanisms have the greatest positive impact on performance. In spite of Harzing's (1999) broad characterization of this category, socialization-based coordination mechanisms for product development can be grouped into two major sub-categories: international groups or networks and expatriation.

International groups. The introductory section on teams (see section 2.2.1) has distinguished teams from groups by complementary skills and accountability to for a common purpose and set of performance goals. In MNCs, groups exist beyond or besides teams and are typically less focused on a specific task than teams (Lipnack & Stamps 2000). They can serve as a governance mechanisms for socialization as they aim to establish informal networks besides the formal organization (cf. section 2.4.2). Gupta & Govindarajan (2000, pp.478–479) discuss international task forces and permanent global committees as international groups: They find that the more an MNC entity is linked to other entities via these mechanisms, the more communication and thus the more knowledge exchange. Björkman et al. (2004) confirm the effectiveness of international committees. Mahnke et al. (2005) explore communities of practice and corporate university (a form of group learning) as tools to support intra-organizational knowledge sharing. Other studies confirm the effectiveness of training in international groups as having a positive influence on the quality of interpersonal relations (Björkman et al. 2004; Zellmer-Bruhn & Gibson 2006; Zhao & Anand 2009).

Expatriation. Many authors point out expatriation as a particular form of socialization (Subramaniam & Venkatraman 2001; Björkman et al. 2004; Wang et al. 2004; Fang et al. 2010). As headquarter-home-country nationals temporarily located in a foreign subsidiary, expats are assumed to support global MNC collaboration in knowledge intense processes based on several aspects (Björkman et al. 2004; Choi & Johanson 2012):

1) According to the principles of agency theory, expatriates are intrinsically motivated to act in the overall MNC interest because their future career prospects in the MNC are likely to depend on the host subsidiary's contribution to the MNC performance.

2) Due to their socialization in the parent company, expatriates identify less with their host subsidiary than local managers and are therefore expected to act more in favor of overall MNC performance.

3)   Expatriation experience supports the development of relationship capability, which is the ability to develop and maintain new relationships, even after the expatriate returns to the home countries.

Findings on the roles of expatriate managers are contradictory: While Subramaniam & Venkatraman (2001) do not find support for the influence of managers with international experience on product development capability *per se*, their study confirms that project members' international experience gains importance with an increasing level of tacit knowledge processed by the team. Holtbrügge & Berg (2004) confirm this findings. Wang et al. (2004) prove that expat managers' transfer skills are positively associated with knowledge acquisition by foreign subsidiaries. Björkman et al. (2004) reject their hypothesis on the positive relationship between the number of expatriate managers and subsidiary outward knowledge transfer. However, the influence of the position held by expatriates might be more important than the sheer number of expatriates. Furthermore, the impact expatriate managers have on subsidiary performance is related to their (soft) skills (Chang et al. 2012; Choi & Johanson 2012). The reviewed studies do not provide specific empiric evidence on expatriation in product development.

Collaboration experience. Yamin et al. (2011) discuss previous collaboration experience in international teams as a factor which impacts on organizational absorptive capacity. They find strong empiric support for the positive impact on previous collaboration experience which they explain by knowledge assimilation: "Units who interact regularly, even if they start with little similarity, over time assimilate one another's knowledge and develop a common knowledge base and a common specialized set of terminologies" (Yamin et al. 2011, p.162). The positive impact of collaboration experience on innovation performance is confirmed by Frishammar & Åke Hörte (2005) and identified as contributor to NPD team ability by Sivasubramaniam et al. (2012). These findings are in line

with the concept of familiarity which was introduced in section 2.2.3 as having a moderating impact on group heterogeneity.

Interaction with other governance mechanisms. Persson (2006) finds that the *relative* impact of socialization on intra-MNC knowledge exchange is lower than that of output-related mechanisms such as incentives.

3.2.4   Empiric evidence on context factors for knowledge governance

3.2.4.1   *Distance*

Although distance is a characterizing element of MNC knowledge transfers, it is analyzed as a context variable in only four papers: Hoegl et al. (2007) confirm Allen's curve, finding that communication, facilitated by physical proximity, is essential for high-quality teamwork. Analyzing knowledge transfers in cross-border acquisitions, Vaara et al. (2012) find evidence for a positive association between cultural distance and international knowledge transfer. They justify this finding with the complementarity of knowledge by MNC members from different national cultures. Niedergassel et al. (2011) discuss the need for of socialization-based mechanisms to supportive long-distance collaborations of engineers and calls for "platforms that enable the participating researchers to learn about and get in contact with [each other]" (Niedergassel et al. 2011, p.586). Ambos & Ambos (2009) test the moderating effects of cultural, geographic, and linguistic distance on the relationship between personal versus technology-based collaboration and knowledge transfer effectiveness in MNCs. They find that personal collaboration becomes less effective for knowledge transfer as distance increases, regardless of the type of distance. This is justified with the travel-related increasing cost of personal interaction with increased distance and the contextual distance which complicates knowledge sharing. Technological coordination mechanisms are less prone to the efficiency decreasing effect of distance as they are less context-dependent, and insensitive of cost increases.

These findings underline the need for socialization to overcome the challenges associated with personal interaction across long distances.

3.2.4.2   Tacitness

Tacitness is among the most widely and unambiguously discussed context factors for MNC knowledge flows. Yamin et al. (2011) show that the degree of tacitness has an overall negative impact on the satisfaction with MNC knowledge exchange. While global teams have been generally found to be particularly effective to transfer tacit knowledge (Björkman et al. 2004; Holtbrügge & Berg 2004), different governance mechanisms vary in their suitability to support the transfer of tacit knowledge.

Socialization, particularly, gains importance with increasing tacitness (Holtbrügge & Berg 2004): Subramaniam & Venkatraman (2001) confirm that rich, personal governance mechanisms such as expatriate involvement are better suited to enhance global product development performance when knowledge is tacit. Fang et al. (2010) explore that expatriate involvement supports transfers of (rather explicit) technological knowledge but not of (rather tacit) marketing knowledge which needs to be locally embedded.

Zhao & Luo (2005) identify a moderating effect of tacitness on the relationship between incentives and successful knowledge exchange, where incentives prove successful to transfer procedural knowledge (rather tacit) but not to transfer declarative knowledge (rather explicit). The positive impact of incentives thus increases with the tacitness of the knowledge involved.

3.2.4.3   Industry velocity

Empiric evidence regarding the impact of industry characteristics on knowledge governance mechanisms is rare. Rundquist (2012) discovers that the integration of domain-specific knowledge has a greater effect on innovation

performance in industries characterized by high technological turbulence than in less turbulent environments, and the study of Christiansen & Varnes (2009) discusses the inapplicability of standard processes for radical innovation, the latter being more common in turbulent, high-velocity markets than in markets characterized by mature technologies.

While few authors directly compare the effect of governance mechanisms in high- and low-velocity markets, several studies concentrate on the (high-velocity) high-technology industry. Im et al. (2013) study British high-tech manufacturing firms and find that standard processes have a negative impact on new product development performance in contrast to socialization and reward systems. Likewise, Sarin & O'Connor (2009) confirms for high-tech companies that goal setting (output-based governance) positively impacts on team collaboration in new product development projects whereas process formalization has no measurable impact. Song et al. (2005) also confirm the applicability of formal rewards as having a positive impact on knowledge application of R&D teams in high-technology companies. Lastly, van der Bij et al. (2003) confirm a significant impact of formal rewards on knowledge dissemination in the development of new products in high-technology firms. In their model, management support is even more strongly related to knowledge dissemination in new product development, and other governance mechanisms are not considered. These examples show that informal coordination mechanisms such as management support and socialization but also rewards which are output-related rather than process-related work well in the context of high-velocity industries.

3.3   Synopsis and hypotheses development

3.3.1   Individual absorptive capacity, knowledge integration and performance

Based on the theoretic basis provided by the KGA and the existing empiric findings, hypotheses can be generated for subsequent empirical testing to answer this dissertation's first three research questions.

The KGA follows the core statement of the KBV that there is a significant relationship between successful knowledge integration and organizational performance (Grant 1996b; Foss 2007). The KGA posits that in order to govern knowledge-intense processes such as product development, knowledge integration and its individual-level micro-foundations have to be taken into consideration. Following the KBV, the integration of tacit individual knowledge into the organization and the creation of new knowledge based on the combination of individuals' (tacit) knowledge is the key source for competitive advantage (Grant 1996b). Individual capacity and knowledge integration (absorptive capacity) are thus two important constructs which add to product development performance. The impactful role of knowledge integration for product development performance has been empirically confirmed in previous studies (Subramaniam & Venkatraman 2001; Kleinschmidt et al. 2007). The first hypothesis of this research is therefore:

H1:   Successfully integrating the knowledge of the members of a global product development project team is positively associated with the performance of the global product development project.

Following the key assumptions of the KGA, knowledge governance has to be studied at the micro-level and consider individuals' predispositions to share and create knowledge (Foss et al. 2010, p.457). The second hypothesis therefore follows the call of KGA proponents who criticize that the role of individuals in

this process is often overlooked in research (ter Wal et al. (2011, p.1) and states that:

H2a: Individual absorptive capacity (iCAP) is positively associated with knowledge integration in global product development teams.

The effect of individual absorptive capacity is not restricted to knowledge integration, however. Motivated and capable individuals will not only contribute to product development performance via sharing and integrating knowledge, but also by driving the speed and quality of the development project directly:

H2b: Individual absorptive capacity (iCAP) is positively associated with the performance of global product development teams.

3.3.2   General impact of governance mechanisms

The knowledge governance approach and its associated theories provide a theoretic foundation to assess the applicability of governance mechanisms. The KGA fails, however, to provide criteria to rank these governance mechanisms and considers context mechanisms only to a limited extent. The review of literature on governance mechanisms helps to fill this gap and develop a framework for governance mechanisms in the context of global product development teams. The literature review reveals that each category of governance mechanisms consists of a multitude of individual mechanisms that can be applied to foster international knowledge integration and product development performance to different extents, thus helping to answer the first research question of this dissertation which inquires about the practically applied governance mechanisms for global product development teams. The previously empirically tested governance mechanisms are summarized in figure 15, categorized in Harzing's (1999) classification scheme.

	Personal/cultural (founded on social interaction)	Impersonal/bureaucratic/ technocratic (founded on instrumental artifacts)
Direct/ explicit	Hierarchical • Operational headquarter involvement • Top management attention • Team structure	Bureaucratic-formalized • Knowledge management systems • Standard processes / process control
Indirect/ implicit	Socialization-based • Expatriation • International groups • International training • Collaboration experience	Output-related • Individual rewards

Figure 15: Governance mechanisms identified in previous empiric research

The amount of research conducted on each of the governance mechanisms suggests that hierarchical and socialization-based governance are applied most.

Hierarchical governance mechanisms deal with organizational structures which the KGA sees as underexplored in knowledge governance literature. The literature review reveals a number of studies on knowledge exchange in the international context which deal with these structures, discussing operational headquarter involvement, top management attention and project team structure.

Operational headquarter involvement is widely confirmed as having a negative impact on knowledge exchange (Yamin et al. 2011; Ciabuschi et al. 2010; Zellmer-Bruhn & Gibson 2006; Tsai 2002; Kostova & Roth 2002) and also on product development performance (Bonner et al. 2002; Keupp et al. 2011) because it undermines deliberate cooperation between the involved parties. This leads to believe that there is a reason why the KGA perceives the role of organization as under-discussed in knowledge governance literature, and confirms the KBV's proposition that organizational hierarchies are the least applicable mechanism to govern, particularly, tacit knowledge (Grant 1996a; Grant 2002). A two-tiered hypothesis is derived:

H3a: Operational headquarter involvement is negatively associated with knowledge integration in global product development projects.

H3b: Operational headquarter involvement is negatively associated with the performance of global product development projects.

Top management attention is another form of direct, personal and thus hierarchical or organizational governance which is, however, more informal than the organizational structure (Michailova & Foss 2009, p.8). Bstieler & Hemmert (2010, p.490) justify the relevance of top management attention for product development with the importance for inter-organizational teams to operate with a shared sense of mission and purpose, and the necessity to reduce ambiguities and discrepancies regarding perceived project goals. Management attention can thus be interpreted from a KGA perspective as a driver for individual absorptive capacity. It creates clarity and motivation for individual team members regarding their role and tasks in the project. The first hypothesis related to top management attention is thus:

H4a: Top management attention is positively associated with individual absorptive capacity in global product development teams.

Practice reports confirm the relevance of top management attention: In a best practice study, Markham & Lee (2013) highlight top management's attention to product development projects as one of the properties that distinguish best-in-class companies from the average. De Brentani & Kleinschmidt (2004) find that management attention works mostly in association with other governance mechanisms. They discuss the involvement of top management in the standard product development process, e.g. by taking part in stage gate reviews and supporting customer involvement, as factors driving the timely completion of the product development project. Furthermore the support with resources, time and money that comes with top management attention is reported to have a positive

impact, both on knowledge integration and product development performance (Bstieler & Hemmert 2010; Kleinschmidt et al. 2007). The second hypotheses related to top management attention thus states:

H4b: *Top management attention is positively associated with the application of standard product development processes in global product development projects.*

Team structures are the third form of hierarchical governance discussed empirically. Overall, temporary global teams have a positive impact on global product development performance (Persson 2006; Salomo et al. 2010; Subramaniam & Venkatraman 2001). It is the higher the stronger the team organization as compared to the line structure (Landsperger et al. 2006; Sarin & O'Connor 2009). Particular attention is put on the project manager who can steer the project the more effectively the more he can impact the project operations regardless of the day-to-day operations in the line organization (Landsperger et al. 2006; Sarin & O'Connor 2009; Denti & Hemlin 2012; Sivasubramaniam et al. 2012). A heavyweight team structure where the project manager has more control over the project team than the line organization is thus assumed to have a positive impact on product development performance. This is supported by KGA proponents promoting flexible organizational structures that support the engagement of individuals with different levels of experience (Christensen & Knudsen 2008). The literature review does not reveal any empiric indications for a direct impact of heavyweight teams on knowledge integration, and it appears logical that the team manager can take more influence on achieving objectives in a timely and cost-effective manner but has only limited impact on the integration of individuals' knowledge and propensity to share knowledge (individual absorptive capacity; ter Wal et al. (2011)). The hypothesis is thus stated that:

H5: *Heavyweight team structures are positively associated with the performance of global product development teams.*

Bureaucratic formalized governance is exercised via knowledge management systems and standard processes.

Knowledge management systems (KMS) are found to have a positive impact on product development performance and appear to be particularly suited for global teams as they are not affected by the distance between team members (Ambos & Ambos 2009; Rundquist 2012). A closer look at the literature dealing with KMS shows, however, that they are well-suited to access knowledge created in previous projects or activities but that they do not serve the purpose of combining the knowledge of current team members (Sherman et al. 2005). KMS are thus assumed to have a rather marginal positive impact on knowledge integration compared to other governance mechanisms.

H6:   *Knowledge management systems are positively associated with knowledge integration of global product development teams (it is low compared to other governance mechanisms).*

Standard processes and associated process control have been disputed in the context of product development. They are reportedly not associated with knowledge integration and performance in product development due to their suppressing impact on creativity (Sarin & O'Connor 2009). This can be ascribed to their limited applicability to deal with tacit knowledge which is characteristic for product development. The findings of governance literature conflict with organizational practice, however: Among large companies, more than 70% report to use a formal, cross-functional new product development process, and the ratio of companies using such a process is much higher in the group of companies rated as "best in class" (Markham & Lee 2013). What explains the disparities between research findings and practice reports? Markham & Lee (2013) find that "best in class" companies apply a more flexible standard process than the average company in their sample. Christiansen & Varnes (2009) highlight the necessity to distinguish between the mere adoption and actual extent of application of

standardized processes. This dissertation follows the theoretic argument of the KBV which identifies standard processes as inapplicable to integrate tacit knowledge (Grant 1996a). However, based on its power to drive the overall development process through stage gates in a timely and quality-oriented manner, particularly when backed-up by top management (Kleinschmidt et al 2007), a positive impact of standard processes on product development is assumed. The two-tiered hypothesis on standard processes posits that:

H7a: *Standard development processes are not associated with knowledge integration in global product development projects.*

H7b: *Standard development processes are positively associated with the performance of global product development projects.*

Output-related coordination is exercised via financial and non-financial rewards for employees and managers. Empiric evidence in the context of MNCs and product development provides ample evidence that rewards targeted at knowledge sharing have a significant, high positive impact on knowledge integration and performance (Minbaeva et al. 2003; van der Bij et al. 2003; Wang et al. 2004; Persson 2006; Sarin & O'Connor 2009; Rijsdijk & van den Ende 2011). Following the theoretic position of the KGA, they can be assumed to be among the most powerful governance mechanisms for a knowledge-intense process such as product development because they target the individual and thus the micro-foundations of knowledge (Foss 2007; Volberda et al. 2010)

H8: *Individual rewards for team members are positively associated with individual absorptive capacity in global product development teams.*

Socialization can be operationalized as social capital which comprises three dimensions: (1) Structural social capital, that is the quality and quantity of interactions between individuals, (2) relational social capital, which is the degree

of trust between individuals, and (3) cognitive social capital, which relates to the identification of the individual with the group (Nonaka 1994; Tsai & Ghoshal 1998; Reiche et al. 2009). The KBV and the related concepts of organizational learning have pointed out the relevancy of socialization for knowledge integration (Grant 1996a; Nonaka 1994). The KGA accepts socialization as an approach to integrating knowledge at the organizational level (Volberda et al. 2010). Socialization is unanimously viewed as having a high positive impact on the integration of tacit knowledge which plays a significant role in product development, and particularly in an international context (Gupta & Govindarajan 2000; Tsai 2002; Björkman et al. 2004; Mahnke et al. 2005; Persson 2006; Najafi-Tavani et al. 2012). In inter-organizational networks such as MNCs, socialization increases trust which reinforces interaction, and harmony which creates an understanding of give-and-take (Landsperger & Spieth 2011). Based on the learning impacts of repeat collaboration, socialization helps overcome the challenges associated with distance between members of global teams (Ambos & Ambos 2009). Overall, socialization has been accepted to be one of the strongest tools to coordinate international knowledge transfers since the 1970s (Ouchi 1979).

H9a: Socialization is positively associated with knowledge integration in global product development teams.

Several socialization mechanisms are discussed in the MNC context: Socialization can be achieved via involvement in international groups, long-term foreign assignments (expatriation), the usage of corporate universities or similar international training methods, and the fostering of repeated collaboration. Among these mechanisms, only expatriation is disputed regarding its effectiveness for knowledge integration and performance (Björkman et al. 2004; Holtbrügge & Berg 2004; Wang et al. 2004; Subramaniam 2006) and has not been studied with regard to product development specifically. However, as it serves the same purpose as the other two socialization mechanisms, it can be assumed to

lead to socialization just the same. It appears that the combinations of these mechanisms creates a high level of socialization. The hypothesis is developed that

H9b: Team members' involvement in international groups (committees) and trainings, their expatriation experience and collaboration experience contribute to the socialization of global product development teams.

These hypotheses are summarized in figure 16. The arrows linking the variables in figure 16 represent positive (+) or negative (-) path relationships between the variables which are represented by circles and boxes.
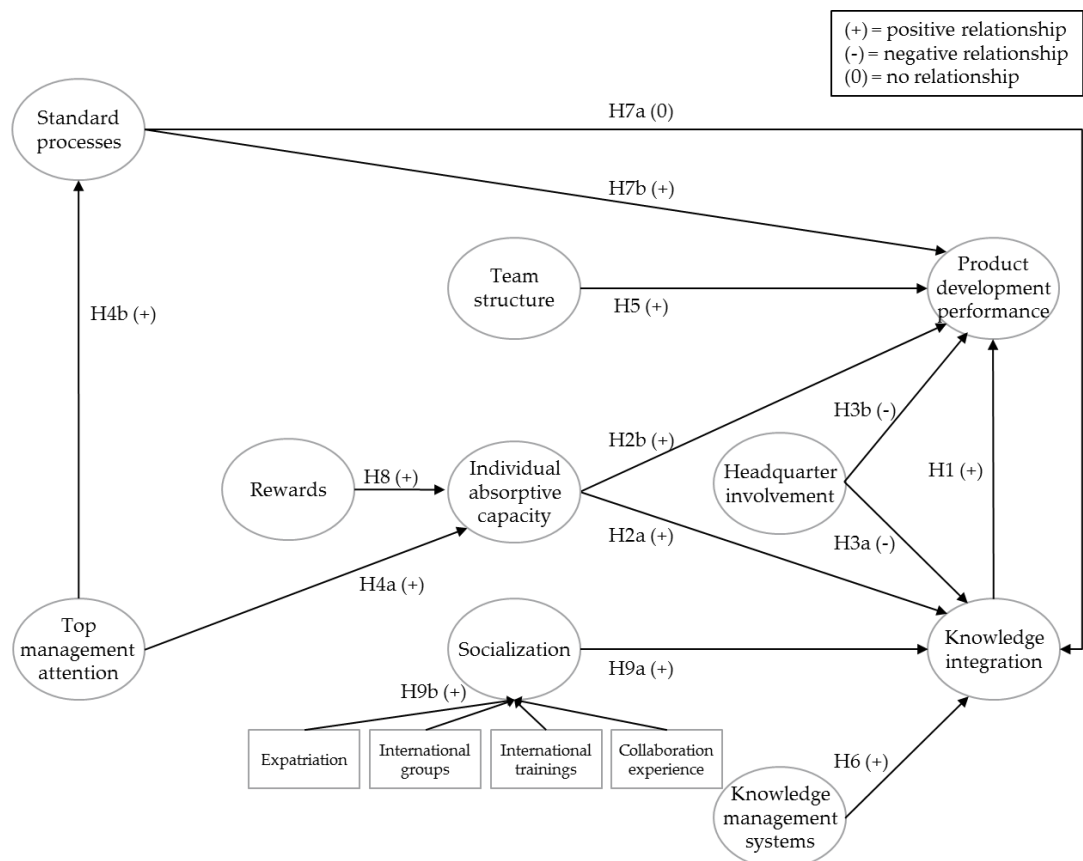
Figure 16: Overview of the basic hypotheses on governance mechanisms

3.3.3   Relative impact of different governance mechanisms

To answer the second research question of this dissertation which inquires about the most impactful governance mechanisms for global product development teams, the relative relationship between governance mechanisms and global product development performance has to be identified. Rooted in TCE, the KGA suggests that cost effectiveness is a main criterion to assess the effectiveness of governance mechanisms. While common sense suggests that hierarchies are less costly to establish than bureaucratic governance mechanisms such as standard processes and systems or socialization-based governance, neither theory nor literature provides a clear answer to this question. Furthermore, only few articles compare two to three categories of governance mechanisms, but none compares the impact of all four categories of governance mechanisms.

In the absence of theory and evidence, the framework of previously developed hypotheses can serve as a basis to address the second research question. Assuming imperfect correlation between all constructs depicted in the basic hypotheses derived above, the total effect of a given governance mechanism is the lower the more constructs are situated between this governance mechanism and the endogenous construct of product development performance. Thus, while incentives and socialization are discussed most unanimously as impactful governance mechanisms in literature, they impact only indirectly on product development performance, with individual absorptive capacity and knowledge integration mediating their impact, respectively. Only standard processes, team structures and headquarter involvement directly impact product development performance. Empiric evidence on the impact of these mechanisms is mixed or negative however.[39] Likewise, theory offers insufficient answers to rate these governance mechanisms: While the KGA stresses incentives based on their impact

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[39] Cf. section 3.2.3

on the individual (micro-foundations), it also emphasizes the validity of organizational mechanisms such as team structures (Foss 2007).

This dissertation thus takes an inductive, exploratory approach to answering *RQ2* on the relative impact of governance mechanisms on product development performance: The path relationships identified by testing the previously introduced hypotheses will be used to calculate the total effect of each governance mechanism on product development. This information provides an empiric basis to rank the tested governance mechanisms by their impact on product development performance.

3.3.4   Influence of context factors

RQ3 seeks to identify context factors and understand their implications for governing global product development teams. Three context factors have been identified when reviewing the KGA as a theoretic foundation for this dissertation: Distance, tacitness and industry velocity. These three context factors are mainly discussed in the reviewed literature in interaction with the socialization-based governance. Socialization appears to be suited best to overcome cultural distance among the participants of a knowledge exchange, to transfer tacit knowledge, and to support knowledge integration in high-velocity markets.

The impact of context mechanisms can be direct, moderating or mediating. A direct impact describes the general association of a context factor with any variable. Moderating and mediating effects impact the relationship between variables (Baron & Kenny 1986): Moderating variables affect the relationship between two constructs without affecting the constructs as such. Mediating variables directly affect the constructs.

More specifically, in mediated relationships, the exogenous variable has predictive relevance for the mediating variable whereas moderating variables are

not affected by exogenous variables (Hair et al. 2014, pp.243–247). Figure 17 graphically depicts moderated and mediated relationships.
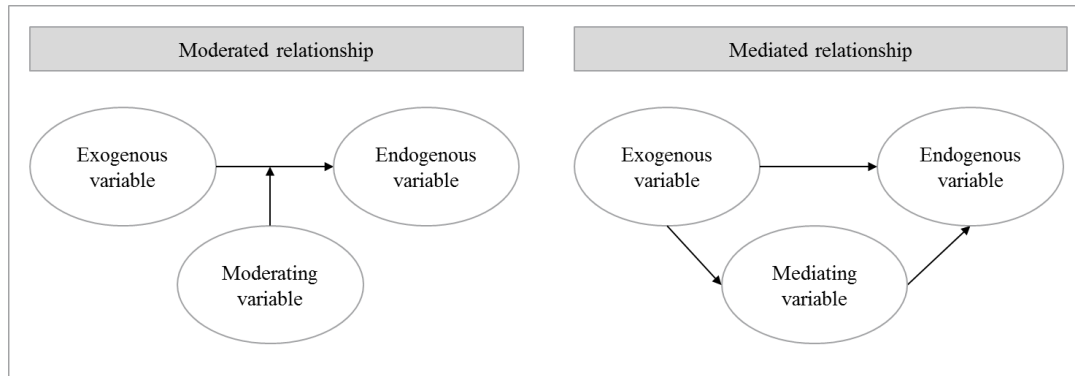
Figure 17: Moderated and mediated relationships
Source: Adapted from Henseler & Fassott (2010, p.30)

The subsequent discussion seeks to identify testable hypotheses on the type of impact of the three context variables considered in this dissertation.

Distance is discussed in three dimensions: Cultural distance, linguistic distance, and a cluster of physical distance which encompasses geographic and temporal distance.

Cultural distance is discussed as a driver for creativity, fostering the combination of complementary, culturally-rooted knowledge (Vaara et al. 2012). At the same time, it risks the establishment of trust and joint team identity and thus negatively impacts knowledge integration (Lucas 2006; Casey 2009). Socialization is discussed as a core governance mechanism supporting the development of trust (Landsperger & Spieth 2011; Zimmermann 2011). This leads to believe that socialization can help moderate the potential negative aspects of cultural distance and unleash the full potential of creativity deriving from combining different worldviews. The findings of Niedergassel et al. (2011) support the assumption that socialization proves successful to overcome –

particularly, cultural – distance. Two hypotheses are derived to test this assumption empirically:

H10a: Cultural distance is positively associated with knowledge integration.

H10b: Socialization positively moderates the relationship between cultural distance and knowledge integration: The higher the extent of socialization, the stronger the positive relationship between cultural distance and knowledge integration.

Linguistic distance is not as thoroughly discussed in the reviewed literature. Other sources (cf. Marschan-Piekkari et al. 1999; Harzing et al. 2011) lead to the assumption that linguistic distance creates language barriers and thus inhibits successful knowledge integration. A better understanding of the relationship in the context of global product development teams requires further research, and thus this dissertation seeks to test the following hypothesis:

H10c: Linguistic distance is negatively associated with knowledge integration.

Physical distance decreases the amount of communication and knowledge exchange between individuals (Allen 1977). Accordingly, in the research model physical distance should be expected to have a negative impact both on knowledge integration and product development performance due to lower frequency and higher cost of communication. Ambos & Ambos (2009) find that socialization becomes less effective with increasing spatial distance between actors. This falls in line with the arguments provided by transaction cost economics: The higher the distance between the actors, the less applicable socialization which incurs traveling cost for individuals to physically meet and interact with individuals from different countries. Physical distance is thus likely to mediate the impact of socialization:

H10d: Physical distance is negatively associated with knowledge integration and product development performance.

H10e: Physical distance negatively moderates the relationship between socialization and knowledge integration: The higher the physical distance, the lower the positive association between socialization and knowledge integration.

Tacitness. Tacit knowledge has been considered to be "sticky" and hard to transfer (Szulanski 1996), yet it is crucial for global product development teams. The satisfaction with knowledge integration has been found to decrease with increasing levels of tacitness (Yamin et al. 2011). From a theoretic perspective, the KBV, KGA and SECI model all outline the importance of socialization as a mechanism to foster the integration of tacit knowledge (Nonaka 1994; Michailova & Foss 2009; Grant 1996a; Foss et al. 2010). In the context of MNCs, Holtbrügge & Berg (2004) discuss socialization as gaining importance with increasing tacitness, and Subramaniam & Venkatraman (2001) confirm that rich, personal governance mechanisms enhance global product development performance when knowledge is tacit. Two hypotheses are derived from these earlier findings:

H11a: Tacitness is negatively associated with knowledge integration.

H11b: Socialization moderates the relationship between tacitness and knowledge integration: The higher the socialization, the weaker the negative relationship between tacitness and knowledge integration.

Figure 18 depicts the hypotheses related to distance and tacitness in the context of the overall research model.
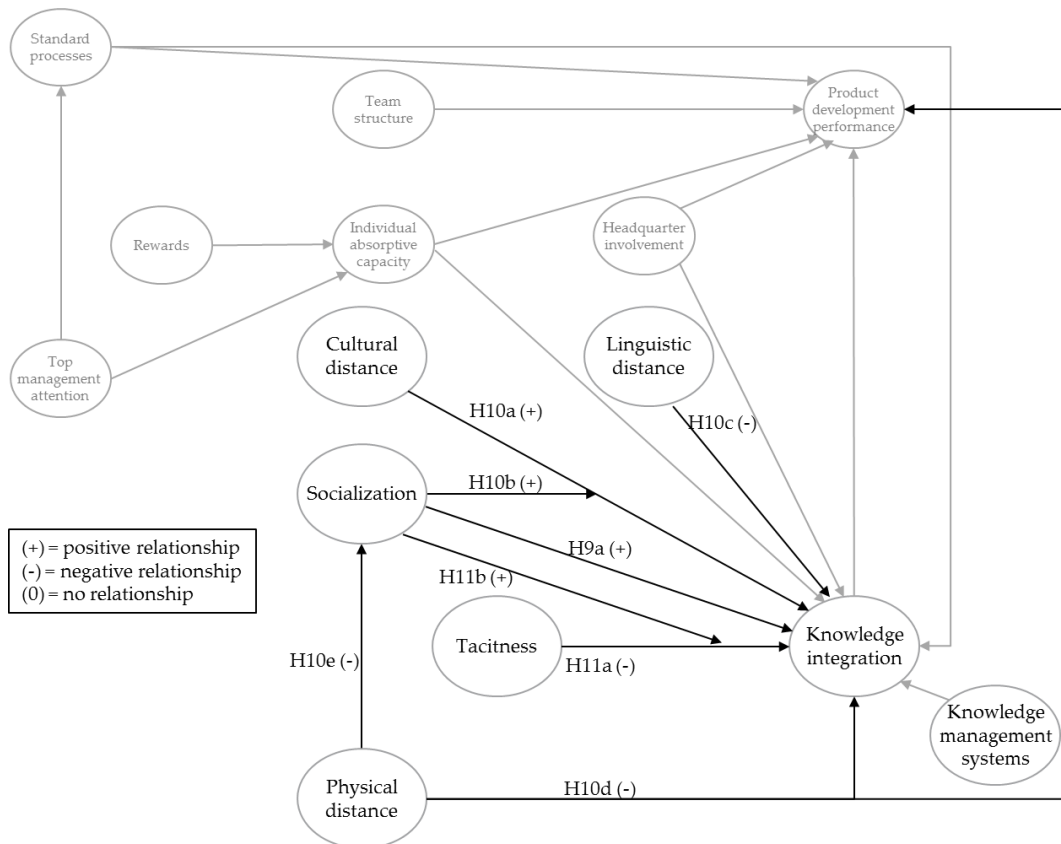
Figure 18: Overview of hypotheses related to distance and tacitness

Industry velocity is neither discussed broadly as a context factor by KGA scholars nor is it considered widely in the reviewed literature sample. Authors studying high-tech industries, however, characterize these markets as "dynamic environments, where strategic planning has to be added by some kind of improvisation, [and] knowledge dissemination leads to a high quality of improvisation" (van der Bij et al. 2003, p.163). They emphasize the internal dynamics of product development teams which have to be supported in order to meet the demand of the constantly changing market environment (Song et al. 2005; Sarin & O'Connor 2009). In such an environment, standardized processes and formalized structures can hamper the required flexibility. Knowledge integration has a higher impact on product development performance in these environments which require frequent creation and adaptation of new knowledge. In consequence, governance mechanisms directed at enhancing knowledge

integration are more relevant than in mature industries. The following set of hypotheses is derived:

H12a: Knowledge integration is more strongly associated with product development performance in high-velocity markets than in moderate-velocity markets.

H12b: Governance mechanisms targeted at knowledge integration either directly or indirectly (i.e., socialization, KMS, rewards and top management attention) are more strongly associated with knowledge integration in high-velocity markets than in moderate-velocity markets.

Having established a theoretically and empirically grounded research model, this dissertation now turns to describing the methodology applied in order to test this model's hypotheses.

4 RESEARCH METHODOLOGY

4.1 EPISTEMOLOGICAL AND METHODOLOGICAL BASIS

Researchers' assumptions regarding the nature of the social world impact the choice of method with which they investigate it (Morgan & Smircich 1980; Guba & Lincoln 1994). These assumptions relate to the epistemological belief and methodological approach how to investigate knowledge (Burrell & Morgan 1979). The major paradigms relating to these assumptions are the positivist, post-positivist and contructivist paradigms (Guba & Lincoln 1994; Ponterotto 2005).[40]

Epistemologically, this research pursues the post-positivist paradigm which accepts "knowledge as nonfalsified hypotheses that can be regarded as probable facts or laws" (Guba & Lincoln 1994, p.113). Three key features of post-positivism, whose key proponents include Carnal, Nagel, Hempel and Popper, are (1) *logicism*, seeking to confirm theory using deductive logic, (2) *empirical verificationalism*, where only statements that are empirically verifiable or falsifiable, or true by definition, are accepted, and (3) *the Human theory of causation*, that is the belief that causal relationships can be established by discovering temporal relationships between observed events (Smith 1996, p.15). Following this paradigm, this dissertation's research questions can be answered by empirical hypothesis testing using methodologies which are valid, reliable and objective (Guba & Lincoln 1994, p.114).

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[40] A comprehensive discussion of these paradigms goes beyond the scope of this dissertation. Guba & Lincoln (1994), Creswell (2003, chap.1) and Ponterotto (2005) provide overviews of the foundations and implications of different paradigms.

While some researchers treat epistemology and methodology as synonymous (Howe & Eisenhart 1990), this dissertation follows Johnson & Onwuegbuzie (2004, p.15) who state that "the logic of justification (an important aspect of epistemology) does not dictate what specific data collection and data analytical methods researchers must use". Following the reasoning of Howe (1992; 1988), they note that

> "Taking a non-purist or compatibilist or mixed position allows researchers to mix and match design components that offer the best chance of answering their specific research questions. Although many research procedures or methods typically have been linked to certain paradigms, this linkage between research paradigm and research methods is neither sacrosanct nor necessary." (Johnson & Onwuegbuzie 2004, p.15)

Purist post-positivist research relies on large-scale, quantitative methodologies which, according to Wolf & Rosenberg (2012), widen the gap between rigorous and practically relevant management research. In order to provide practically applicable recommendations, this research thus combines a post-positivist epistemology with a pragmatist research methodology.[41] The methodological standpoint of pragmatism overcomes the purist quantitative methodology postpositivts subscribe to. Pragmatism is concerned with finding a practical methodology to answer real-world questions, offering a problem-centered, pluralistic methodology and providing researchers with freedom of choice regarding their selection of tools, instruments, and methods (Creswell 2003, chap.1). It is suited to develop possibilities of action and organize future observations and experiences (Dewey 1931). While purist pursuers of

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[41] The pragmatist epistemology goes back to the American philosophers William James, Charles Sanders Peirce and John Dewey. It regards knowledge as experimental and seeks to construct "a web of belief that enables us to organize our experiences" (Smith 1996, p.24), without believing in certainty. The pragmatic epistemology is not applicable to this research which looks for generalizable patterns to make recommendations for action. Cf. Aune (1970) and Diggins (1994) for a more detailed discussion of the pragmatist philosophy.

postpositivism exclusively subscribe to quantitative research methodologies, pragmatism opens the floor for researchers to mix and match those methodologies that apply best to answer their research questions. *Mixed methods research* is a methodology which supports the pragmatist view (Tashakkori & Teddlie 2003; Johnson & Onwuegbuzie 2004): In line with the principles of pragmatism, it draws on many ideas and uses diverse approaches, valuing both objective and subjective knowledge (Cherryholmes 1992; Creswell 2003). Pragmatic mixed-methods allow mixing qualitative and quantitative approaches and thus combining the most suitable instruments for the specific research context.

4.2   EMBEDDED MIXED METHODS RESEARCH DESIGN

Testing the hypotheses outlined in chapter 3 requires quantitative research in order to evaluate the strength and significance of the associations between the identified variables. Quantitative research offers rigor and structure, and promises generalizable findings on cause-and-effect relationships whereas qualitative research focuses on the interpretation of verbal material (Bortz & Döring 2009, pp.298–302). Developing a quantitative research tool requires a thorough understanding of the research object which consists, in the case of this research, of global product development teams deployed by German-based MNCs in the B2B market. Before collecting data for quantitative analysis, qualitative research is viable to understand the nature and characteristics of this specific population. Qualitative research can furthermore help tailor the quantitative research instrument to the target group and make it understandable and applicable for respondents (Creswell 2003). A mix of qualitative and quantitative research thus applies to achieve the research objectives of this dissertation.

The need to combine qualitative and quantitative research methods has been discussed since the 1970s (Campbell 1974; Cronbach 1975; Denzin 1978), and

has been applied since the 1980s in the fields of sociology, evaluation, education and management. It became popular as *mixed methods* in the 1990s (Creswell & Plano Clark 2011, p.20).[42] *Mixed methods* has become an accepted research philosophy, methodology and design approach for studies which include at least one qualitative and one quantitative research strand (Creswell & Plano Clark 2011, p.3; Punch 2013, p.11), where a *strand* includes asking a question, collecting and analyzing data, and interpreting the results (Teddlie & Tashakkori 2009).

Out of the various prototypes for mixed methods studies[43], the *embedded design*[44] approach suits the qualitative and quantitative research objectives this dissertation best:

> "The embedded design is a mixed methods approach where the researcher combines the collection and analysis of both quantitative and qualitative data within a traditional quantitative research design or qualitative research design. The collection and analysis of the second data set may occur before, during and/or after the implementation of the data collection and analysis procedures traditionally associated with the larger [principal] design." (Creswell & Plano Clark 2011, pp.90–91)

In this mixed methods approach, the purpose of including a qualitative strand is tied to but different from the purpose of the quantitative strand, which distinguishes the embedded design from the convergent design that uses both methods to answer the same question (Creswell & Plano Clark 2011, chap.3).[45]

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[42] Cf. Creswell & Plano Clark (2011, p. 19-52) for a more detailed overview of the history of mixed methods research.

[43] Cf. Creswell & Plano Clark (2011) and Hanson et al. (2005) for an overview of different prototypes of mixed methods research design.

[44] The terms *embedded design* and *nested design* are sometimes used synonymously (Hanson et al. 2005).

[45] Mixed methods scholars use the notation *"qual → QUAN"* to describe this approach, where "qual" stands for qualitative and "quan" stands for quantitative. The arrow characterizes the sequential nature of the approach, starting with qualitative research and proceeding to quantitative research, and the capitalization of QUAN refers to the dominant status of quantitative review (Johnson & Onwuegbuzie 2004; Creswell & Plano Clark 2011).

This dissertation adds a qualitative research strand *before* the quantitative strand to improve the quality of the latter. Thereby, this dissertation applies the embedded instrument development and validation variant (Plano Clark & Galt 2009) of embedded mixed methods design, using qualitative research as a *pre-study* in order to

(1) strengthen the understanding of the context

(2) validate the assumptions that shall be tested quantitatively

(3) develop a suitable instrument for the quantitative analysis

The mixed methods approach has not been applied in the sample of articles related to knowledge governance discussed in section 3.2. It has however been applied to support in-depth studies of knowledge-intense processes in other dissertations (Marzec 2013; Moosdorf 2008) and gains popularity in knowledge and information systems research (Venkatesh et al. 2013). The remainder of this chapter introduces the appropriate research instruments and analysis procedures for qualitative (section 4.2) and quantitative (section 4.3) research which are operationalized in the subsequent chapters.

4.3   METHODOLOGY OF THE QUALITATIVE PRE-STUDY

4.3.1   Expert interviews as a qualitative data gathering instrument

In order to meet the objectives of this dissertation's qualitative research strand as outlined above, this dissertation uses a collective, instrumental case study design, where several cases[46] are examined to understand a phenomenon or refine a theory (Berg & Lune 2004, p.325; Punch 2013, p.121). That is, in the context of this dissertation, the phenomenon of German-based MNCs in the B2B sector) and the theoretic approach f the KGA. Yin (1981) identifies case studies as an applicable research strategy in research situations where the boundaries

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[46] A case is defined as a phenomenon occurring in a bounded context (Miles et al. 2013).

between a phenomenon and its context are not clearly evident. This applies to this dissertation because much of the empiric evidence regarding knowledge governance is from a Non-German context, as explored in section 3.2.1.

More specifically, this dissertation uses *expert interviews* with practitioners from German-based MNCs in the B2B sector as a qualitative case study instrument (Berg & Lune 2004; Yin 2014). *Interviews* are a broadly accepted form of collecting case evidence (Yin 1981, p.111; Punch 2013, pp.144–153). *Expert interviews* are a type of interview in which "the investigator is willing, and often eager, to let the interviewee teach him what the problem, the question, the situation is" (Dexter 1970, p.3).[47] The *expert* status of the interviewee can derive from the interviewee's technical or experiential expertise which provides him or her with knowledge that is not broadly accessible (Meuser & Nagel 1991; Meuser & Nagel 1997). The context knowledge of the experts is of key relevance for the choice of this research instrument (Pfadenhauer 2009, p.452) and is the key reason why expert interviews are selected as a qualitative research instrument for this dissertation.

Expert interviews have gained popularity as qualitative research instrument since the early 1990s (Meuser & Nagel 2009, p.35; Pfadenhauer 2009, p.450). Originally criticized as not being clearly methodologically founded, a significant amount of research has been geared at structuring and systematizing expert interview as an approved instrument which can be analyzed via *qualitative content analysis* (Bogner & Menz 2001; Meuser & Nagel 2009; Gläser & Laudel 2010). This dissertation uses *systematizing expert interviews* to gather objective facts

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[47] Dexter's (1970) definition relates to "elite interviews" which have been subsequently been discussed synonymously to expert interviews (cf. Meuser & Nagel 1991).

about knowledge governance based on the experts' practical experience with global product development teams deployed by German-based MNCs.[48]

Implementation process. Once the research objective has been identified, the implementation of systematizing expert interviews follows a six-step process which is outlined subsequently (Bassey 2007, p.149; Bortz & Döring 2009, p.308):

1. Identification of the sample
2. Development of an interview guideline
3. Preparing and conducting the interviews
4. Recording the interview
5. Qualitative data analysis
6. Interpretation

Identification of the sample. Managers in elevated or specialized functions are a common type of expert in management science (Bogner & Menz 2001; Trinczek 2009). As the objective of expert interviews is to gather a thorough understanding of practically applied governance mechanisms for global product development teams deployed by German-based MNCs in the B2B sector, managers with product development expertise from this group of companies are the sampling population for this research strand. These managers need not specifically be top executives: Gläser & Laudel (2010) suggests interviewing hierarchically lower people if they possess the required information because they may be more available for interviews. Leitner & Wroblewski (2009, p.269) agree that expert status is based on function and can include decision makers as well as executors without decision making competency. The guiding criterion for the selection of experts with *relevant and precise information* is thus the functional involvement and

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[48] Bogner & Menz (2001) identify three types of expert interviews: (1) The *explorative* expert interview provides a first overview of a new or complex research field, (2) the *systematizing* expert interview aims to gather objective facts about certain issues, (3) the *theory generating* expert interviews support the generation of new theories derived from the decision making maxims of the interviewed experts. See also Meuser & Nagel 1991).

personal experience with the research topic. Four questions need to be answered to identify the sample of expert interviewees (Gläser & Laudel (2010, p.117):

- Who has the relevant information?
- Who is most likely able to provide precise information?
- Who is most likely ready to provide information?
- Who of these informants is available?

Given these theoretical considerations, theoretical or *purposive* sampling is appropriate because it maximizes the researchers' opportunities to discover variations and densify categories in the population (Yin 2003). Purposive sampling provides a sample that covers a wide range of insights (e.g. from respondents in different industries) rather than meet statistical criteria (Malhotra & Birks 2006, p.364).[49]

When determining the sample size, it is important to note that this dissertation's qualitative research strand pursues a rather exploratory approach while the quantitative research strand aims to derive generalizable findings. Therefore, broadness is more relevant than generalizability for the qualitative study, and it is preferable to study a few cases thoroughly rather than cover many cases with little depth (Dubois & Gadde 2002). The number of cases is accordingly influenced by the scope of differences expected in the population rather than by statistical considerations, and is ultimately an individual decision of the researcher (Yin 2003). This research follows the approach of *saturating data* where data is gathered until additional interviews do not alter the themes in the categories that shall be explored (Morse 1995; Morse 1995; Guest et al. 2006).

Interview guidelines. Systematizing expert interviews typically follow an interview guideline with open questions (Meuser & Nagel 1991; Bogner & Menz 2001) designed to identify facts rather than confirm the researchers' assumptions

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[49] This sampling approach has been previously applied in studying knowledge management via expert interviews (Pillania 2007).

or follow subjective theories of the interviewee (Gläser & Laudel 2010). In order for the interview guidelines to consider theoretical research implications and simultaneously allow for openness and flexibility, the interview guideline asks open rather than closed questions and keeps the level of detail of the questions low (Liebold & Trinczek 2009). For this dissertation, a semi-structured interview approach is chosen: It uses guiding questions to structure the interview and leaves scope for the participants to provide further explanations and contribute additional aspects (Bradfield & Gao 2007).

Preparing and conducting the interview. Expert interviews can be conducted face-to-face or via telephone. Face-to-face interviews give the interviewer greater control over the interview, enable the interviewer to build a relationship with the expert and typically provide more (e.g., visual) context information whereas telephone interviews provide greater flexibility regarding the timing and duration of the call (Gläser & Laudel 2010; Christmann 2009). The interviews should start with explanations of the research context and the scientific objectives of the interview (Liebold & Trinczek 2009) and allow time to understand the interviewee's context which might have implications for the interpretation of results.

Recording the interview. To holistically capture all information and control for subjective interviewer interpretation, any interview must be recorded (Liebold & Trinczek 2009) with prior consent of the interviewee. To systematically analyze the gathered data, recorded expert interviews are transcribed.[50]

The subsequent *analysis and interpretation* of the information requires the selection of an applicable qualitative analysis procedure.

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[50] Transcripts of expert interviews do not require details such as tone and pauses as in sociological or psychological interviews but need to provide all information required for the subsequent interpretation (Liebold & Trinczek 2009).

4.3.2   Qualitative content analysis as a qualitative analysis procedure

Content analysis is a research technique that compresses texts into fewer content categories following rules of coding (Berelson 1952; Krippendorff 1980; Weber 1990; Graneheim & Lundman 2004) in order to examine large amounts of (textual) data systematically and thus to understand contexts (Krippendorff 1989). These objectives meet the goals of this dissertation's qualitative research and render content analysis applicable for this study (Mayring 2004). Content analysis is applicable as a systematic approach to analyze the content of expert interviews in a post-positivist research epistemology because it

> "assures not only that all units of analysis receive equal treatment, whether they are entered at the beginning or at the end of an analysis but also that the process is objective in that it does not matter who performs the analysis when and where."
> (Krippendorff 1989, p.404)

Researchers distinguish quantitative and qualitative content analysis (Mayring 2004). Quantitative content analysis is mostly occupied with word counts to identify focus topics and categorize data. Qualitative content analysis has emerged based on the critique that quantitative content analysis oversimplifies and thus reduces the accuracy of analysis, using distorting quantification rather than thorough qualitative interpretation (Kracauer 1952).[51] (Mayring 2004; Hsieh & Shannon 2005). Mayring (2004) defines qualitative content analysis as

> "an approach of empirical, methodological controlled analysis of texts within their context of communication, following content analytical rules and step by step models, without rash quantification." Mayring (2004, p.266)

Qualitative content analysis seeks to preserve the advantages of quantitative content analysis by following clear rules and categories for analysis, and applying criteria for reliability and validity. Compared to quantitative content analysis, it pays more attention to the content or contextual meaning of the text

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[51] Cf. Mayring (2004) for a comprehensive overview of the history of qualitative content analysis.

Hsieh & Shannon (2005) distinguish conventional[52], directed[53] and summative[54] content analysis. *Directed content analysis* is applicable when "theory or prior research exists about a phenomenon that is incomplete or would benefit from further description" (Hsieh & Shannon 2005, p.1281). This applies to this research where the qualitative analysis strand builds on theoretical considerations and existing research in the field of knowledge governance (see chapter 3), and seeks to conceptually extend this knowledge in the new context of German-based MNCs in the B2B sector.

Directed content analysis follows a structured process starting with key concepts derived from theory as initial coding categories (Hickey & Kipping 1996). These *a priori codes* are revised and reduced up to the point of maximum mutual exclusivity and exhaustiveness (Weber 1990). This approach has implications for the interviewing technique: Open ended questions might be followed by targeted questions about the categories determined a priori (Hsieh & Shannon 2005), in line with the previously outlined approach of semi-structured interviews. In the operationalization of this technique, particular care is required to avoid bias by a priori coding and guiding the interviewee to provide answers which match the researchers' upfront coding structure.

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[52] Synonyms used for conventional content analysis are *inductive category development* Mayring (2004) and *inductive content analysis* (Elo & Kyngäs 2008). Conventional content analysis avoids preconceived categories but derives categories from the data (Kondracki et al. 2002) and is applicable to describe phenomena which have not been thoroughly conceptualized by theory (Hsieh & Shannon 2005).

[53] Synonymous used for directed content analysis are *deductive category application* (Mayring 2004) ad *deductive content analysis* (Elo & Kyngäs 2008))

[54] A summative approach starts out with quantitative content analysis to count pre-determined words and continues to identify contexts in which these words are used, and how they are used (Hsieh & Shannon 2005)

The transcribed recordings of the interviews form the basis of the directed qualitative content analysis. The interview paraphrases are categorized in the pre-defined categories or, if none of the a priori categories matches, the categories are revised until all paraphrases are categorized (Elo & Kyngäs 2008). The resulting findings either support or discount previous theory. Dubois & Gadde (2002) suggest *systematic combining* as an interpretation technique, where case study findings are systematically reviewed against previous theory, the research framework and related findings from the empiric world. The researcher aims to match theory and reality, and redirects his research framework to dissolve potential contradictions between theory and the case findings. In the case of this dissertation, this relates to a confirmation, alteration or rejection of the variables and hypotheses contained in the research model. The findings are then presented "in such a comprehensive manner as to enable the reader to feel as if they had been an active participant in the research and can determine whether or not the research findings [are valid]" (Baxter & Jack 2008, p.555) while simultaneously ensuring that only that part of interview information is provided which contributes to answering the research questions (Baxter & Jack 2008; Yin 2003). Evidence for the interpretation of the results is provided by showing codes and related examples, and providing descriptive evidence (Elo & Kyngäs 2008; Graneheim & Lundman 2004; Elo & Kyngäs 2008).

A number of techniques exists to evaluate the *reliability* and *validity* of the findings of qualitative content analysis (Graneheim & Lundman 2004; Mayring 2010, pp.116–125) which apply to this research.[55]

Reliability can be established by *intercoder-reliability*.[56] It is established when coding by different people leads to the same results. Cohen's Kappa (Cohen 1960)

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[55] These techniques are commonly used to assess qualitative research; for comprehensive overviews of assessments of trustworthiness in qualitative research cf. Krefting (1991) and Morse et al. (2008) and, in the context of case study research Yin (2003).

is a widely applied coefficient to assess the extent to which two researchers agree on codes using the formula

$$K = \frac{P_A - P_C}{1 - P_C}$$

where P_A equals the proportion of units on which the raters agree and P_C represents the proportion of units for which agreement is expected by chance. Values above 0.6 are considered reliable (Dorussen et al. 2005; Burla et al. 2008).

Validity refers to the generalizability of the results and is assessed via external verification, prediction validity and construct validity (Mayring 2010, pp.116–125):

- *Construct validity* is given when the results are checked for plausibility against proven theories, as presented in section 3.1.
- *External verification* is performed by comparing the results with external research results (e.g., previous research as identified in the literature review provided in section 3.2).
- *Prediction validity* is given if the prognoses based on the results of the qualitative analysis are tested successfully. This can be tested ex-post based on the results of the quantitative study.

These tests are collectively applied to assess the results of the qualitative pre-study in chapter 5. Having interpreted and validated the findings of the qualitative pre-study, they are used to refine the research model and operationalize the subsequent quantitative study.

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[56] Two other reliability tests suggested by Mayring (2010) are not applicable to this study. These include re-testing the same data with a different methodology and split-half tests verifying that two halves of analyzed material lead to the same results if analyzed individually. These to tests are not applicable due to the applied research approach of saturating data. This approach, by design, prevents all interviews from revealing similar data because the scope of analysis shifts from one interview to the next depending on the extent of data saturation.

4.4   METHODOLOGY OF THE QUANTITATIVE PRINCIPAL STUDY

4.4.1   Online survey as a quantitative data gathering instrument

While the qualitative research strand seeks to assess whether the theoretically identified governance mechanisms are applied in practice, the quantitative research strand constitutes the principal research strand to test the hypotheses related to these governance mechanisms.

Written survey. The objective of the quantitative research for this dissertation is to test theories on cause-and-effect relationships derived from theory and a qualitative exploratory study. The instrument of standardized written surveys is widely accepted as the most suitable and most applied instrument to achieve this objective in social sciences such as management research (Buckingham & Saunders 2004; Töpfer 2010, p.236). In comparison to personal or telephone-based surveys, written surveys provide a number of advantages that are relevant to meet the objectives of the suggested quantitative research: Firstly, interviewer effects, typically a source of measurement error, do not arise (Bortz & Döring 2009, p.246). Secondly, respondents can reflect on the questions as long as necessary and even use additional material (Aaker & Day 1980, p.135). Furthermore, the survey instrument provides respondents with higher flexibility as to when and where to answer the survey. This can increase motivation and response rates (Schumann 2006, pp.129–130). Similarly, a written survey is more cost efficient than other primary research methods that require a large number of responses to allow for generalizations (Snow & Thomas 1994).

Online operationalization. Mail and online surveys are the two common options for written surveys. While online surveys offer the advantage to get responses quickly at low cost, they are not appropriate for every research project. Online surveys are an applicable medium when the sample size is fairly large and geographically distributed, when the target group has access to the internet, and

when electronic features (e.g., interactive elements) enhance the survey experience for the respondents (Sue & Ritter 2007, pp.5–6). These three criteria fully apply to the suggested survey on international product development teams. The most critically discussed characteristic of online surveys is the risk of coverage errors deriving from the target group's access to and familiarity with the internet (Dillman et al. 2009, p.43). This aspect is not relevant when surveying managers of international product development projects who nowadays frequently use emails to communicate with their globally dispersed teams.

Implementation process. After having identified the research objective, the operationalization of an online survey requires a six-step process (Bortz & Döring 2009, pp.252–262):

1. Identification of the sample
2. Development of the online questionnaire
3. Pre-testing and optimization
4. Survey launch and data collection
5. Quantitative data analysis
6. Interpretation

Identification of the sample. In order to tailor the survey to the target group, the implementation process starts by identifying the unit of analysis and target population for the questionnaire and identifying an approach to sample a subgroup of this population. As the total target population (individuals experienced of global product development teams in the group of target companies) is not known, non-probability sampling is permissible including snowball sampling are admissible to access as many potential respondents as possible (Biernacki & Waldorf 1981; Malhotra & Birks 2006, pp.364–365; Babbie 2012, p.192).

Developing of the online questionnaire. The questionnaire must be designed with utmost care to **avoid common method bias**, one of the greatest risks for measurement errors in self-administered surveys (Podsakoff & Organ 1986;

Meade et al. 2007). The four main groups of potential sources for common method bias are (1) item characteristic effects, (2) item context effects, (3) measurement context effects and (4) common rater effects (Podsakoff et al. 2003; Spector 2006). *Item characteristic effects* and *item context effects* refer to biases induced by the influence of item properties (positive or negative connotations) or item context (e.g. printing, embeddedness with other items), and can be controlled for in the survey design by using neutral wording, formatting and a survey structure that does not clearly link the causes and effects the researcher seeks to understand (Posdakoff & Organ 2003; Dillman et al. 2009). *Measurement context effects* can hardly be controlled in an self-administered online survey, however the self-administered survey design diminishes risk for respondents to reply in a social desirable way compared to a personal interview (Podsakoff et al. 2003). Thus, the largest remaining risk derives from *common rater effects* including respondents' tendency to provide consistent answers (consistency motif), respondents' believes that some questions should be answered in a certain way in order to meet expectations (implicit theories and social desirability), leniency bias, and acquiescence bias. For this dissertation's survey, this means that respondents rating the performance of product development projects they were involved in tend to overinflate performance as they perceive that their personal status is closely linked with this performance. The only alternative to circumvent common rater bias is to obtain measures of the exogenous and endogenous variables from different sources (Podsakoff & Organ 2003). Gathering data from multiple sources would significantly increase the complexity of the survey and risk low response rates, however.[57] This dissertation's survey design accepts the risk of common rater bias and seeks to minimize it via survey design (e.g., by protecting respondent anonymity and creating proximal distance between the endogenous

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[57] In a survey setting comparable to this dissertation, Von Deylen (2010, p. 121) asked respondents to provide email addresses of colleagues who are capable of evaluating the respondents' projects' performance. This information was provided by less than 11% of respondents, indicating the low success rate of using secondary sources in primary management research.

and exogenous variables: (Podsakoff et al. 2003; Lindell & Whitney 2001) and to control for it statistically post-hoc.

Pre-testing is applied to identify potential issues with the wording, question order, visual design, and/or navigation of the survey instrument (Dillman et al. 2009, pp.219–230), and is success critical to assess how well a questionnaire performs under actual data collection conditions (Sudman & Bradburn 1982, pp.282–285; Churchill Jr 1999, pp.364–366; Collins 2003). Following the feedback of initial pre-testers, the questionnaire is modified and re-tested by a second group of pre-testers ("think-aloud" pre-testing method; see Collins 2003).

The *survey launch* must be designed in a way that supports high participation rates. *Tailored survey design* is an approach to achieving this objective by viewing surveys as a means of social exchange in which survey participants need to perceive *rewards. Participation costs* should be low and *trust* must be established (Dillman et al. 2009, pp.23–40). This advice is incorporated in the launch of this dissertation's survey.

The *quantitative data analysis and interpretation* involves descriptive statistics to describe the characteristics of the sample and requires an applicable statistical method to analyze and interpret the data. Applicable techniques are explored in the subsequent section.

4.4.2   Partial-least-squares structural equation modeling as a quantitative analysis procedure

4.4.2.1   *First generation versus second generations techniques for multivariate data analysis*

This dissertation's quantitative strand seeks to test hypotheses based on a set of empirically collected data (Shaffer 1995; Dixon & Woolner 2007). Various statistical approaches exist to test causality based on empirically gathered data.

This dissertation's literature review reveals multivariate regression analysis as the most common approach for empiric studies of knowledge governance. This approach is part of the first generation of multivariate methods aiming to analyze the impact of more than two variables (Fornell 1982; Sheth 1971). A key weakness of the first generation of multivariate methods is that they require observable variables which can be gathered and measured by real-world sampling experiments (Hair et al. 2014, p.3). As previously outlined, not all variables in this dissertation's research model are directly observable: Product development performance, the main endogenous variable in the research model, can not be directly observed, but can be measured via several manifest variables (Ciabuschi et al. 2010, p.480).[58] Unobservable variables constitute *constructs* or *latent variables* whose values can be approximately measured by multiple manifest variables, called items or indicators (Hair et al. 2010).

Another limitation of the first generation of multivariate methods is their assumption that variables can be measured without measurement error. Measurement errors cannot be avoided in reality. Leading first generation methods such as OLS regression assume that only the dependent variable is subject to measurement errors while the independent variables are believed to be fixed by the researcher at definite values – an assumption that does not hold true for most experiments (Haenlein & Kaplan 2004, p.284; Jairo 2008, p.16).

A second generation of multivariate methods evolved in the 1970s to resolve the limitations of the first generation techniques and allow for more complex model structures (Fornell 1982). Second generation methods allow to combine primarily confirmatory methods such as path analysis (e.g., based on regression analyses) to test the relationship between constructs with primarily exploratory methods such as factor analysis to measure constructs and their validity (Fornell 1987). Structural equation modeling (SEM) evolved as a leading

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[58] Cf. section 2.1.2.

second generation research technique for measuring causal relationships between constructs (Bollen & Lennox 1991; Hair et al. 2010, chap.12; Schumacker & Lomax 2010, chap.1): It includes

> "a number of statistical methodologies meant to estimate a network of causal relationships, defined according to a theoretical model, linking two or more latent complex concepts, each measured through a number of observable indicators" (Vinzi, Trinchera, et al. 2010, pp.47–48)

and explicitly models measurement error (Chin 1998b; Haenlein & Kaplan 2004).

With the increasing availability of user-friendly software packages to perform SEM, this powerful statistical technique has turned "one of the most popular statistical methodologies available to quantitative social scientists" (Kaplan 2000, p.6), applied broadly in economic and managerial research (Kaplan 2000; Kaplan 2000; Henseler et al. 2009; Vinzi, Chin, et al. 2010; Hair, Sarstedt, et al. 2011; Ringle et al. 2012). SEM is discussed as an applicable research method in international business studies (Hult et al. 2006), also in the context of knowledge governance mechanisms. Based on its power to deal with latent variables, SEM is selected as the most applicable statistical method to test this dissertation's research model.

4.4.2.2   *Basics of structural equation modeling*

SEM contains two types of models: (a) *measurement models* and (b) *a structural model* (Tenenhaus et al. 2005, p.161; Henseler et al. 2009).

Measurement models (outer models) make constructs measurable via observable indicators and measure how well constructs are captured by these indicators. A measurement model exists for each construct to display the relationship between a construct and its indicators. Two alternatives for the measurement of constructs exist, depending on the direction of causality between the indicators and the construct (Diamantopoulos et al. 2008; Chin 1998a):

- In *reflective measurement models*, the indicators observed to measure a construct are affected by the same underlying concept and the direction of causality leads from the construct to the indicators
- *Formative measurement models* assume that the indicators form or cause the construct and the direction of causality leads from the indicators to the construct

Constructs are not inherently reflective or formative. The measurement approach depends on their conceptualization and the objectives of the study (Hair et al. 2014, p.45)[59] and must follow theoretical considerations (Diamantopoulos & Siguaw 2006; Bollen 2007). Both types of operationalization can coexist in an SEM for different constructs. SEM scholars warn researchers to carefully choose the right measurement perspective (i.e., formative vs reflective) as misspecification may cause measurement errors and lead to wrong conclusions (Bollen & Lennox 1991; Edwards & Bagozzi 2000; Jarvis et al. 2003; Diamantopoulos & Siguaw 2006).

Reflective measurement is applicable when there is causality from the construct to the indicators, and the construct is a trait explaining the indicators rather than a combination of the indicators (Diamantopoulos & Winklhofer 2001; Fornell & Bookstein 1982). Indicators of reflective measurement models are typically similar in content and thus correlate (Chin 1998a; Jarvis et al. 2003). Formative constructs are characterized by causality from the indicators to the construct, which is a combination of its indicators that have to neither correlate nor be similar in content (Fornell & Bookstein 1982; Chin 1998a; Diamantopoulos & Winklhofer 2001; Jarvis et al. 2003). Measurement mistakes occur on indicator level in reflective measurement models and on construct level for formative

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[59] Albers (2010) provides a simple example for measuring the construct "hotel satisfaction" either reflectively by indicators such as "I appreciate this hotel", "I am looking forward to staying in this hotel", "I recommend this hotel to others", or by formatively by indicators such as "The service is good", "The personnel is friendly", "The rooms are clean".

measurement models (Ringle 2004). Table 7 summarizes the differentiation criteria to specify the measurement approach.

Criterion	Reflective measurement	Formative measurement	Source
Direction of causal priority	From the construct to the indicators	From the indicators to the construct	Diamantopoulos & Winklhofer (2001)
Explanatory power	Construct is a trait explaining the indicators	Construct is a combination of the indicators	Fornell & Bookstein (1982)
Indicator correlation	Prerequisite	Undesirable (multicollinearity)	Chin (1998a)
Indicator interchangeability	Desirable	Not required	Jarvis et al. (2003)
Occurance of potential measurement mistakes	On indicator level	On construct level	Ringle (2004)

Table 7: Guidelines for choosing the measurement model model
Source: Author, based on Hair et al. (2014, p.47) and Naskrent (2010, p.96)

Figure 19 depicts the two alternative modeling approaches where ξ represents a construct, λ represents the paths between a reflective construct and its indicators x and π represents the paths between a formative construct and its indicators x. The arrows represent the direction of causality between the construct and the indicators. δ represents the measurement error terms associated with the measurement models (Haenlein & Kaplan 2004; Götz & Liehr-Gobbers 2004).
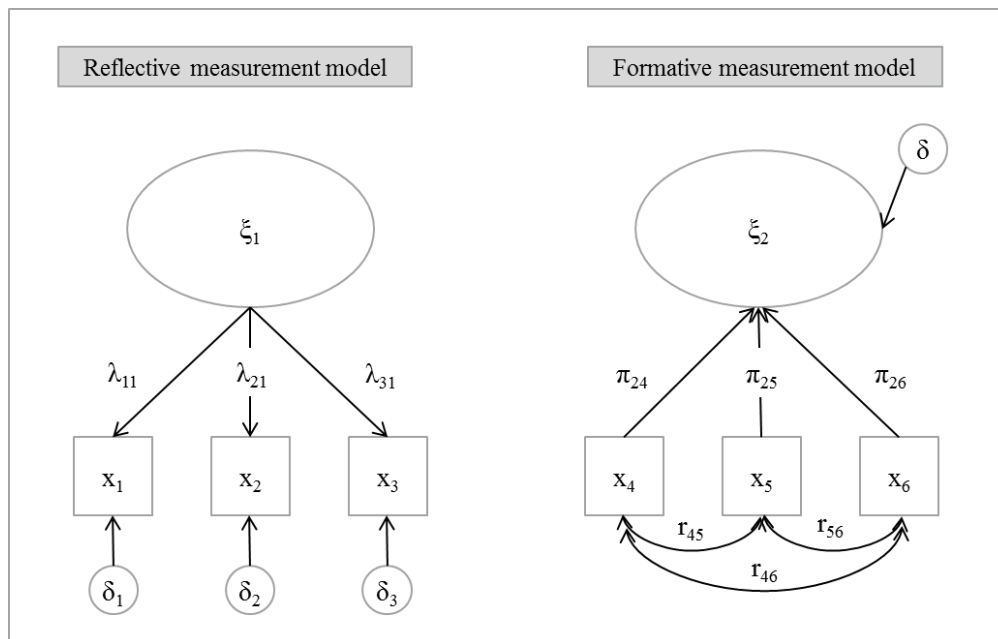
Figure 19: Reflective vs. formative measurement models
Source: Adapted from Götz et al. (2010, p.694)

Some structural equation models furthermore contain *second order constructs* which are more abstract than first order constructs. Second order constructs are not measured by directly observable indicators but by first order constructs. The relationship between first and second order constructs can also be formatively or reflectively measured (Jarvis et al. 2003; Diamantopoulos et al. 2008).

The **structural model** (inner model) measures the causal relationships between exogenous (independent) constructs and endogenous (dependent) constructs in a path model. It describes the regression relationships between the endogenous and exogenous constructs.

Figure 20 depicts the common SEM notation for a generic structural model with two exogenous (independent) constructs ξ and one endogenous (dependent) construct η. ζ represents the error term (random disturbance) associated with the endogenous construct (Götz & Liehr-Gobbers 2004; Haenlein & Kaplan 2004). The strength of the path relationship is characterized by the arrow notated γ.
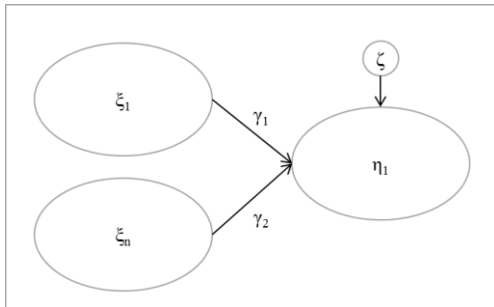
Figure 20: Generic structural model

Subsequent figure 21 shows a generic, complete SEM with the elements introduced in this section.
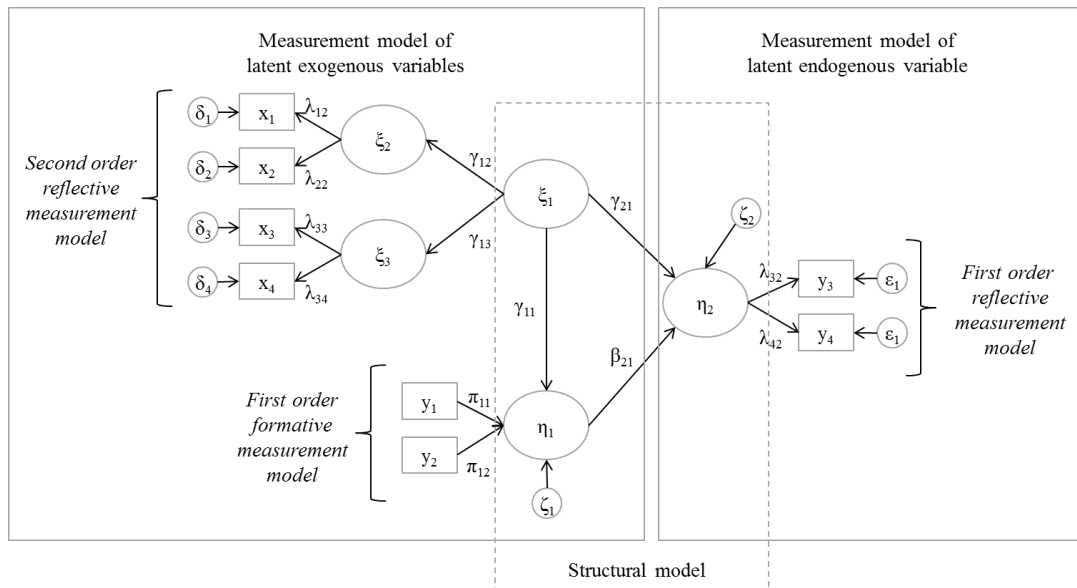
Figure 21: Generic structural equation model
Source: Adapted from Götz & Liehr-Gobbers (2004, p.716)

4.4.2.3   Selection of the applicable SEM approach: CB-SEM vs. PLS-SEM

Two complementary, established approaches exist to estimate structural equation models: Covariance-based approaches (CB-SEM) and variance-based approaches following the partial least squares approach (PLS-SEM).

CB-SEM is attributed to the work of Jöreskog (1970; 1973; 1979) and often associated with software package LISREL.[60] The focus of CB-SEM is to estimate a set of model parameters that minimizes the difference between the theoretical covariance matrix implied by the system of structural equations and the empirically observed covariance matrix (Chin 1998b, p.297; Reinartz et al. 2009, p.332), typically with a maximum likelihood function (Jöreskog & Sörbom 1978). CB-SEM has been criticized for some limitations related to the maximum likelihood function: These include the prerequisite of multivariate normality in the analyzed data, large sample size requirements and difficulties to cope with missing data (Boomsma 1982; Boomsma 1985; Babakus et al. 1987; Savalei 2008).

PLS-SEM is largely attributed the work of Wold (1975; 1980; 1982). Viewed as a "soft modeling approach" (Wold 1980)[61], where "no strong assumptions (with respect to distribution, sample size and measurement scale) are required" (Vinzi, Trinchera, et al. 2010, p.48), PLS-SEM can be used to test or develop theories: The approach is applicable for confirmatory and exploratory research (Hair et al. 2014, p.4). The PLS algorithm "estimates the model parameters to maximize the variance explained for all endogenous constructs in the model through a series of least squares (OLS) regressions" (Reinartz et al. 2009, p.332). Where CB-SEM seeks to minimize residual covariance, PLS-SEM minimizes the residual variance of endogenous variables in the structural model (Chin 1998b) and thus seeks to predict the observable indicators related with a construct using iterative least squares regressions based on canonical correlation analysis (Fornell

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[60] Many authors use LISREL (linear structural relationships; cf. Jöreskog & Sörbom (1978) as a synonym for covariance-based approaches while it is basically the name of a software package used for this technique (cf. Henseler, Ringle, Sinkovics 2009, p. 277). LISREL and AMOS are the most commonly used statistic software packages used for covariance-based structural equation models.

[61] The term "soft" is attributed to sample size and distributional considerations and not to the associated concepts, estimation techniques or evaluation criteria (Lohmöller 1989; Hair et al. 2014).

& Cha 1994, p.62).[62] The iterative procedure of the PLS-SEM algorithm can be described as follows: In the first stage, the construct scores are estimated starting in the first iteration with arbitrary values. In the second stage, the partial regression model is estimated based on these scores: For each formative measurement model, the outer weights are estimated via partial multiple regressions where the construct represents the dependent variable. For reflective measurement models, the outer loadings are estimated via single regressions for each indicator variable on the corresponding construct (Hair et al. 2014, p.77). The inner weight coefficients (i.e., the path coefficients of the structural model) are estimated via a partial regression model for each dependent (endogenous) construct linked to each of its directly preceding construct. [63] These two stages are repeated until an additional iteration cannot further maximize the model fit, i.e. when the variance between the observed indicators or estimated construct scores and the values predicted by the respective measurement or structural model is minimized and the coefficients of determination (R^2) of the endogenous constructs are maximized.

The fact that CB-SEM represented the most common SEM technique in management research until the late 1990s is often justified by the availability of appropriate statistical software packages such as LISREL, AMOS and EQS (Ringle 2004, p.8; Chin 1998b). More recently, the variance-based PLS approach has been increasingly applied by researchers, based on the advancement of applicable software packages (Ringle, Sarstedt, Straub 2012). Although its proponents call

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[62] Lohmöller (1989), Fornell & Cha (1994), Chin (1998b), Chin & Newsted (1999), Haenlein & Kaplan (2004), Henseler et al. (2009), Henseler et al. (2012), Hair et al. (2014, pp.74–83) and others provide concise overviews of the statistical procedures applied which are summarized here in brief.

[63] Cf. Chin (1998b) for a discussion of the alternative weighting schemes available to estimate the inner weights, which have a minor impact on the results obtained. The path weighting scheme, which includes the directionality of the structural model and provides the highest R^2 values (cf. Hair et al. 2014 p.80), is the most popular scheme which is also applied in this dissertation.

PLS-SEM a "silver bullet" (Marcoulides & Saunders 2006; Hair, Ringle, et al. 2011) the technique is also associated with problems: The construct scores estimated by the PLS algorithm are linear combinations of the associated indicator data and consequently prone to measurement error resulting from the empiric data and the specification of the measurement model. This measurement error only disappears if the number of observations and the number of indicators increases to infinity.[64] As long as this is not the case, the measurement error remains and biases the model: The path model relationships are frequently underestimated, whereas the parameters for the measurement models (i.e., the loadings and weights) are typically overestimated (Hair et al. 2014, p.79). This structural *PLS-SEM bias* (Hair, Ringle, et al. 2011; Hair, Sarstedt, et al. 2011) is one of the major drawbacks of PLS-SEM (Chin 1995; Dijkstra 2010).

The right SEM approach must be carefully selected based on methodological considerations and the underlying research philosophy (Ringle 2004; Herrmann et al. 2006). Five aspects have to be taken into consideration (Henseler et al. 2009, p.283; Hair et al. 2014, pp.14–24) and are assessed subsequently:

1. Research philosophy (exploratory vs confirmatory)
2. Considerations of sample size
3. Assumptions about the distribution of variables
4. Ability to handle formative measurement models
5. Complexity of the model
6. Criteria for the evaluation of fit

Theoretical considerations. CB-SEM is suitable for confirmatory purposes, testing the consistency between the theoretical model and the observed data where strong theoretical and empiric evidence exists (Bentler & Chou 1987). In cases where the theory is relatively new, the SEM has not been tested or new

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[64] Cf. Lohmöller (1989) and Haenlein & Kaplan (2004) for this issue refered to as *consistency at large*.

constructs are introduced, the PLS algorithm is more appropriate for obtaining optimal predictions for dependent variables than the maximum likelihood function used in CB-SEM which requires a thorough pre-specification of the model to arrive at significant results (Fornell & Cha 1994, p.26; Henseler et al. 2009, p. 74).

Sample size. CB-SEM requires sample sizes of at least five, ideally ten times the number of all parameters that shall be estimated by the model, and sample sizes should ideally exceed n = 200 in order not to risk non-convergence and improper solutions (Marsh et al. 1998; Boomsma & Hoogland 2001). In PLS-SEM, the rule of thumb to estimate the required sample size for PLS-SEM requires at least ten times the number of indicators applied to measure the most complex construct or ten times the number of exogenous constructs explaining an endogenous construct (the larger of these two values for minimum sample sizes applies) (Henseler et al. 2009, p.292). Consequently, the PLS-SEM allows for models to be estimated with as little as 20 observations for simple models and is commonly preferred as an SEM technique when sample sizes are small (Chin & Newsted 1999; Henseler et al. 2009; Reinartz et al. 2009).[65]

Distributional assumptions. The maximum-likelihood function used in CB-SEM requires a (multi-)normal distribution (Jöreskog 1967) of the observable values, which is unrealistic to be achieved in empirical research (Micceri 1989).[66] PLS-SEM can cope with data that is normally as well as extremely non-normally

[65] Hair et al (2014, p. 18-20) criticize that "small sample size is probably the most often abused argument associated with PLS-SEM", and thus the major reason for general skepticism about SEM: "PLS-SEM—like any statistical technique—requires researchers to consider the sample size against the background of the model and data characteristics" (Hair et al, 2014, p.20). While Chin & Newsted (1999) and Reinartz et al. (2009) confirm that PLS-SEM works well with small sample sizes, Goodhue et al. (2012) find that PLS, like LISREL, suffers from reduced sample size, rendering sample size considerations an insufficient reason to choose one approach over the other.

[66] See Reinartz et al. (2009, p.335) for alternative estimation techniques suggested to deal with this shortcoming of CB-SEM which are not yet broadly implemented.

distributed without strict distribution assumptions (Hair et al. 2014, p.22)[67,68] and copes more easily with missing data (Savalei 2008).

Integration of formative measurement models. Contrary to the frequently misstated argument that CB-SEM "is not able to specify formative measurement models", both CB-SEM and PLS-SEM can cope with formative and reflective measurement models (Hildebrandt & Temme 2006, p.2).[69] The requirements for the operationalization of formative variables in CB-SEM are, however, rather complex (Herrmann et al. 2006, p.43) compared to PLS-SEM which makes PLS-SEM the approach of choice for most researchers seeking to integrate formatively measured constructs into their model (Reinartz et al. 2009, p.333).[70]

Model complexity. Complex models are characterized by a large number of constructs and path relationships, moderating relationships and/or higher order constructs. PLS-SEM has several advantages in this setting: Firstly, the previously discussed approach of modeling moderating effects with an interaction variable can only be applied in variance-based structural equation models (Chin et al. 2003). Secondly, the previously discussed PLS-SEM bias has been proven to be

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[67] Cf. Dijkstra (2010, pp.28–32), p. 28-32, for a mathematical explanation of the PLS approach to multinrmality.

[68] Hair et al (2014, p. 22) point out that in spite of the ability of PLS-SEM to deal with non-normally distributed data, influential outliers and collinearity impact the OLS regressions in PLS-SEM and must be considered by the researcher.

[69] This is related to the strengths and weaknesses of the underlying algorithms applied to estimate the measurement models, i.e. principal components analysis for PLS-SEM as compared to common factor analysis for CB-SEM (Chin 1995). See Babakus et al. (1987) and Brown (2012) for an introduction to common factor analysis and the related challenges for measuring formative constructs in CB-SEM, respectively. See McIntosh et al. (2014) for the recent debate on the two SEM techniques' abilities to deal with common factor models.

[70] Hildebrandt & Temme (2006) assume that the increasing popularity of PLS-SEM in management research in this millennium can be partly attributed to the increasing amount of research criticizing the misspecification of reflective measurement models (cf. Diamantopoulos and Winklhofer 2001; Jarvis et al 2003).

low when the number of constructs, indicators and paths is high and the sample size is low (Reinartz et al. 2009; Ringle et al. 2009). These models are difficult to be adequately specified in CB-SEM due to the considerable amount of theoretical backing for each measurement model and structural relationship which is required to arrive at valid models, and consequently PLS scholars advise PLS-SEM for complex models (Hair, Ringle, et al. 2011).

Availability of evaluation-of-fit criteria. In contrast to PLS-SEM, CB-SEM offers both global and local criteria to evaluate the model fit. PLS-SEM relies on local goodness-of-fit indices which evaluate individual components of the structural equation model, such as the structural model or the measurement model *per se*. CB-SEM makes use of global goodness-of-fit criteria, further underlining its fit for theory testing provided the distributional assumptions are met (Hulland et al. 1996; Henseler et al. 2009; Reinartz et al. 2009; Hair, Ringle, et al. 2011). Although researchers have developed a multitude of local goodness-of-fit criteria applicable to PLS-SEM, the absence of a global goodness-of-fit criterion remains a critique of PLS-SEM (Fuchs 2011).

Based on the aforementioned criteria, PLS-SEM is selected as the most appropriate statistical approach for this dissertation's quantitative research strand. This is based on the following considerations:

- *Theory building (exploratory research):* The hypotheses that shall be tested in this dissertation are based on thorough theoretic considerations and previous empiric findings as discussed in chapter 3. However, the core contributing theory, the KGA, has been described as a "network of connected ideas" rather than a clear-cut theory (Grandori 1997; Prencipe 2006; Foss 2007; Foss & Michailova 2009a) and thus lacks the empiric evidence and strong theoretic foundations required for CB-SEM (Bentler & Chou 1987; Henseler et al. 2009). Although empiric evidence exists regarding the relationship between individual governance mechanisms and product development

performance, no holistic overview of their comparative performance exists, and only few studies have operationalized some of the relevant variables as constructs. The need to newly establish some constructs points to the use of PLS-SEM as an exploratory method. Although the methodological objective of the quantitative research strand is to confirm well-grounded hypotheses rather than to explore new path relationships, PLS-SEM is evaluated as the superior technique for this dissertation.

- *Non-normal distribution:* Due to the limited application of SEM in previous, related research, little empiric evidence exists about the distribution of the individual constructs. PLS-SEM hence is a more precautionary approach due to its higher flexibility regarding data distributions.

- *Formative measurement:* Although the structural equation model to test this research's hypotheses has not yet been specified, the theoretical framework discussed in section 3.3.2 already points towards the necessity to integrate formative constructs: The governance mechanism of socialization has been presented as a construct that can be achieved via various individual mechanisms which do not have to be correlated or similar (e.g., international training, expatriation, previous collaboration). Based on the theoretical discussion regarding the specification of measurement models, a formative measurement model is applicable for this type of construct and can be implemented more straightforwardly in PLS-SEM (Hair, Ringle, et al. 2011).

- *Model complexity.* This dissertation's SEM requires a large number of constructs and contains continuously scaled moderating effects (*H10b* and *H11b*). Both aspects make PLS-SEM the technique of choice.

Based on the previous discussion and criticism of the applicability of PLS-SEM for *small sample sizes*, the sample size criterion is not used for decision-making. The lack of *global goodness-of fit criteria* remains as a concern that cannot be discarded

but appears manageable given the stated advantages of the application of PLS-SEM in the context of this dissertation. However, a key requirement in the post-positive epistemological perspective taken by this dissertation is to assess the validity and reliability of any empirical findings. Therefore, the following section provides an overview of the evaluation criteria applicable to assess the quality of PLS-SEM findings.

4.4.2.4   *Evaluation criteria for PLS-SEM results*

Careful examination of the model fit, the magnitude of the identified relationships and the statistical power are necessary steps in applying PLS-SEM research (Marcoulides & Saunders 2006). A series of criteria to evaluate the fit of the measurement models for reflective and formative constructs and of the structural model are summarized in table 8 and discussed subsequently (Fornell & Cha 1994; Chin 2010b; Götz et al. 2010; Hair et al. 2014). Further criteria discussed below relate to the assessment of common method bias and to moderating effects.

Step 1: Evaluation of the measurement models	
Step 1a: Reflective measurement models	Step 1b: Formative measurement models
• Internal consistency (composite reliability) • Indicator reliability (outer loadings) • Convergent validity (AVE) • Discriminant validity	• Convergent validity • Collinearity among indicators • Significance and relevance of outer weights
Step 2: Evaluation of the structural model	
• Size and significance of path coefficients and total effects • Coefficients of determination (R^2) • Effect sizes (f^2) • Predictive relevance (Q^2, q^2) • Common method bias (marker variable)	
Step 3: Evaluation of moderating effects	
• Interaction terms • Multi-group analysis	

Table 8: Overview of evaluation of fit criteria
Source: Adapted from Hair et al. (2014), p.97

Only if the measurements for the constructs are acceptable, the structural model can be evaluated (Chin 2010b; Hair et al. 2014). The model evaluation thus starts with the assessment of the measurement models.

Reflective measurement models. Assessing the measurement models requires evaluations of their reliability and validity. Firstly, *internal consistency reliability* is measured to identify the degree to which the indicator variables of a construct are intercorrelated. In reflective measurement models, a high degree of correlation between the indicators is desirable. Cronbach's alpha and composite reliability (ρ) can be applied to measure internal consistency. Since Cronbach's alpha (Cronbach 1951; Peterson 1994) is sensitive to the number of items in the scale and is likely to underestimate internal consistency reliability (Götz et al. 2010), PLS scholars suggest assessing internal consistency reliability via

composite reliability ρ_η (Hair et al. 2014, p.101; Götz et al. 2010)[71] using the following equation (Fornell & Larcker 1981, p.45)[72]:

$$\rho_\eta = \frac{(\sum_{i=1}^{p} \lambda_{yi})^2}{(\sum_{i=1}^{p} \lambda_{yi})^2 + \sum_{i=1}^{p} var\varepsilon_i}$$

Values above 0.6 are satisfactory in exploratory research and when using many indicators, while research in advanced stages should achieve values between 0.7 and 0.9; values above 0.9 are undesirable because they indicate that the indicators are redundant (Götz et al. 2010; Hair et al. 2014; Bagozzi & Yi 2012).

The second relevant criterion to evaluate reflective measurement models is *indicator reliability*, assessing the statistical significance of the outer loadings of the reflective indicators. A construct should explain at least 50% of an observed indicator's variance, corresponding to an outer loading of 0.708, and reflective indicators should be removed either when their outer loading is below 0.4 or when deleting the indicators increases the construct's composite reliability or convergent validity (Hair et al. 2014).

Convergent validity indicates the extent to which a measure correlates with alternative measures of the same construct. As reflective indicators are considered traits of a construct, they should share significant variance, which can be measured by the average variance extracted (AVE) (Götz et al. 2010; Hair et al. 2014). AVE is calculated according to the following formula (Fornell & Larcker 1981, p.46):

$$AVE = \frac{\sum_{i=1}^{p} \lambda_{yi}^2}{\sum_{i=1}^{p} \lambda_{yi}^2 + \sum_{i=1}^{p} var\varepsilon_i}$$

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[71] Composite reliability includes the actual factor loading to calculate construct reliability while Cronbach's alpha uses equal weighting; cf. Götz et al. (2010, p.695)

[72] Cf. notation introduced in section 4.4.2.2

An AVE value of 0.50 or higher indicates that the construct explains more than 50% of the variance of its indicators. 0.50 is therefore set as a threshold value for accepting convergent validity of a reflectively measured construct.

Eventually, *discriminant validity* must be considered which evaluates in how far a construct is empirically distinct from other constructs. To evaluate discriminant validity, the cross loadings of the indicators should be considered, where the score of an indicator's outer loading should be higher on the associated construct than on all other loadings. Additionally, the Fornell-Larcker criterion can be applied (Fornell & Larcker 1981). This requires comparing the square root of AVE with the construct's correlations with other constructs: The square root of each construct's AVE should exceed its highest correlation with any other construct (Hulland 1999, p.199; Hair et al. 2014, p.105).

Formative measurement models. Formative indicators underlie the assumption that they are free of error (Edwards & Bagozzi 2000), and thus internal consistency reliability is not applicable. Formatively measured constructs must be sufficiently derived from previous research and include experts' judgments in the construct specification (Götz et al. 2010, p.697). Kline (2011, p.72) stresses the role of expert opinion as "the basis for establishing content validity".

To evaluate formative measurement models, *multicollinearity* must be assessed. It refers to undesirable high correlations between the formative indicators (Götz et al. 2010; Hair et al. 2014). The presence of multicollinearity impacts the estimation of weights in the PLS-SEM algorithm as high inter-indicator-correlations firstly boost standard errors and secondly risk that weights are estimated incorrectly (Diamantopoulos & Winklhofer 2001, p.272; Götz et al. 2010, p.698; Hair et al. 2014, pp.123–126). Hair et al. (2014, p.124) suggest the variance inflation factor (VIF) as a measure of collinearity. VIF measures in how far any formative indicator is effected by other formative indicators related to the

same construct and can be derived from the following formula (Hair et al. 2010, p.158):

$$VIF_{x_1} = \frac{1}{1 - R_{x_1}^2}$$

where x_1 refers to the first indicator of a construct and R^2 measures its variance resulting from the regression of x_1 on all other formative indicators measuring the same construct. If an indicator reveals VIF values above 5, more than 80% of its variance is explained by the other indicators. The indicator should then be removed in order to prevent concerns of multicollinearity (Hair, Ringle, et al. 2011).

Eventually the *significance and relevance* of the formative indicators must be assessed. This is based primarily on an assessment of their *outer weights*, derived from the multiple regression of the construct scores with the formative indicators. Each outer weight value signifies the relative contribution of each indicator to the construct which can be evaluated by applying the *bootstrapping* algorithm (Diaconis & Efron 1983). This computational procedure draws subsamples from the original data set and runs the PLS-SEM algorithm on each subsample (Chin 2010a; Hair et al. 2014).[73] Then, the subsamples' standard errors are derived to calculate *t* values which assess each indicator weight's significance using Student's t-test following the subsequent formula:

$$t = \frac{w_1}{se_{w_1}^*}$$

where w_1 is the outer weight of the indicator derived from the original PLS-SEM algorithm and $se_{w_1}^*$ is the standard error of w_1 derived from the bootstrapping

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[73] Cf. Efron & Tibshirani (1994) for an introduction to the bootstrapping procedure and Chin (2010a) for an overview of its application in PLS-SEM.

algorithm. In two-tailed t-tests, empirical t-values above 2.57, 1.96 or 1.65 suggest that the path between the indicator and the construct is significantly different from zero at a significance level α of 1%, 5% and 10%, respectively. Hair et al. (2014, p.129) highlight that "Nonsignificant indicator weights should not automatically be interpreted as indicative of poor measurement model quality. Rather, researchers should also consider a formative indicator's absolute contribution to [….] its construct." The absolute contribution is provided in a formative indicator's outer loading. Indicators with non-significant weights and loadings above 0.5 should be interpreted as "absolutely important but not as relatively important" (Hair et al. 2014, p.129) and be retained, provided that there is strong support for an indicator's inclusion based on theory and/or expert assessments (Hair et al. 2014, p.129). Even when the outer loadings do not exceed the 0.5 threshold, the indicators can be retained provided that their outer loadings are significant. The empirical evidence to retain an indicator is insufficient only when a formative indicator's weight and loading are insignificant (Hair, Ringle, et al. 2011).

Structural model. The structural model is evaluated based on the five criteria of collinearity (VIF), significance of path coefficients, predictive accuracy (R^2), predictive relevance (Q^2) and effect size (f^2 and q^2) (Chin 1998a; Götz et al. 2010).

The assessment of *collinearity* follows the same measures as describe above for the evaluation of formative indicators. To evaluate the structural model, the VIFs are calculated based on the regression of each exogenous construct with all other exogenous constructs related to the same endogenous construct.

Path coefficients are crucial for hypotheses testing: Negative path coefficients indicate negative association, positive path coefficients indicate positive association between two constructs. The larger the path coefficient (with maximum values at 1 and -1), the stronger the association, provided the path

coefficient is significant. The assessment of the path coefficients (the inner weights) follows the same bootstrapping procedure and significance rules applied for the assessment of the formative indicators' outer weights (Hair, Ringle, et al. 2011). The significance is tested via the empirical t-values of the path coefficients which are derived from the bootstrapping procedure. The following formula applies (Hair et al. 2014, p.171):

$$t = \frac{p_{12}}{se^*_{p_{12}}}$$

where p_{12} is the path coefficient between constructs Y_1 and Y_2 and $se^*_{p_{12}}$ is the standard error of this path coefficient. To accept a hypotheses regarding path relationships, the path direction should be in line with the a priori expectations and at least exceed 0.1 (Lohmöller 1989, p.60; Henseler et al. 2009, pp.303–304).

Predictive accuracy is evaluated for each endogenous construct based on the coefficient of determination (R^2). R^2 is calculated as the squared correlation between the actual and predicted values of each endogenous construct where the maximum achievable value, 1, indicates perfect correlation (Kvålseth 1985). Henseler et al. (2009) and Hair, Ringle, et al. (2011) prescribe R^2 values for endogenous constructs of 0.75, 0.50, or 0.25 respectively as substantial, moderate, or weak. This dissertation, however, does not seek to explain 100% of the variance in product development performance or knowledge integration which represent the key endogenous constructs of this research. These two variables are influenced by many factors other than governance mechanisms. A high R^2 is therefore not required:

"Nothing in the CR (Classical Regression) model requires that R² be high. Hence a high R² is not evidence in favor of the model, and a low R² is not evidence against it." Goldberger (1991, p.177)[74]

To assess and compare the effect of each individual exogenous construct on the endogenous construct, the *effect size* (f²) is calculated based on the following formula (Cohen 1988, pp.410–413):

$$f^2 = \frac{R^2_{included} - R^2_{excluded}}{1 - R^2_{included}}$$

where $R^2_{included}$ is the total R^2 of an endogenous construct, as derived above, and $R^2_{excluded}$ is calculated by excluding the effect of a specific endogenous variable from the model by means of deleting one exogenous variable from the structural model at a time, and re-running the PLS algorithm each time (Götz et al. 2010, p.702; Hair et al. 2014, pp.177–178). Effect sizes of 0.02, 0.15, or 0.35 can be interpreted as weak, moderate or substantial influence of the exogenous construct on the particular endogenous construct (Cohen 1988, p.410).

Finally, the *predictive relevance* of the structural model is calculated using Stone-Geisser's Q² value (Stone 1974; Geisser 1974). While R² and f² test the individual relationships between constructs, Q² assesses how well the generated PLS model predicts the empirically observed values for reflective indicators of endogenous constructs (Fornell & Cha 1994, p.72; Götz et al. 2010, p.702; Hair et al. 2014, pp.178–184). To apply the procedure to formative endogenous constructs, they can be replaced by single-indicator constructs whose indicator represents the construct scores derived before by running the PLS algorithm on the formatively specified construct. Q² is derived from the blindfolding procedure, an iterative process whereby some data is removed from the sample

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[74] Cf. Götz et al. (2010, p.701) and von Deylen (2010, pp.101–102) for similar lines of argumentation in research using PLS-SEM.

and treated as missing data.[75] The parameter estimates obtained from the PLS-SEM algorithm run on this data set are used to reconstruct the removed data, and cross-validation metrics are produced to calculate the predictive errors as the difference between the original values and the values predicted by the blindfolding procedure (Tenenhaus et al. 2005; Fornell & Cha 1994).[76] The Stone-Geisser test criterion is represented by the following formula:

$$Q_j^2 = 1 - \frac{\sum_k E_{jk}}{\sum_k O_{jk}}$$

where E_{jk} represents the squares of the prediction errors, and O_{jk} represents the squares of the prediction error derived from the blindfolding procedure. Index j represents the observed endogenous measurement model, and index k represents all indicators of the related measurement model. If Q² is larger than zero, the model has predictive relevance (Fornell & Cha 1994; Götz et al. 2010; Chin 1998b).

As with R², Q² expresses the total predictive relevance of an endogenous construct. To assess the predictive relevance of individual exogenous constructs, the effect size of Q² is therefore derived following the following formula:

$$q^2 = \frac{Q^2_{included} - Q^2_{excluded}}{1 - Q^2_{included}}$$

where $Q^2_{included}$ is the total Q^2 of an endogenous construct, as derived from the original blindfolding procedure, and $Q^2_{excluded}$ is calculated by excluding the effect of a specific endogenous variable. If the resulting q² value is larger than zero, the model has predictive relevance (Hair et al. 2014, pp.183–184).

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[75] For a more detailed discussion of the blindfolding procedure see Hair et al. (2014, pp.178–184).

[76] Cf. Wold (1982) for the applicability of the Stone-Geisser cross-validation test to PLS.

The outlined criteria for goodness of fit validate the structural model only if it is free of *common method bias* (cf. section 4.4.1). While the research needs to be designed in a way that prevents common method bias a priori, various statistical methods exist to test the existence of common methods post hoc (Podsakoff et al. 2003). The most commonly applied test is Harman's single factor test (Sharma et al. 2009). It can be operationalized by loading all indicators into an exploratory factor analysis. If a single factor emerges from the factor analysis, common method bias is present. This test is criticized for being able to detect but not to control for common method bias (Podsakoff et al. 2003; Sharma et al. 2009). Lindell & Whitney (2001) provide an alternative test criterion for PLS-SEM (Chin et al. 2012). The Lindell-Whitney test introduces a marker variable which is theoretically unrelated to the other constructs in the model and is a measure for the assumed source of method variance (Podsakoff et al. 2003). If the respondents report a very optimistic attitude towards this topic, they tend to overinflate its performance. After evaluating the structural model, this marker variable is added to the structural model as a construct linked to the endogenous construct. The shared variance between the marker variable and the endogenous construct represents the extent of common method bias. It should not exceed 50%. If the test reveals the existence of common method bias, it must be controlled by including the marker variable in the model and assessing the resulting path relationships (Rönkkö & Ylitalo 2011).

Total effects. The criteria stated up so far assess the quality of the measurement models and structural model, and are required to test hypotheses *H1-H9*, *H10a*, *H10d* and *H11a*. To assess the comparative impact of different governance mechanisms, the path coefficients and predictive relevance between each type of governance mechanism and product development performance have to be assessed. Total effects are derived by multiplying the direct path coefficients between an exogenous construct with the endogenous construct it points to with the path coefficient between that endogenous construct and the next endogenous construct in the chain of constructs until the final endogenous construct (for this

dissertation, product development performance) is reached. The product of this multiplication is added to path coefficients potentially representing further direct relationships between those constructs to arrive at the total effect. To answer this dissertation's *RQ2*, governance mechanisms are ranked by their total effect on product development performance.

Moderating effects. To assess the remaining hypotheses and answer *RQ3* regarding context factors, moderating effects have to be evaluated. Moderating effects explain the extent to which the relationship of an exogenous construct with an endogenous construct varies with a third variable (Baron & Kenny 1986). Although the existence of moderating effects is of profound relevance to the specification of structural equation models, the majority of structural equation models does not take them into account (Henseler & Fassott 2010, pp.715–716). The approach how to include moderating variables into a structural equation model depends on the scale of the moderating variable (Henseler & Fassott 2010; Henseler & Chin 2010; Rigdon et al. 2010): Moderators on a continuous scale can be measured using an interaction variable. The interaction variable is generated by multiplying the observed values for the moderator with the observed values for the exogenous construct (ξ x *M*, where *M* is the moderator variable). The interaction variable is then included in the structural equation model as an exogenous construct. A moderating effect exists if the path coefficient between the interaction variable and the endogenous construct is significant, regardless of the path coefficients between the each of the endogenous variables, ξ and *M*, with the exogenous variable. Figure 22 displays the integration of the moderating variable M as a construct into the structural model. The interaction term $\xi * M$ is created by multiplying each indicator of *M* with each indicator of ξ. The structural model including the moderator effect follows the equation:

$$\eta = p_1 * \xi + p_2 * M + p_3 * (\xi * M)$$

The path coefficient p₃ expresses how the unmoderated path p_1 changes when the moderator variable *M* is included.
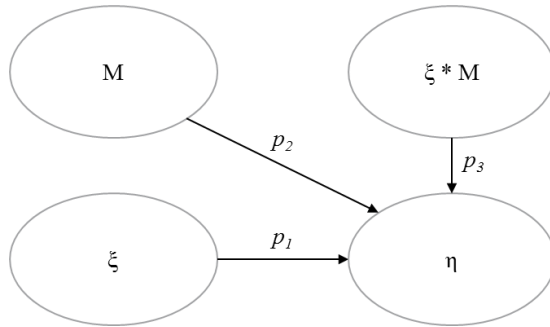
Figure 22: Interaction term in moderation
Source: Adapted from Hair et al. (2014), p. 261

Continuously scaled moderators. Testing this dissertation's hypotheses *H10b*, *H10e* and *H11b* requires assessing whether a moderating effect exists when inserting an interaction term as a construct (Chin et al. 2003).[77] The construct representing the interaction term is assessed for reliability following the previously described evaluation procedure for measurement models. Next, the path relationship between the interaction term and the endogenous construct is assessed for significance. If the interaction term is reliable and the path coefficient is significant, a moderating effect exists (Chin et al. 2003; Hair et al. 2014). A significant moderating effect can be interpreted as follows: As the moderator variable *M* increases by one standard deviation point, the relationship it moderates changes by the size of the interaction term. Furthermore, the effect size

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[77] To calculate moderator effects between two reflective constructs, an interaction term is created by multiplying each indicator of the exogenous construct with each indicator of the endogenous construct and using these product indicators as the indicators for the new, reflectively measured interaction term (Hair et al. 2014, p.263). When calculating indicators for a formative and a reflective construct or between two formative constructs, a two-stage approach is applied: Firstly, the unmoderated model is estimated to obtain the construct scores, secondly these scores are used to create new, single-item constructs for which the product indicators are then calculated (Hair et al. 2014, pp.264–265)

(f²) of the moderator indicates how much of the variance of the endogenous variable is explained by the moderating variable (Henseler & Fassott 2010).

Categorically scaled moderators. Categorically scaled moderator variables require a multi-group analysis (MGA) where the sample is split into different parts (one per scale value), and the model is estimated for each sub-group. Moderating effects exist when the path coefficients between endogenous and exogenous variables differ significantly between the sub-groups. Testing this dissertation's hypotheses *H12a* and *H12b* requires an MGA. The null hypothesis is tested whether $p^{(1)} = p^{(2)}$, i.e. whether the path coefficient p between two constructs is the identical in the sub-samples (1) and (2) (Henseler & Fassott 2010). Hair et al. (2014, pp.247–249) discuss a parametric approach to achieve this objective: The sample is split into two groups and the PLS path models are estimated for each subgroup. Then, the standard errors for each subgroup are determined using the bootstrapping procedure. Levene's t-test (Levene 1960) is then applied to assess whether the variance of the estimated parameters differ significantly between the subsamples (Hair et al. 2014, p.284). If the standard errors are equal, the following test statistic applies:

$$t = \frac{\left|p^{(1)} - p^{(2)}\right|}{\sqrt{\frac{\left(n^{(1)} - 1\right)^2}{\left(n^{(1)} + n^{(2)} - 2\right)} * se\left(p^{(1)}\right)^2 + \frac{\left(n^{(2)} - 1\right)^2}{\left(n^{(1)} + n^{(2)} - 2\right)} * se\left(p^{(2)}\right)^2} * \sqrt{\frac{1}{n^{(1)}} + \frac{1}{n^{(2)}}}}$$

where p is the path coefficient and n is the number of observations in a subsample. If the standard errors are unequal, a different test statistic is used:

$$t = \frac{\left|p^{(1)} - p^{(2)}\right|}{\sqrt{\frac{\left(n^{(1)} - 1\right)}{\left(n^{(1)}\right)} * se\left(p^{(1)}\right)^2 + \frac{\left(n^{(2)} - 1\right)}{n^{(2)}} * se\left(p^{(2)}\right)^2}}$$

If Levene's t-test renders significant results (using the same threshold values for significance as outlined earlier for the outer weights and path coefficients), the moderating effect of the categorical variable is confirmed. Since this approach assumes that the data is normally distributed, it requires a careful pre-examination of the subsamples' data distribution (Henseler & Fassott 2010).

Table 9 provides an overview of the presented tests and associated threshold criteria discussed by scholars of PLS-SEM and applied in this dissertation.

Criterion	Acceptance threshold
Step 1: Evaluation of the measurement models	
Step 1a: Reflective measurement models	
Internal consistency (composite reliability)	$\rho_\eta > 0.6$
Indicator reliability (outer loadings)	$\lambda > 0.708$
Convergent validity	$AVE > 0.5$
Discriminant validity	$\sqrt{AVE} > CORR^2$
Step 1b: Formative measurement models	
Convergent validity	$p_{\xi\eta} > 0.8$ Or theoretical / expert validation
Collinearity among indicators	$VIF < 5$
Significance of outer weights	$\alpha = 0.1: t > 1.65$ $\alpha = 0.05: t > 1.96$ $\alpha = 0.01: t > 2.57$
Relevance of outer loadings	$\lambda > 0.5$
Significance of outer loadings	$\alpha = 0.1: t > 1.65$ $\alpha = 0.05: t > 1.96$ $\alpha = 0.01: t > 2.57$

Criterion	Acceptance threshold
Step 2: Evaluation of the structural model	
Size of path coefficients	$p > 0.1$
Significance of path coefficients and total effects	$\alpha = 0.1: t > 1.65$ $\alpha = 0.05: t > 1.96$ $\alpha = 0.01: t > 2.57$
Effect size	$f^2 = 0.02$ *weak* $f^2 = 0.15$ *moderate* $f^2 = 0.35$ *substantial*
Predictive relevance	$Q^2 > 0$ $q^2 = 0.02$ weak $q^2 = 0.15$ moderate $q^2 = 0.35$ substantial
Common method bias (marker variable)	*VAR (marker variable, Y) < 0.5*
Step 3: Evaluation of moderating effects	
Interaction term (continuous moderator scale)	$f_M^2 = 0.02$ weak $f_M^2 = 0.15$ moderate $f_M^2 = 0.35$ substantial
MGA (multi-group-analysis for moderators on a categorical scale)	$\alpha = 0.1: t > 1.65$ $\alpha = 0.05: t > 1.96$ $\alpha = 0.01: t > 2.57$

Table 9: Evaluation criteria and thresholds applied

4.4.2.5   Methodology of the importance-performance matrix

The qualitative and quantitative analysis techniques discussed thus far are applicable to answer the first three research questions of this dissertation. *RQ4* enquires about practical recommendations how to use governance mechanisms to increase the performance of global product development teams. A meaningful analysis for this purpose is to relate the practical application of governance mechanisms against the impact these governance mechanisms have on product development performance as assessed by the total effect derived from the PLS

analysis. This approach is called *importance-performance analysis* (Martilla & James 1977) and can be combined with the results of PLS-SEM (Ahmad & Bin Wan Afthanorhan 2014; Sarstedt et al. 2014; Schloderer et al. 2014).

Importance is derived from each governance mechanism's total effect. These values are indexed on a scale from 1 to 100 by multiplication with 100.

In the context of this dissertation, performance assesses to what extent the governance mechanism is applied in practice and is measured via the corresponding constructs' index values. These index values are generated by subtracting the lowest value on each construct's scale from the data point Y, and dividing the result by the difference between the scale's maximum and minimum values (Hair et al. 2014, p.209):

$$Y_i^{rescaled} = \frac{(Y_i - Minscale\,[Y])}{(Maxscale[Y] - Minscale[Y])} * 100$$

The rescaled indicator data is re-entered into the model and the algorithm is run again. This procedure does not change any of the PLS estimates but provides index points for each construct which can be placed on a scale from 1 to 100.

The results are visualized in the so-called *importance-performance matrix* (IPMA), a diagram comparing the relative impact (importance) of the different governance mechanisms with the extent to which they are applied in practice (performance) (Martilla & James 1977; Slack 1994). Normative management advice is provided for each quadrant in this matrix (see figure 23).

	A	B
Extremely important	A Concentrate here!	B Keep up the good work!
Slightly important	C Low priority	D Possible overkill

Fair performance   Excellent performance

Figure 23: Generic importance-performance matrix
Source: Author, adapted from Martilla & James (1977) and Slack (1994)

Governance mechanisms in quadrant A are extremely important but underutilized. Managers should focus on enhancing these mechanisms. Governance mechanisms in quadrant B are extremely important and strongly applied. Managers should keep up this high level of application. Governance mechanisms which are only slightly important need not be prioritized. If they are overutilized (quadrant D), managers run the risk of wasting resources. Following the propositions of the KGA, managers seeking to optimize knowledge governance mechanisms should apply governance in line with effectiveness, on an imaginary diagonal from the bottom left to the top right in figure 23.

When analyzing an IPMA, particular attention should be given to those data points far off this line as they display the greatest disparity between importance and performance and provide most improvement opportunity (Martilla & James 1977).

5   QUALITATIVE PRE-STUDY

5.1   IDENTIFICATION OF THE SAMPLE

Following the methodology for this dissertation's qualitative research strand laid out in section 4.3, the process of the qualitative pre-study starts with the identification of a sample of experts who can provide *relevant and precise* information on governing product development teams in German-based MNCs in the B2B sector.

Population. A suitable set of experts is identified from the target population of German-based MNCs in the B2B sector with international product development activities. This target population is established based on the following procedure: The 2011 listing of the largest 500 companies in Germany as published by 'Die Welt' (Welt 2012) serves as a basis.[78] The websites of the included companies are researched to filter out (1) all companies not headquartered in Germany[79], (2) all companies without reported sales from B2B activities and (3) all companies without international product development activities. The filtered list features 86 companies which meet these criteria. In order to include also companies that are not large enough to be considered a top 500 company but spend significant amounts on product development, the ranking of the top 1500 worldwide R&D investors as published by the European Union (EuropeanUnion 2012) is screened for German-based companies with

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[78] The approach to identify the relevant sample based on the German top 500 companies as published by 'Die Welt' has been taken by other studies of international management with a focus on German-based MNCs (Ambos 2005; Ambos & Schlegelmilch 2007; Richter et al. 2009).

[79] Note that this study does not focus on MNCs that are legally based in Germany but on MNCs that are managed predominantly from Germany, i.e. where the majority of the global top management team is based in Germany. This criterion is considered more relevant to control for home-culture bias than other criteria such as country of legal registration.

international product development activities. 10 additional MNCs are identified and added to the list. The target population thus consists of 96 companies.[80] Figure 24 presents the distribution of the population of companies by annual sales 2011.
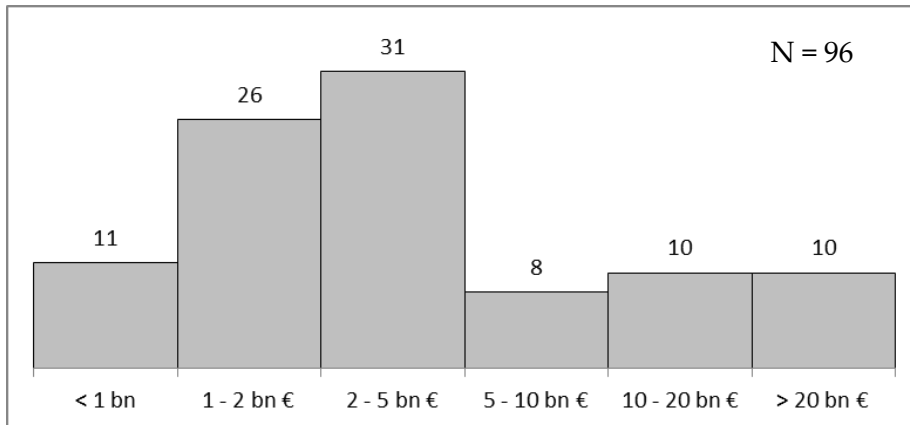
Figure 24: Histogram of companies in the population by annual sales 2011

Figure 25 depicts how the population of companies is distributed by industries following Standard & Poor's (Standard & Poor's 2010) Global Industry Classification Standard (GICS) on the four-digit aggregation level.[81]

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[80] For details, see Appendix B: Leading German-based MNCs in the B2B sector.

[81] For details, see Appendix C: GICS categories.
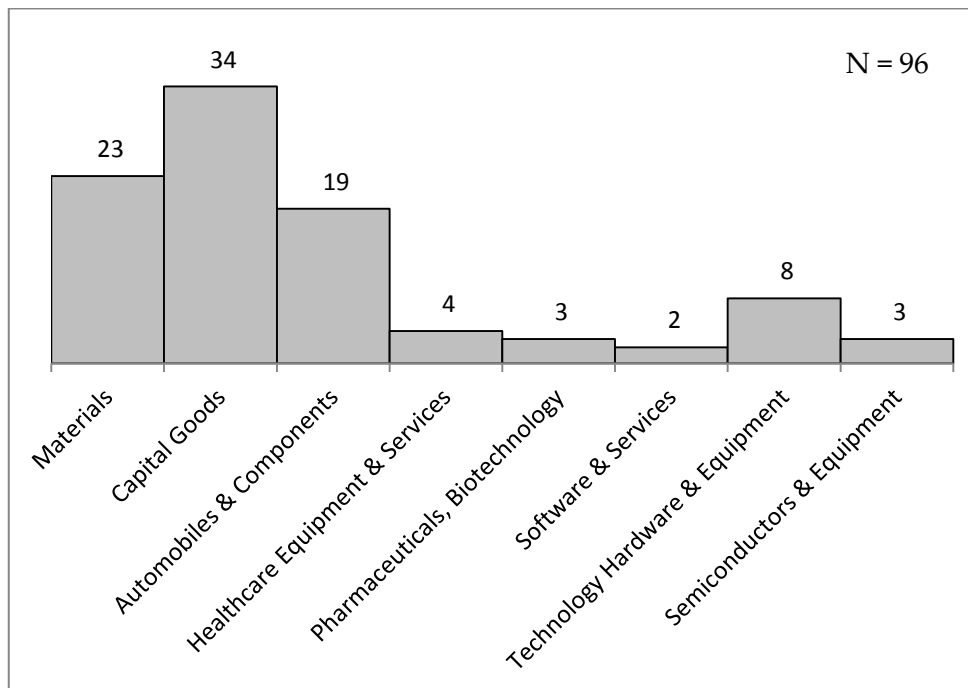
Figure 25: Histogram of companies in the population by GICS category

Sample selection. Product development experts are identified from the population following the sampling suggestions of Gläser & Laudel (2010) discussed in section 4.3.1. All employees involved in global product development activities in the sample of companies can provide expert information about the application of governance mechanisms. While experts in top management positions are more likely to have a general overview of the applied mechanisms and their effectiveness, employees at lower management levels can share insights from their own involvement in global development teams. In order to identify experts who are *available and ready* to provide information, companies from the identified sample were contacted via email and telephone based on judgmental sampling. To avoid selection bias potentially arising from homogeneous judgmental sampling, the following sampling criteria are applied:

- All major industries represented in the population should be included in order to assure that industry specifics are covered.

- Different hierarchy levels in the product development organization should be included in order to assure that strategic and operational aspects of global product development teams are covered.
- Experts from the German corporate headquarters and from international subsidiaries should be involved to explore potential home country bias.

Eleven interview partners ready to share their insights are identified and interviewed between September 2012 and February 2013, when data saturation was considered to be achieved. Table 10 provides an overview of the conducted interviews. The sample of companies represented by the interview partners includes at least one company from each B2B industry category, with technology hardware being the only exception. Their companies' annual sales range from 200 million Euro to 49 billion Euro, with R&D quotas[82] from as little as 0.6% to as much as 15.8%[83], thus accounting for the large diversity in the population of German-based MNCs in the B2B market without aiming to be statistically representative. The 9 MNCs represented in the sample represent 9.4% of the population of 96 MNCs, account for 28% of the population's total sales and 32% of the population's total R&D spending.

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[82] The R&D quota equals R&D expenditure divided by total sales.
[83] Data from fiscal year 2011 according to company publications.

Expert code[84]	Industry	Position of expert	Interviewee location	Interview type	Date
A	Capital goods	Head of Corporate Center Technology and Innovation	Headquarters (Germany)	Face-to-face	28. September 2012
B	Aerospace & Defense	Chief Operating Officer Innovation	Headquarters (Germany)	Tele-phone	5. November 2012
C	Health care equipment and biotech-nology	Senior Director Global Operations Strategy & Program Management	Headquarters (Germany)	Face-to-face	4. January 2013
D	Semicon-ductors	Managing Director China	Subsidiary (China)	Tele-phone	10. January 2013
E	Capital goods	Senior Manager Product / R&D	Headquarters (Germany)	Face-to-face	14. January 2013
F	Autombile & components	Senior Vice President Engineering Solutions	Headquarters (Germany), temporarily located in Russia	Tele-phone	21. January 2013
G	Autombile & components	Team Manager Product Testing	Headquarters (Germany)	Face-to-face	22. January 2013
H	Software development	Head of Applied Research	Headquarters (Germany)	Face-to-face	22. January 2013
I & J	Materials	Manager Innovation Intelligence (I), Central Innovation Manager (J)	Business Unit headquarters (Germany)	Face-to-face	29. January 2013
K	Materials	Vice President Product Development	Subsidiary (China)	Tele-phone	1. February 2013

Table 10: Overview of conducted expert interviews

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[84] Following the request of several interviewees, people and company names are not published in this dissertation but are available from the author upon request.

5.2   I<small>NTERVIEW GUIDELINE AND A PRIORI CODING</small>

Interview guideline. Following the guidelines for expert interviews discussed in section 4.3.1, the experts interviewed for this dissertation received a rather general questionnaire by email upfront which provided them with the possibility to familiarize with the topic but provided flexibility and openness in the interview (Meuser & Nagel 1991; Bogner & Menz 2001).[85] Following the theoretical advice, the questionnaire includes contextual questions that invite the respondents to describe contextual factors for their own organization's reality (Liebold & Trinczek 2009). This aspect is particularly valuable in order to explore the context factors relevant to answer this dissertation's research questions. Table 11 shows the open questions asked in the interviews and their link to this dissertation's research questions. Besides being directly linked to the research questions, these questions express the three objectives of this qualitative research strand which intends to strengthen the understanding of the context (German-based MNCs), to validate the formulated research hypotheses and to facilitate the operationalization of the subsequent survey.

The interview guideline follows the maxim not to ask the respondents directly about feedback on the hypotheses in order to avoid self-fulfilling prophecies. At the same time, the approach of *directed qualitative content analysis* selected for this research strand requires the interviewer to develop initial coding categories (Hickley & Kipping 1996)[86] and to gather respondents' perspective on these categories by targeted questions (Hsieh & Shannon 2005).

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[85] Cf. Appendix D: Expert interviews: Interview request and guideline
[86] Cf. section 4.3.2

Interview questions provided upfont (contextually related to global product development)	Link to research questions
How do you coordinate international knowledge transfers within your company?	*RQ1*: Which governance mechanisms are applied to govern global product development teams, and to what extent?
Which types of international knowledge transfers are relevant for product development in your company?	*RQ3*: Which context factors influence the governance and performance of global product development teams, and to what extent?
Based on your experience, what do you perceive as critical success factors for international knowledge transfers?	
Which factors do you perceive as relevant when designing coordination mechanisms for international knowledge transfers?	
Which specific objectives does your company pursue when supporting international knowledge transfers in product development?	*RQ2*: What impact do these governance mechanisms have on successful product development performance, (a) either directly or (b) indirectly via knowledge supporting the integration of team members' knowledge?
(How) is the achievement of these objectives measured?	No link to research question. Seeks to operationalize the construct "product development performance"

Table 11: Interview questions provided upfront

A priori coding. Four categories of codes are derived from theory and existing empiric findings in order to cover all aspects covered in the hypotheses developed in section 3.3. These are

- Governance mechanisms
- Product development performance criteria
- Indirect success factors for product development performance (knowledge integration, iCAP)
- Context factors

For each of these categories, subcategories are outlined and used as coding categories, as shown in figure 26.
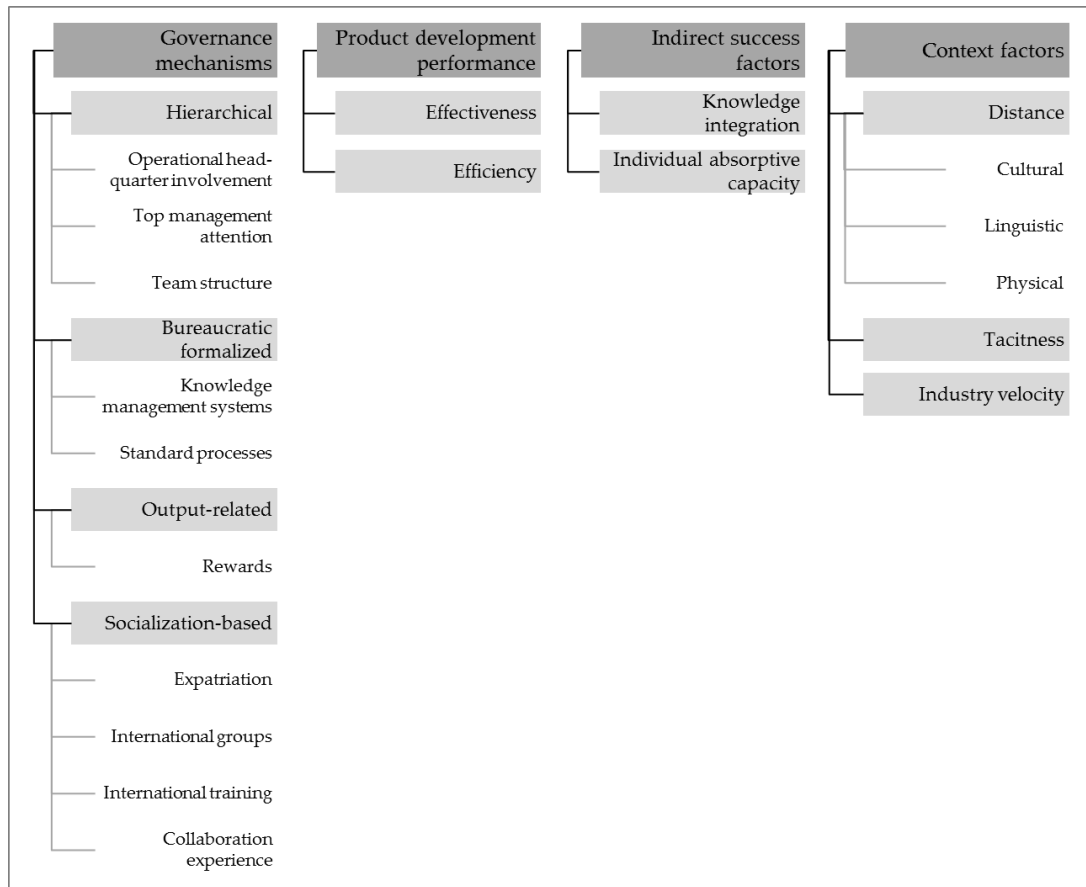
Figure 26: Initial coding categories

The experts are asked targeted questions about those categories following the rule of saturating data.[87] When a respondent raises a topic which does not fit any of the initially developed coding categories but appears relevant in the context of this research, a new category is added and the following interviews incorporate questions about those new categories until the point of data saturation is achieved, i.e. no further themes are identified. Figure 27 depicts this process.

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[87] Cf. section 4.3; cf. Morse (1995), Sandelowski (1995)
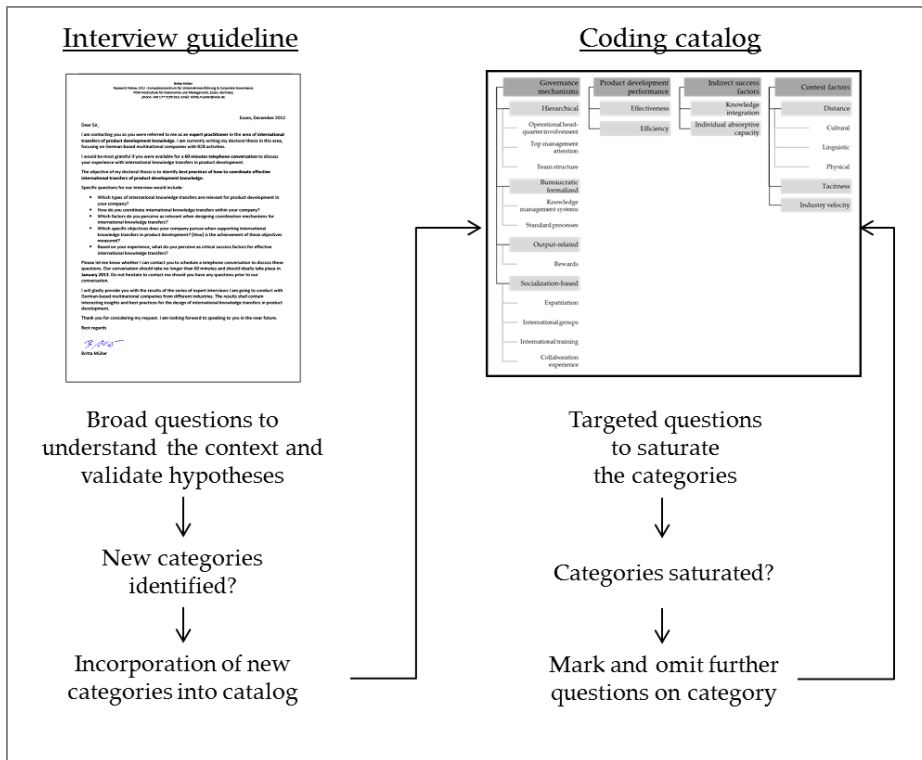
Figure 27: Adaptation of interview questions to achieve data saturation

5.3 INTERVIEW PREPARATION, CONDUCT AND DOCUMENTATION

The interview guideline is provided to the experts several days before the interviews.[88] The interviews are conducted both face-to-face and via telephone (cf. Table 10), with face-to-face being the preferred option. The face-to-face interviews are conducted at the respondent's workplace. Interviews with experts located abroad are conducted via telephone for reasons of time and cost efficiency.

After an introduction of the researcher and research objectives, each interviewee is asked to introduce him- or herself, his or her role in the company and describe the characteristics of global product development in his or her company. Then, the core information gathering process starts following the

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[88] Cf. Appendix D: Expert interviews: Interview request and guideline

guidelines outlined in the previous section. An interview technique combining previous knowledge and naivety is applied: While previous knowledge increases the authority of the interviewer and challenges the expert to answer questions more deeply (Pfadenhauer 2009; Liebold & Trinczek 2009), naivety invites the interviewee to provide a broader context and more thorough explanations (Littig 2009; Trinczek 2009). At the end of each interview, the experts are thanked for their time and contribution, the interview documentation process is explain and the respondents are offered an anonymized summary of all interviews. Furthermore, the respondents are asked to support the subsequent online survey either personally or by involving further experts in their company.

The interviews are recorded[89] to facilitate subsequent transcription. The interviews are then paraphrased, an approach that is methodologically accepted when the transcriber and the interviewer is the same person and thus has thorough contextual and factual knowledge of the transcribed material (Liebold & Trinczek 2009).[90] In March 2013, each interviewee was provided with an anonymized summary of all interviews' results, and asked about consent or potential objections. No changes had to be made.

5.4   DIRECTED QUALITATIVE CONTENT ANALYSIS

5.4.1   Extension of the coding categories

As the interviews evolve, various codes have to be added to the initial list in order to capture phenomena that previously seemed unimportant. In addition to the initially established coding categories, a number of additional coding categories emerge from the interviews.

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[89] Two interview partners did not agree to a recording of the interview. Their insights are documented based on notes taken during the interview.

[90] Nine out of ten interviews were conducted in German; however they are transcribed in English in order to be processed (including direct quotes) in this dissertation.
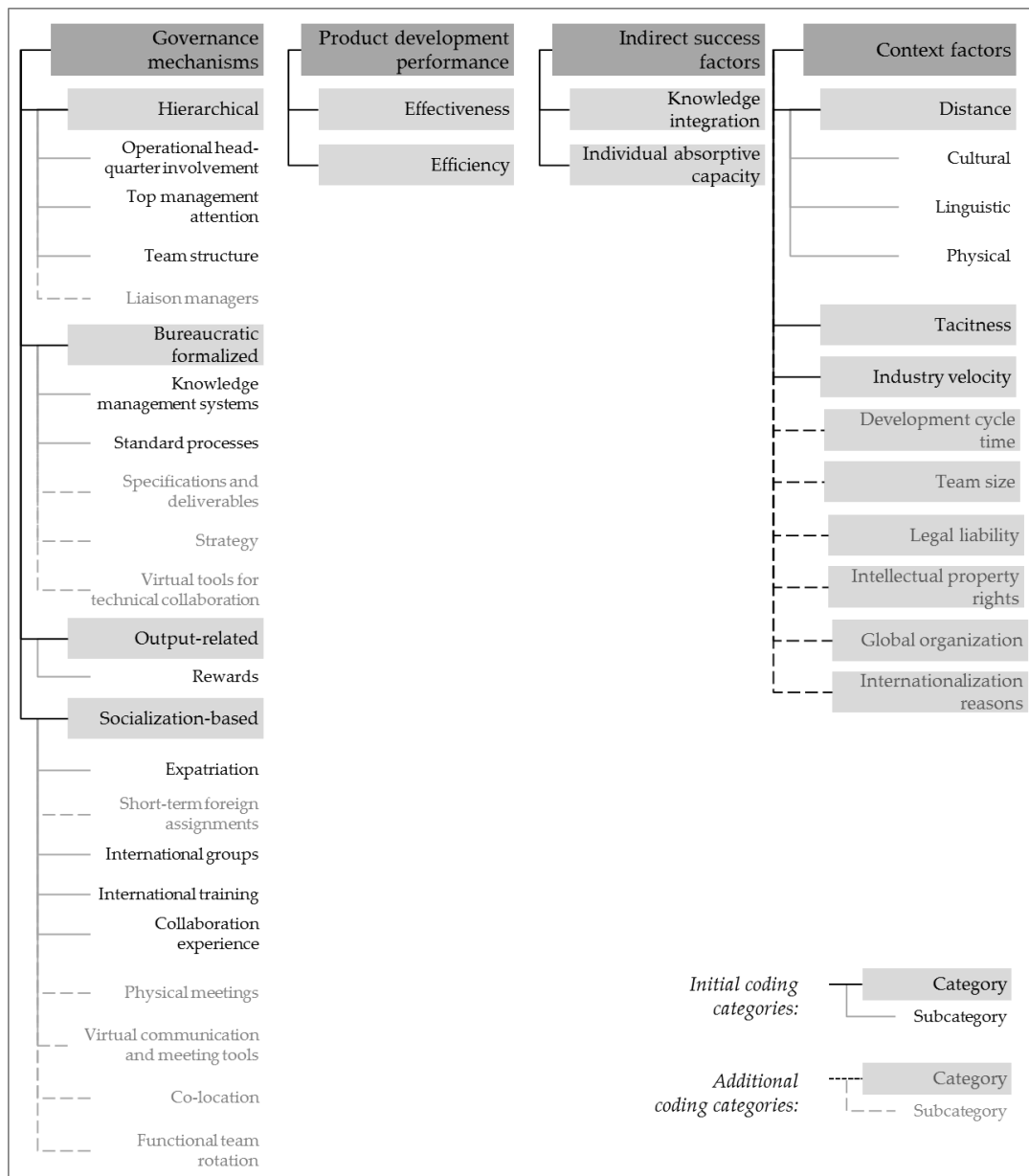
Figure 28: Extension of coding categories

The following nine coding categories are added under the umbrella category of governance mechanisms:

- *Liaison managers* are mentioned as staff acting as single point of contact for one location. Constituting an organizational form of governance, this

concept is added as a sub-category to the category of hierarchical mechanisms.

- *Functional team rotation* is revealed as a concept where team members temporarily work in another function. This approach breaks up typical hierarchical structures and could be added as a sub-category of hierarchical governance mechanisms.[91] Functional team rotation is, however, not specific to global product development teams (Reger 1999; Brettel et al. 2011). While it can be applied to enhance an individual team members' overall understanding of the development context, is not further covered as a governance mechanism in this study.

- *Specifications and deliverables* are mentioned as the technical specifications and functional requirements of the product established at the outset of the development process and checked upon during the process. They are discussed subsequently in relation to standard processes.

- *Strategy* is mentioned as the overarching process of developing a portfolio strategy for new products beyond individual projects and discussed subsequently in the context of formalized-bureaucratic governance.

- *Temporary foreign assignments* are mentioned as an alternative to expatriation where employees are sent abroad for a shorter time period in order to familiarize with a foreign working environment. This is incorporated as a sub-category of socialization.

- *Physical meetings* emerge as mechanisms to strengthen the identification of global teams and are discussed subsequently as an aspect of socialization.

- *Virtual tools for technical collaboration* include technical drawing tools which can be assessed by all team members. They are regarded as technical tools rather than governance mechanisms and not further discussed in this dissertation.

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[91] Expert C, Expert G

- *Virtual meeting and communication tools* are mentioned as ICT-based instruments to support team collaboration. Respondents discuss instruments such as advanced video-conferencing systems. These can be considered ICT-based tools of socialization-based governance.
- *Co-location* of international team members in one place for the duration of the project is discussed by one expert[92] as a socialization mechanism which actually makes a team *non-gobal* by definition[93], and is thus not further considered in the context of this dissertation.

Another six added coding categories fall into the umbrella category of context factors:

- *Development cycle time* is concerned with the typical time it takes to develop a product which correlates with the resource investments and thus the risk associated with the project. It differs considerably between companies.
- The same applies for the *size of the development team* (number of team members).
- *Legal product liability* is mentioned as an aspect potentially impacting the collaboration between different sites and the associated governance mechanisms.
- The same applies to *intellectual property rights*.
- *Global organization* is concerned with the international organizational set-up of innovation, R&D and/or product development and the cross-functional character of product development teams.
- *Reasons for internationalization* describe why international R&D activities and/or global teams are set up.

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[92] Expert F

[93] Cf. section **Fehler! Verweisquelle konnte nicht gefunden werden.** for this issertation's definition of global teams as "comprised of individuals who work and live in different countries and are culturally diverse", following McDonough et al. (2001, p.111). Colocated teams do not match the criterion of working in different countries.

All coding categories are analyzed regarding their content and systematically combined with theory and existing empiric findings (Dubois & Gadde 2002)[94] to better grasp the context of Germran-based MNCs, enhance the previously developed hypotheses and operationalize the variables for the subsequent quantitative survey.

5.4.2 Qualitative findings on product development performance, knowledge integration and individual absorptive capacity

This section outlines the qualitative findings regarding the three constructs *product development performance*, *knowledge integration* and *individual absorptive capacity* and their relationships, as referred to in hypotheses *H1*, *H2a* and *H2b*.

Product development performance. In order to operationalize the multi-faceted construct of product development for the purpose of this study, the experts are asked to describe how their organizations measure product development performance. All experts quote aspects of efficiency, including the adherence to budgets, planned development hours and original schedules. The only aspects related to effectiveness are quality and cost effectiveness, where the latter is referred to in the context of governance mechanisms. Expert F refers to a case where high governance costs are tolerated in order to achieve overall cost synergies:

> "A development project easily costs 15 million Euro in 5 years. If we perform it twice this cost doubles. In our case, [international simultaneous engineering centers] increase development cost to 17 million Euro but the collaboration saves us [the costs and time of] a second development."

Interestingly, market-related measures of development effectiveness are not mentioned by any interviewee. Explicitly asked about this finding, Expert B states that:

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[94] Cf. section 4.3.2

"[Measuring the market success of a new product] is something else, meaning: Have I developed what the customer wanted? We measure this of course but do not set it in relationship with the development work."

This is not in line with suggestions of product development scholars such as Griffin & Page (1996) who identify customer-based measures and market share as the most useful success measures for new product development projects. It also goes against product development management practices reported by the Product Development and Management Association (PDMA) in 2012 where the two indicators rated as most important for product development by member companies are *profits* and *sales from new products* (Markham & Lee 2013). The interview results suggest, however, that product developers in German MNCs in the B2B sector all the way up to the functional top management level are more concerned with pre-launch efficiency criteria which they can directly measure and influence than with the long-term, post launch effects of their work. Werner (2002, p.67) reports similar findings: In Germany, R&D performance focuses more on input KPIs whereas in the US, R&D performance is measured based on output KPIs. One key reason is that output-related performance measures are very long-term oriented and retrospective, and thus inapplicable for managers of product development project (Werner 2002). This has important implications for the operationalization of the construct of product development performance in the subsequent survey: If project managers are unaware of the market performance of the products they develop, they cannot provide respective success measurements in a survey.

Knowledge integration. Experts view knowledge integration as "a basic issue of innovation" (Expert B) and an important management task: "We really have good people and we need to combine their knowledge in an effective way" (Expert E). Expert C states that knowledge integration gains importance as the complexity of products increases:

"[Our instruments] involve different components, such as the actual instruments, that is hardware, software programs that interpret the data plus the chemistry that runs on the instruments. This requires the integration of different kinds of expertise that is contributed by different locations."

Hypothesis *H1* linking knowledge integration and product development performance is therefore retained. However, knowledge integration is not measured in practice (Expert B, Expert C). Therefore, successful knowledge integration must be operationalized based on previous scholarly work when approaching this dissertation's quantitative research strand.

Individual absorptive capacity. The KGA considers iCAP as a crucial micro-foundation for organizational knowledge and the outcomes of knowledge application (cf. section 3.1.3). The previously developed hypotheses link iCAP with knowledge integration (*H2a*) and product development performance (*H2b*). These relationships are confirmed in the expert interviews: Expert D states:

"One key success factor is the quality of the employees who are in charge of transferring knowledge. (…) There are not a lot of people with this capability in our business."

Likewise, Expert D declares:

"The more I work in this area, the more I realize that no matter how good your processes and structures, success depends on individuals."

Ability and motivation emerge as contributing factors for iCAP (Expert A, Expert D, Expert G) which need to be considered in the subsequent operationalization of the construct. Expert A mentions that individuals' ability largely depends on their previous university education whereas Expert G stresses the role of experiential organizational knowledge and expert D discusses "knowledge of human nature" as crucial for project team managers.

5.4.3   Qualitative findings on governance mechanisms

5.4.3.1   Hierarchical governance mechanisms

This section outlines the qualitative findings regarding the three initially defined coding categories of operational headquarter involvement, top management attention and strong team structures, and discusses a fourth category of liaison managers which emerges from the interviews. The direct and indirect linkages between these governance mechanisms and product development performance, as stated in hypotheses *H3a, H3b, H4a, H4b* and *H5*, are validated.

Operational headquarter involvement. The experts largely agree on headquarter involvement as a strategic or coordinative task rather than an operational task: In the interviewed experts' organizations, global headquarters prioritize projects and set overall priorities (Expert C), provide corporate funding for prioritized projects (Expert E) or joint research projects between international entities in order to generate cost savings from synergies (Expert B), or ensure interface management between projects (Expert F). Expert B quotes headquarters' lack of direct access to local team resources as a circumstance preventing headquarters' direct involvement.[95] The organization of Expert I and Expert J uses headquarter functions to provide operational expert support and overall project management tasks for global development projects.

If headquarter involvement includes funding, coordination and selected expert support, it is less *operational* than discussed in previous studies. In conclusion, the construct *operational headquarter involvement* used in hypotheses *H3a* and *H3b* is renamed into *headquarter involvement*. Such headquarter

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[95] Another reason for the headquarters of Expert B's organization not to engage in operational project management is to prevent any legal cases against headquarters resulting from product liability. This aspect is not mentioned by any other Expert, however.

involvement is ascribed to two objectives by the experts: Funding and overall project coordination ensures smooth cooperation between different entities which would otherwise potentially compete. Providing expert support centrally is more cost effective as it prevents each country organization to employ the same type of experts. The negative association between headquarter involvement and product development performance postulated by the original hypothesis *H3b* is thus reversed to reflect a positive association. While previous scholarly findings discussed in section 3.2.3.1 suggest the opposite for operational headquarter involvement, the arguments provided by the interviewed experts regarding coordinative headquarter involvement are convincing if examined through the lens of TCE: Headquarter coordination and funding creates synergies and reduces transaction costs for the MNC. The revised hypotheses are indicated with an asterisk:

H3a*: Headquarter involvement is negatively associated with knowledge integration in global product development projects.

H3b*: Headquarter involvement is positively associated with the performance of global product development projects.

Top management attention. Management attention (also named commitment by the experts) is described unanimously as a supportive driver for product development projects. This is attributed to top management's power to set (project) priorities and drive processes:

> "Management commitment is empowerment. If someone is in charge of a project which suddenly becomes critical because it does not lead to immediate benefits or resources are restricted, then this person needs to be able to access the corporate hierarchies that are able to re-prioritize resources" (Expert B).

Top management attention is mostly directed at high priority projects (Expert C, Expert E, Expert G). Top management sets the "tone from the top" (Expert G) and reinforces the corporate mission and vision (Expert K), thus providing direction for individuals. This provides support for hypothesis *H4a* linking top

management attention to iCAP. Experts furthermore support hypothesis *H4b* linking top management attention with standard processes: In most experts' organizations, top managers drive the implementation of and adherence to standard development processes by being involved in stage gate reviews (Expert C, Expert E, Expert G).[96] The absence of this type of involvement is viewed as negative (Expert J).

In conclusion, the operationalization of the construct *top management attention* in the subsequent quantitative survey includes personal top management communication, resource provision and involvement in stage gates. Hypotheses *H4a* and *H4b* are retained.

Heavyweight team structures in which the project manager has direct access to resources no matter whether they report to him in the line organization or not have been or are being implemented in the organizations of four interviewed experts (Expert C, Expert E, Expert F, Expert G). Expert C explains the issues related to weak project management structures in the past vividly as follows:

> "We used to have project leaders who had […] to request resources from the line managers. These resources were prioritized by their line managers. If [an engineer] should be involved in a development project in order to assure that the developed design can be produced, and then a problem [in this engineer's line function] occurred, the resource would be shifted towards solving that problem and would not be available for the project team any longer. This is a problem which we have dealt with for a long time […]."

This experience match the findings of Sarin & O'Connor (2009) relating to the competition between line organization and project organization. Such structures are not yet the norm in German-based MNCs: respondents of three organizations

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[96] Only Expert K makes an exception to this rule in stating that his company's stage gate process is deliberately designed in a way that is "pretty easy so that you do not have to wait for the CEO to make that decision".

report on teams where team members remain strongly embedded in their line positions and even project managers are only allocated part-time (Expert H, Experts I and J, Expert K). The strong team structure of Expert C's organization also has implications for project staffing, where in the past, project teams were staffed with the next available rather than the most capable employee (Expert C). Now, his organization establishes a strong team structure:

> "The project manager gets resources for at least 50% or even 100% and he can decide on the daily work and prioritization of the daily work of these resources. The line managers have to assure that the allocated employees are fit for purpose, which means that they have the right expertise, know the state of the art, can bring in ideas and have the required competency. The line managers have to ensure expertise and capacity for the portfolio of development projects. The line managers have to lend these resources to the project managers" (Expert C).

This explanation suggests a link between strong team structures and absorptive capacity which has up to this point not been considered in this dissertation's hypotheses.

In conclusion, hypothesis H5 is retained as hypothesis H5a*, and a new hypothesis is added to indicate the link between strong team structures and team members' iCAP derived from the project managers ability to select the most capable staff for the team. While this link does not evolve from the literature review in section 3.2.3.1, it is referred to by KGA proponents who view strong team structures as a fluid form of hierarchical organization which makes most use of the abilities of individuals (Christensen & Knudsen 2008).

H5a:* *Heavyweight team structures are positively associated with the performance of global product development teams.*

H5b:* *Heavyweight team structures are positively associated with individual absorptive capacity.*

Liaison managers are mentioned by two experts as a concept that is losing importance, however. Expert H describes these positions as

> "central people to contact or dedicated managers who establish contacts within the local organization so that the other country's team does not have to communicate with several points of contact. But generally it is neither desired only to communicate via one central point of contact."

Expert E expresses similar concerns:

> "In the past, each location had one liaison manager, normally the head of R&D, who communicated with other locations. This is definitely not enough if people from different locations shall cooperate in projects."

On first glance, these positions resemble a concept discussed in literature on MNCs and product development as *boundary spanning* (Brown & Eisenhardt 1995). Previous research reveals that "the boundary spanning ability enables the facilitation of expertise sharing by linking groups or organizations" (Schotter & Beamish 2011, p.253) within or across firms (Friedman & Podolny 1992; Mudambi & Swift 2009). However, the role of boundary spanners is exercised by individuals based on their personal power rather than on organizational power, and successful boundary spanners assume this task without being assigned to it in their job specifications (Schotter & Beamish 2011). Expatriates have been considered boundary spanners due to their knowledge of (at least) two country organization and the derived ability to foster communication between the two (Au & Fukuda 2003). These abilities and powers do not necessarily match those of designated liaison personnel as described in the experts' examples, which might lack the personal connections, influence and conflict resolving abilities of a true boundary spanner and rather act as *pointers to expertise* which have –in the twenty-first century– been replaced by ICT tools (Becerra-Fernandez & Sabherwal 2001; Ambos & Ambos 2009). The concept of dedicated liaison managers is neglected for the further course of this dissertation because neither expert information nor literature reveals a significant association with product development performance or knowledge integration, and because the concept appears to be outdated.

5.4.3.2   Bureaucratic-formalized mechanisms

This section presents the qualitative findings regarding the two initially defined coding categories of knowledge management systems and standard development processes which are linked with knowledge integration and product development performance in hypotheses *H6*, *H7a* and *H7b*. Furthermore, the findings related to the two added coding categories of *specifications and deliverables* and *strategy* are discussed.

Knowledge management systems are referred to by the interviewed experts as databases (Expert F, Expert H) or file repositories (Expert D, expert E) that capture the distributed development knowledge of project members within or across product development teams. Advanced KMS follow a Wiki approach (Expert G) that enables users to access, browse, and edit hypertext pages in a real-time context (Leuf & Cunningham 2001). Expert A regards KMS based on the reason that product development knowledge is too complex to be captured in a database for others to apply it. Expert D views KMS as a means to share explicit rather than tacit knowledge and points to the difficulties arising from geographical distance when these documents are not made available electronically:

> "It is often neglected to make the required information available to other locations in writing. We need documents and that is often a restricting factor. As long as you are located at one site, you can just walk over to your colleague and get the information from him. That does not work when you are in a different time zone."

The link between knowledge management systems and knowledge integration posited in hypothesis *H6* is plausible in this context. It appears, however, that te application of KMS is low.

Standard processes including stage gates are mentioned by 10 out of 11 experts. According to Expert K

> "No one likes stage gates but everyone uses them. My argument is if you don't use them then your hands are tied in a big company".

The widespread application of standard processes is likely to be a German phenomenon: German culture ranks at the higher end of the uncertainty avoidance index (Hofstede 1980; 1994). Studies of intercultural management differences have thus pictured German organizations as "well-oiled machine" (Hofstede 1994) preferring rules and regulations over other forms of coordination.[97] Some of the interviewed experts fully subscribe to standard processes as a success factor for product development performance, supporting the earlier finding of Christiansen & Varnes (2009) that standard processes must be adhered to which is captured in hypothesis *H7b*:

> "Projects typically deviate from plan if people stop sticking to the predefined process. Developers have a tendency to develop what they like rather than what the market needs. When the process is not adhered to, we realize too late that something went wrong" (Expert I).

While the experts' organizations are committed to standard processes, the importance of flexibility to operate within these processes is made explicit (Expert F, Expert G). Expert G reports on the consequences to following too rigid long-term project plans in the software industry:

> "We changed our development tremendously in the last years. We worked with waterfall development in the past and now switched to design thinking. This is an enormous difference. We used to plan projects thoroughly a priori and now work incrementally."

Knowledge integration is not mentioned in this context. Accordingly, both hypotheses *H7a* and *H7b* are maintained.

Specifications and deliverables are mentioned explicitly as a success factor by Expert A. The product specifications and deliverables defined at the beginning of the project set out the expectations, including customer expectations, against which the project will be measured upon completion. While this fact points to

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[97] According to Hofstede (1994), these beliefs are also reflected in the most common organization theories developed by German management theorists such as Weber, Kieser and Kubicek and thus reinforce themselves via management education in Germany.

output-related governance, the interviews highlight that the definition and review of specifications are typically an integral part of the standard product development process, covered at the stage gate reviews (Expert A, Expert H, Expert K). Clearly defined specifications and deliverables are therefore integrated into the operationalization of the construct of standard processes and not regarded as a separate governance mechanism.

Strategy is mentioned by Expert B, Expert E, Expert F and Expert I as the overarching process to define the product roadmap. It is typically developed by headquarters and provides the basis for selecting and prioritizing product development projects. The strategy process is, however, an overarching process and not related to the governance of an individual development project. Following the terminology of Griffin and Page (1996), strategy is relevant to the success of a product development *program* rather than an individual *project*. A product development *program* seeks to operationalize the product development strategy and entails several individual *projects*. Strategy is not further considered as a governance mechanism in this dissertation, as this study focuses on the performance of global product development *projects* rather than *programs*.

5.4.3.3   Output-related mechanisms

Rewards are rarely applied as an output-related governance mechanism for members of product development teams in the experts' organizations. Expert B mentions personal incentives for knowledge sharing as part of some individual target agreements which is, however, not institutionalized across his organization. Expert C refers to the individual design of incentives: Rather than financial incentives, he believes in rewards that relate to intrinsic motivation such as travel between international sites to provide employees with development opportunities. Expert A expresses skepticism towards effective reward systems for international knowledge exchange which he has neither seen at his current, nor at his previous employer, both being large German-based industrial MNCs.

The interview findings offer little support for the related hypothesis *H8* which posits a relationship between individual rewards and iCAP. This goes against the theoretic assumptions of the KGA which stresses governance mechanisms that affect the individual, and against previous scholarly findings that prove the effectiveness of rewards (van der Bij et al. 2003; Sarin & O'Connor 2009; Rijsdijk & van den Ende 2011). However, referring to the characterization of German culture provided by Hofstede (1994), it is likely for German-based MNCs to apply market-based mechanisms (such as rewards) less and focus more on bureaucratic mechanisms (such as standard processes). This arises from the high uncertainty avoidance embedded in German culture. The United States or the Netherlands, where some of the previous studies on governance mechanisms were conducted, are characterized by a much higher acceptance of uncertainty and apply market-based mechanisms more widely (Hofstede 1980; Egelhoff 1984; Reiche et al. 2009). Due to the convincing theoretical and empiric support, hypothesis *H8* is maintained although it is likely that the concept of individual rewards is not widely applied by German-based MNCs. Based on the interview feedback, this study will operationalize the construct of rewards using both financial and non-financial reward elements. As discussed in section 5.4.2, knowledge integration is rarely measured. Therefore individual rewards are also likely to be associated to product development performance than to knowledge integration.

5.4.3.4   *Socialization-based mechanisms*

The previous literature review identified expatriation, international groups, international training, and collaboration experience as governance mechanisms contributing to the *socialization* of members of global product development teams. A number of additional mechanisms emerge from the expert interviews. While the previously mentioned mechanisms are typically applied beyond or across projects, various project-specific socialization tools emerge from the expert interviews: These include temporary foreign assignments, physical meetings,

virtual meeting and communication tools, and co-location. The qualitative research findings thus support the broad definition of the category of socialization-based mechanisms which is "defined by what it is not: it is not hierarchical, it is not bureaucratic, there are no fixed targets, it is usually not very formal, etc." (Harzing 1999, p.22).

Socialization as a concept and basis for trust is viewed as vital by experts. Expert H describes the importance of building trust over time:

> "(…) trust must be carefully established; it does not come out of the blue. With the Brazilians it has existed longer and it is easier based on our joint history [compared to the Japanese]."

Expert F provides an example of what happens when trust is not carefully built:

> "We developed one [product] in the US. Two years later, the same product was developed in Germany because the engineers thought they could develop a better and cheaper product. At the end, the newly developed [product] was not really better. This was inefficient and an example for the typical not-invented-here syndrome. If people had communicated more and knew each other better there would have been a higher level of trust in the other team's development."

While the necessity of building trust is widely acknowledged, tools to socialize members of global product development teams are not always consciously applied (Expert D). Numerous examples show, however, that German MNCs increasingly react to the need to build trust. Hypothesis *H9a* linking socialization of team members with knowledge integration is therefore retained.

Expatriation is used widely by the interviewed companies to "to foster exchange and knowledge transfer" (Expert H). For some companies, impatriation[98], describing *reverse expatriation* of staff from foreign subsidiaries to MNC headquarters (Harvey et al. 1999; Harzing 2004; Scullion & Paauwe 2004), plays an equally important role in order to ensure, for example, global project

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[98] Some authors use the term "inpatriation" (Harvey & Buckley 1997; Harvey et al. 1999)

management standards (Expert G, Expert J). Lasting approximately three years, im- and expatriation are regarded as costly (Expert F, Expert G, Expert K) but are valued for their long-term effects:

> "The employee who relocates back home takes a lot of knowledge with him to the local market, and prevents the not-invented-here syndrome." (Expert F)

Im- or expatriation programs are typically designed for and used by experienced managers as these have the experience to implement home-country practices abroad (Expert H, Expert K).

Faced with the high costs associated with im- and expatriation, some experts report on using **short-term foreign assignments** as a less costly alternative to familiarize employees, including those in non-management positions, with their colleagues abroad. These assignments range from repetitive trips of two to three weeks (Expert D) via so-called "mini-fellowships" of six to eight weeks (Expert G) to programs for operational and administrative staff of one-and-a-half years (Expert H).

International groups are characterized by the interviewees as platforms for experts to exchange knowledge across projects (Expert B, Expert G) and standing committees of R&D managers (Expert E).

International trainings are also applied, however to different extents: Expert E's company brings international R&D staff on different hierarchical levels together for formal trainings whereas Expert J reports on headquarters' trainings for foreign R&D teams. Expert K uses trainings purposefully for socialization:

> "It's not uncommon for a new chemist in Asia that we send him to either Germany or Dublin or the US on the premise that he is going to learn something but the real reason is that he should meet people."

Previous collaboration experience in teams is mentioned as a strong socialization mechanism by expert F:

"The better the team members know each other, the less you need physical meetings. I have projects in which I cooperate with people who I have worked with for more than 10 years. I can kick off projects with them without personal meetings, simply because we know each other well and share personal experience."

For newly established, unfamiliar teams, on the other hand, experts unanimously report the necessity to hold **physical meetings** at the beginning of the project in order to familiarize project members (Expert C, Expert H, Expert K) or during complex project phases (Expert D, Expert G) in spite of the high cost associated with bringing the global team together:

"Particularly the mutual visits [with our colleagues from Japan] helped us much, when we had a chance to get together also informally after work. That facilitates cooperation much more than just screens inspite of their great resolution. It helps a great lot if you have got to know someone personally on a different level" (Expert H).

"Having people meet in person [makes an impact] - it's pretty hard to distrust someone you have actually sat with. People tend to like each other if they know what they look like" (Expert K).

Research findings on virtual teams provide evidence for the experts' belief in bringing virtual teams together physically: In an experiment with virtual teams, Wilson et al. (2006) find that in the long-run, team effectiveness is not associated with physical meetings. Initially, however, teams which meet in person become effective much sooner than teams which depend on virtual meetings and communication. Their finding falls in line with research on interpersonal effects in virtual or *computer-mediated* interaction by Walther (1992; 1993) who concludes that social information processing is considerably harder in *computer-mediated* communication and, as a core element of communication, has a decelerating effect on building trust in virtual teams. Brown et al (2010, p. 133) recommend face-to-

face meetings as preferred mode of communication for virtual teams to resolve conflict.

Virtual meeting and communication tools are an integral feature for managing global teams in the 21st century and rose by most interviewed experts. They are mentioned as cost-efficient alternative to physical meetings, ranging from web-based and telephone-based conferences to conventional and advanced video-conferencing systems. Three experts highlight the effectiveness of advanced video-conferencing systems which generate the impression that the globally distributed participants are located in the same room (Expert F, Expert G, Expert K). This concept is also known as telepresence, defined as the sense of being in an environment generated by media (Steuer 1992; Held 1992). Telepresence as a form of virtual communication almost resembles personal communication is used extensively by two of the interviewed experts:

> "I use telepresence all the time because it makes you feel like you are really there." (Expert K)

> "We switched strongly to videoconferences a few years ago. All sites have Cisco telepresence systems installed which enable very natural conversations with colleagues. This is strictly pursued also to save costs." [99] (Expert G)

While neither physical meetings nor the application of advanced videoconferencing systems constitute a governance mechanism as such, they both represent significant firm investments in rich communication and building trust, and they both represent vital tools to resolve conflict as they allow team members to capture nonverbal communication which contains the majority of communication content, particularly in emotional conflicts (Brown et al. 2010, p. 133). Therefore, *rich personal communication* via physical meetings and advanced videoconferencing are incorporated into hypothesis *H9b* as tools to socialize a team.

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[99] The technology company Cisco provides a series of advanced video-conferencing products (Cisco 2014) named by the interviewed experts to achieve this impression.

In conclusion, hypotheses *H9b* is extended to capture short-term assignments and rich personal communication:

H9b*: Team members' international experience from expatriation or short-term foreign assignments, their involvement in international groups (committees) and trainings, their previous collaboration experience and the extent of rich personal communication all contribute to the socialization of global product development teams.

5.4.4   Qualitative findings on context factors

5.4.4.1   Distance

The challenges related to distance are discussed in 9 out of the 10 interviews. The cultural dimension of distance is discussed most widely, followed by linguistic distance. Only two experts explicitly mention challenges associated with physical (geographical and temporal) distance.

Cultural distance is important to understand in order to effectively manage intercultural teams. The interviewed experts provide several examples for the particularities of different cultures which have an impact on team work:

> "In France for example you need to factor in a lot of time for informal communication. In Germany things are different: What has been decided is being implemented. In France the individual must be convinced by a topic or he will not implement it if the informal communication has not taken place" (Expert B).

> "Americans tend to work longer hours but also speak more during meetings. (…) I am also aware of the typical optimism of the Americans as opposed to the natural wariness of the Germans. That has to be leveled out by the managers" (Expert F).

> "Indians (…) are very playful but also very self-confident. They would promise you a lot more than you would have asked from them and not achieve half of it. This is a shame because the technical capabilities of the staff there are really good but you need a lot of management to steer it. Here in Germany we have the typical

human issues. People often report project problems rather late because they believe for a long time that they will achieve their objectives" (Expert G).

"With the German way to approach things and the Japanese way to refuse things, we turn in circles again and again until we reach a consensus. Particularly if someone from the Japanese management still interferes after we already agreed on something. We have to find a healthy mix between assertive management and the acceptance of the other team. You cannot push through things aggressively like you would in Germany (…)" (Expert H).

The provided examples show that knowing the cultural differences is very relevant to managing teams effectively, particularly when conflict arises or projects do not work according to plan. This supports the relevancy of considering culture as a context factor in this dissertation. Furthermore, it provides anecdotal support to *H10b*, which proposes a moderating effect of (international) socialization to the relationship between cultural distance and knowledge integration.

Linguistic distance is likewise experienced as a significant challenge by various experts. Expert K provides a vivid example of the destructive combined effect of linguistic and temporal distance:

"If the people from the left [referring to team members from the USA] talk to people in Asia – bad phone connection, second language, late at night – you have to really make sure that the people from the left reinforce what they say, bright eyed, because it's day time for them, speaking quickly in English. You have to reinforce that the people on the other side are not dumb or disengaged, they just cannot hear you. A lot of very simple discussions on that and train people on communication practice."

Similar evidence is provided by Expert D whose company has underestimated the difficulties associated with collaboration between Russia and Germany:

"(…) if you communicate in a different language, you are communicating on a quite low level since your own foreign language capability does not meet that of your mother tongue and even if it does your counterpart's language proficiency maybe does not meet that. That means you stay on a rather simple level and thereby lose a lot of information between the lines. That means that all personal communication is strongly limited and that people have difficulties to develop and to learn."

The quotes on cultural and linguistic distance imply that these challenge team effectiveness unless well understood and managed. Expert H and Expert K report on special intercultural trainings to speed up this process, the companies of Expert D and Expert E offer extensive language training. The experts do not provide evidence for the previously stated hypotheses *H10a* and *H10b* related to the positive association between cultural distance and knowledge integration, but express that cultural distance creates risks and time delays for global teams if they are not properly managed. This notion is supported by empiric evidence in the field of global product development (Murray & Chao 2005). Therefore, two hypotheses are added:

H10f: Cultural distance is negatively associated with product development performance.

H10g: Socialization moderates the relationship between cultural distance and product development performance: The higher the extent of socialization, the weaker the negative relationship between cultural distance and product development performance.

However, the cost of socialization, which requires international travel, increases with geographic distance, and the interviewed experts confirm that their companies seek to achieve equilibrium where the cost of travel does not outweigh the benefits of personal interaction (see section 5.4.3.4), supporting the core assumption of TCE that transactions have to be cost efficient which is also transferred to the KGA. This provides some support for hypothesis *H10e* on the

moderating impact of physical distance on the relationship between socialization and knowledge integration.

5.4.4.2   Tacitness

Tacitness is covered by two experts as a given, pronounced aspect of product development (Expert A, Expert D). For Expert C, one of the key reasons why global teams are utilized is the complexity of products which consist of different components developed in different parts of the world.

Expert A provides support for the negative association between tacitness and knowledge integration posited in hypothesis *H11a*. Expert D provides support for hypothesis *H11b* on the moderating effect of socialization on the relationship between tacitness and knowledge integration. He specifically mentions expatriation as an important factor:

> "A complex product is the result of the cooperation of many individual specialists.
> It is only possible to a very limited degree to write down this specialist knowledge.
> Even if you could write it down, people would not read all the time and remember
> all this. A lot of knowledge is acquired by doing and the transfer only works if you
> live in another country for a certain time."

In consequence, both hypotheses relating to tacitness, *H11a* and *H11b* are retained.

5.4.4.3   Industry velocity

Three of the eleven interview partners represent companies from high-velocity industries: Expert C's company is active in the biotechnology industry, expert D's company develops semiconductors and expert G represents the software industry. Experts C and G make some explicit statements that relate to the context of high-velocity markets and how this impact on governance mechanisms.

The high industry velocity of Expert C's company is revealed by a large number of acquisitions to get access to licenses and intellectual property rights

associated with new breakthrough developments. While some of the acquired entities are shut down as soon as their knowledge has been absorbed by the company, others are integrated and play an integral part in product development. Some of the surviving acquired entities do not implement the central standard development process simply because it does not meet their specific requirements and is not adapted quickly enough. In the context of software development, Expert G reports that classical stage gate processes planned out at the beginning of a project are too rigid to cope with the constant changes in market requirements. All three experts stress the importance of individual absorptive capacity, and to some extent discuss the need to remain flexible.

Hypothesis *H12b* states that governance mechanisms targeted at knowledge integration are more strongly associated with knowledge integration in high-velocity markets. This explains why the companies of Expert C and Expert G are depending less on standard processes than companies in moderate-velocity markets. To fully capture the impressions of the expert interviews, one hypothesis is added:

H12c: Governance mechanisms targeted at individual absorptive capacity that can be applied flexibly such as team structures, rewards and management attention have a stronger impact in high-velocity markets than in moderate-velocity markets.

This hypothesis is theoretically backed by the Dynamic Capabilities approach which calls for flexible governance mechanisms in high-velocity industries (Grant 1996a, Eisenhardt & Martin 2000, Christensen & Knudsen 2008; cf. section 3.1.4).

5.4.4.4   Other context factors

Other context factors identified during the expert interviews include development cycle time, team size and legal implications as well as the global organization and reasons for internationalization.

Development cycle time differs considerably between companies: While one company brings new developments to the markets within six months (Expert G), the majority of the experts report development times between two and five years. Expert C whose company offers both products with long and short development cycles, highlights the differences: "In our company, *quick and dirty* works in one business area while *first time right* matters in the other business area." Expert G explains how his company breaks projects down into sub-projects that have a cycle time of maximum 6 months in order to make large and complex projects more manageable than in the traditional project management approach. Based on the previously cited findings of Katz (1982) and Katz & Allen (1982), longer team permanence can deteriorate the performance of product development teams. Their studies however identify product team permanence between 1.5 and 5 years as optimal. In order to better understand the impact of cycle time on the performance of global product development teams, it is added to the model as a control variable to understand correlations with other constructs.

Team size likewise differs considerably between the companies where Expert I reports typical team sizes of 10 project members compared to projects consisting of 20-30 teams of 10 members each in Expert G's company. Team size is also incorporated as a control variable.

Legal implications of liability and intellectual property rights are mentioned by Expert B as reasons not to apply specific mechanisms such as headquarter involvement in order to prevent corporate legal liability of headquarters for actions of individual subsidiaries. Expert B also mentions legal considerations as a reason to refrain from knowledge integration in order to prevent intellectual property rights. Interviews with other experts reveal however that both aspects are handled very differently by MNCs and no other expert mentions legal implications as an impact factor for the governance of global

product development teams. This aspect is therefore discarded for the further course of this study.

Global organization. The organization of global R&D in the respective MNC pursues different objectives and impacts the need to form global teams and the division of labor within these teams. However, no differences regarding the interaction within individual projects are revealed, and like the previously mentioned aspect of strategy this aspect is viewed as relevant to the design of product development programs rather than projects. The same holds true for **reasons for internationalization** which range from access to low cost development resources to access to customers, highly qualified development resources or new competences and impact on the reason why global teams are formed[100] but not necessarily on their interaction.

5.4.5   Reliability and validity of the qualitative findings

The findings of the qualitative analysis allow the researcher to consider the context of German-based MNCs in the research model which has been previously derived from theoretical considerations and empiric evidence without taking particular attention to this context. Additionally the qualitative research findings help to refine the research model and reveal insights for the subsequent operationalization of constructs. Before accepting these findings, however, their reliability and validity has to be assessed following the previously introduced criteria for assessing qualitative content analysis (cf. section 4.3.2).

Inter-coder reliability is assessed as a precondition for the reliability of the coding categories and the allocation of gathered information to these categories. The gathered information is therefore shared with another researcher who is familiar with the qualitative research technique of coding. He disagrees with 3 of

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[100] Cf. section **Fehler! Verweisquelle konnte nicht gefunden werden.** for references on cademic findings on reasons for internationalization.

the 34 final the coding categories (91.2% agreement) and allocates 10 of the captured paraphrases to the different categories as the author (97.0% agreement). After adjusting for chance, the similarity between the two coders leads to a Cohen's Kappa of 0.969 which exceeds the threshold of 0.6 by far. This result indicates a high degree of inter-coder reliability (Dorussen et al. 2005; Burla et al. 2008).

Construct validity is assessed by comparing the core concepts revealed against proven theory. The qualitative findings are therefore reviewed against the theoretic propositions of the KGA as the theoretic framework underpinning this research. As discussed in chapter 3, the KGA views the individual as the critical element in knowledge sharing processes. Likewise, seven of the interviewed experts mention individuals and the integration of their knowledge as important success factor for the performance of global product development projects. Furthermore, four key propositions of the KGA related to this research (see section 3.1.3, figure 11) are supported by the findings derived from the qualitative expert interviews[101]: Proposition 1 states that governance mechanisms influence individual absorptive capacity. This is reflected in strong team structures quoted by Expert C or individual rewards quoted by Expert B and Expert C. Proposition 2 states that individual absorptive capacity influences knowledge integration. This is reflected by Expert D and Expert E. Proposition 3 states that knowledge integration matters for product development performance. Four experts provide support for this proposition by explicitly mentioning the critical role of knowledge integration for product development performance (Expert B, Expert C, Expert D, Expert E). Proposition 4 draws a direct link from governance mechanisms to organizational outcomes and concludes that governance mechanisms influence product development performance. This proposition can

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[101] Due to the research design aspect of saturating data word counts and statistic extrapolations are not applicable for the interpretation of qualitative data, therefore a proposition does not have to be confirmed by a statistically significant share of interview partners or a high word count.

be logically accepted as all previous propositions are confirmed. Furthermore, several experts discuss the direct link between governance and product development performance, particularly in relation to standard processes (Expert A, Expert G).

External validity of the findings is assessed by *external verification*: The qualitative findings basically support empiric findings previously stated in the literature review, as referenced in the text. All amendments and additions to the initial research model which are derived from the qualitative findings are backed either by broadly accepted theories such as TCE and the KBV or by empiric findings, following the previously introduced approach of systematic combination.

Based on these criteria, the reliability and validity of the qualitative findings is deemed acceptable, and their **predictive validity** will be further tested by the subsequent quantitative study (chapter 6).

5.5   DISCUSSION OF THE QUALITATIVE FINDINGS

Rather than aiming to answer this dissertation's research questions, the objectives of the qualitative pre-study are, firstly, to strengthen the understanding of the context of global product development teams in German-based MNCs, secondly, to validate the hypotheses derived from theory and previous empiric studies before testing these hypotheses quantitatively, and thirdly to aid the operationalization of the constructs used in the subsequent quantitative analysis. These objectives are met by conducting and analyzing ten semi-structured interviews with a total of eleven experts from nine German-based MNCs of different sizes active in various segments of the B2B market.

Based on these ten interviews, the qualitative study discusses a final total of twenty-seven hypotheses dealing with the relationships between eighteen variables. The qualitative study thus represents a research situation where the

number of variables of interest far outstrips the number of data points, a typical situation for which case study-type research such as expert interviews is applicable (Yin 1999). The findings are considered reliable and valid based on assessments of inter-coder reliability, external validity and construct validity.

Context of German-based MNCs. The qualitative pre-study provides three insights related specifically to the context of German-based MNCs: Firstly, product development managers in German-based MNCs measure development performance based on pre-launch criteria such as adherence to budget, schedule and quality objectives. Secondly, national culture influences the application of governance mechanisms: The interview responses suggest that German-based MNCs unanimously apply standard processes, confirming the tendency of German companies to rely on bureaucratic governance which has been previously accredited to the high level of uncertainty avoidance characterizing German culture. The same reason is likely to influence the low extent of application of reward-based mechanisms among the sample. Rewards are a market-based mechanism which has been found to be widely applied and very effective in the North American or Dutch cultural environment which leans more towards market-based mechanisms. Thirdly, the interviews provide a range of examples which highlight the cultural and linguistic differences between headquarters and international subsidiaries of German MNCs. While some previous studies reveal a largely positive impact of cultural distance on knowledge integration which should theoretically also result in a positive impact on product development performance, this study's interviewees provide ample anecdotal evidence to question this positive association.

Validation of hypotheses. The expert interviews provide anecdotal evidence to support the majority of the hypotheses previously derived from theory and earlier empiric findings.

Five of the 23 initial hypotheses need to be amended. Hypotheses *H3a* and *H3b* on the relationship of headquarter involvement with both knowledge integration and product development performance are rephrased to deal with "headquarter involvement" rather than "operational headquarter involvement" as the experts revealed that their organizations' headquarters support projects in a tactical rather than an operational way, for example by means of financing or providing specific expert support. Furthermore, the sign of hypothesis *H3b* is changed to reflect the experts' positive perception of (non-operational) headquarter involvement which helps to prioritize projects and create intra-organizational synergies, thus driving schedule adherence and cost efficiency. Hypothesis *H5* is expanded to include a hypothesis on the relationship between strong team structures and absorptive capacity of the team members, as experts note that leaders of strong teams have more influence on selecting the most capable staff to join their team. Hypothesis *H9b* is expanded to include a wider range of mechanisms contributing to socialization than previously identified in literature, such as short-term foreign assignments, and the extent of rich communication, via personal or rich virtual meetings. Hypothesis *H10d* initially dealt with the relationship between cultural distance and knowledge integration and is altered to link physical distance and socialization, as expert insights reveal that physically widely dispersed teams can integrate knowledge well if their team members are well socialized.

Three hypotheses are added to incorporate perspectives shared by the experts that were previously not considered in the research model. These are all related to context factors. Discussing distance, a recurrent theme in the interviews was a sense amongst interviewees that global teams facing large cultural distance and language problems experience difficulties in decision making which can put project schedules at risk. This is reflected in the added hypothesis *H10f* expressing a negative relationship between cultural and linguistic distance with product development performance. Socialization moderates the negative of cultural distance by establishing trust among project members. This is reflected in the

added hypotheses *H10g*. In the context of German-based MNCs where product development managers measure the performance of product development projects predominantly by pre-launch project efficiency, this raises a question of causality: Does cultural distance really impact negatively on the overall performance of a project (pre- and post-launch, efficiency and effectiveness), or does it negatively impact on the criteria related to pre-launch efficiency which are overstressed by product managers due to their narrow definition of project performance? This question has to be further explored in the quantitative survey. Finally, a third hypothesis that is added based on expert information relates to the context factor of industry velocity. The expert insights from high-velocity companies point at a stronger utilization of flexibly applicable governance mechanisms such as rewards, team structures and management attention, included in hypothesis *H12c.*

A summary of the original hypotheses and the amendments as well as additions derived from the qualitative study is provided in the appendix.[102]

Operationalization of variables. The third objective of the qualitative study was to contribute to the operationalization of the variables. As aforementioned, the analysis findings particularly contributed to the operationalization of product development performance in German-based MNCs in a way that is appropriate for the managers of global product development projects. Further relevant findings for the operationalization of variables include (1) that measuring the success of knowledge integration is uncommon in the practice of German-based MNCs and thus needs to be derived from literature, (2) that individual absorptive capacity consists of individual ability and motivation of the team members, (3) that the operationalization of headquarter involvement should include funding, coordination and selected expert support, (4) that top management attention

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[102] Cf. Appendix E: Initial hypotheses and amendments based on the findings of the qualitative study.

includes the aspects of top management communication, resource provision and involvement in stage gates, (5) that the operationalization of standard processes should involve clearly defined specifications and deliverables and (6) that rewards involve both financial and non-financial incentives.

Furthermore, team size and development cycle time emerge as context variables whose impact on the overall model is yet to be assessed. These variables are thus included into the model as control variables.

The qualitative findings largely support the propositions of the KGA but also indicate the complexity of the topic: A large number of governance mechanisms are applied in practice, and the relationships between governance mechanisms, individual absorptive capacity, knowledge integration and product development performance are manifold and partly dependent on context factors such as distance, tacitness and industry velocity. The qualitative study enriches the knowledge of the subject which is required to operationalize the subsequent quantitative survey. This survey, in turn, is required to test the validity and relevance of the total of twenty-seven hypotheses developed hitherto to answer the research questions.

6   Quantitative principal study

6.1   Model specification

6.1.1   Approach to model specification

The mixed methods methodology applied in this dissertation requires testing the hypotheses derived from theory and qualitative research with quantitative data. Following the research methodology outlined in section 4.4, quantitative data is gathered via an online survey and analyzed using the PLS-SEM technique. Before operationalizing the survey, the structural and measurement models for the PLS-SEM model[103] must be specified.

To guide the subsequent analyses, one *basic structural model* and two *moderated structural models* are developed: A *basic structural model* is developed to answer *RQ2* which enquires about the impact of different governance mechanisms on product development performance. This basic structural model seeks to test hypotheses *H1* to *H9a*. It is presented in section 6.1.2. The same basic structural model is applied to conduct the multi-group analysis which is required to test hypotheses *H12a, H12b* and *H12c*. This multi-group analysis helps to answer *RQ3* which is concerned with context factors for governing global product development teams. Two other context factors, distance and tacitness, require the development of *moderated models*. Two moderated models are developed to examine the impact of each of these two context variables. One model tests hypotheses *H10a-g* (related to distance), the other tests hypotheses *H11a* and *H11b* (related to tacitness). The two moderated models are presented in section 6.1.3. The constructs contained in the different structural models are defined by *measurement models* which are specified in section 6.1.4. Hypothesis testing is

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[103] Cf. section 4.4.2.2 for references on the approach

applicable to answer *RQ2* and *RQ3*. *RQ1* enquires about the governance mechanisms applied in practice and is partly answered by the feedback from qualitative research. Further evidence to answer *RQ1* can be gathered by assessing the extent to which the governance mechanisms applied in the quantitatively surveyed projects. After having gained an understanding of the frequency distribution and the cause-and-effect relationships between governance mechanisms, context factors and product development performance, *RQ4* can be answered. It asks how governance mechanisms can be utilized to increase the performance of global product development teams. Section 6.7 applies the IPMA as an instrument to approach this question. Figure 29 presents this step-by-step approach of the quantitative research to answering the four research questions.

RQ1:	Which governance mechanisms are applied to govern global product development teams, and **to what extent**?
Operationalization:	6.1.4 Specification of the measurement models
Interpretation:	6.3.3 Descriptive statistics

RQ2:	What impact do these governance mechanisms have on successful product development performance?	RQ3:	Which context factors influence the governance and performance of global product development teams, and **to what extent**?
Hypotheses H1 - H9		Hypotheses H10 - H12	
Operationalization:	6.1.2 Specification of the basic structural model	Operationalization:	6.1.2 Specification of the basic structural model for the MGA, 6.1.3 Specification of the moderated models
Interpretation:	6. 4 Evaluation and discussion of the basic model	Interpretation:	6. 5 Evaluation and discussion of the moderated models 6.6 Evaluation and discussion of the MGA

RQ4:	How can governance mechanisms be utilized to increase the performance of global product development teams?
Operationalization:	Based on preceding qualitative and quantitative research results
Interpretation:	6.7 Importance-performance matrix

Figure 29: Approach to operationalization and interpretation of data

6.1.2   Specification of the basic structural model

The basic structural model is applied to test the unmoderated hypotheses *H1* to *H9*. Each of these hypotheses expresses a path relationship (association) between an exogenous and an endogenous construct. These path relationships are represented in PLS-SEM as an arrow pointing from the exogenous construct *X* to the endogenous construct *Y*.

Two control constructs are derived from the expert interviews which differ considerably for projects: Team size and project duration (i.e., project cycle time). Additionally, a marker variable is added to permit testing for common method bias following the Lyndell-Whitney test (Lindell & Whitney 2001).[104] Project manager attitude is selected as a marker variable which expresses the personal preferences of the project manager. This construct should not be related to the final endogenous variable, product management performance, or else the data would likely be influenced by common method variance (Lindell & Whitney 2001; Podsakoff et al. 2003).

Figure 30 summarizes the basic structural model where each circle represents a construct and each arrow represents a path relationship between these constructs, thus operationalizing the associations suggested in this dissertation's hypotheses *H1 – H9*.

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[104] Cf. section 4.4.2.4 for details
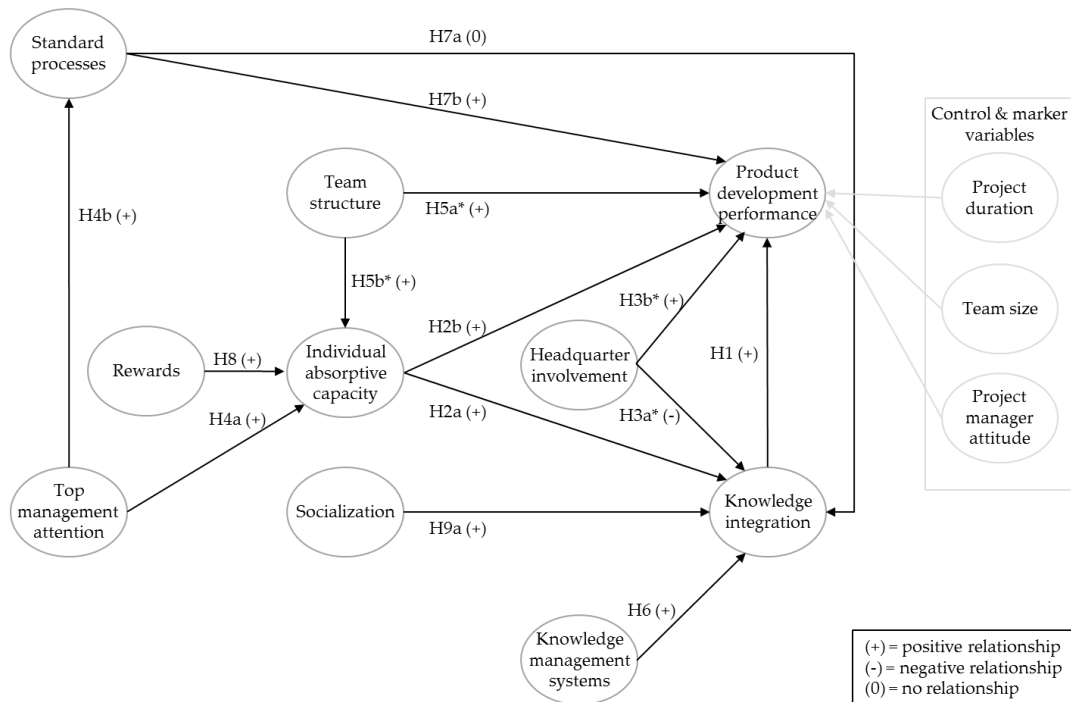
Figure 30: Basic structural model

Table 12 lists acronyms for each of the thirteen constructs of the structural model. These acronyms are used hereafter when discussing the statistical characteristics of these constructs.

Construct	Acronym
Heavyweight team structure	HEVY
Headquarter involvement	HQIN
Individual absorptive capacity	ICAP
Knowledge integration	KNIN
Knowledge management systems	KMSY
Product development performance	PDPF
Project duration	PRDU
Project manager attitude	PMAT
Rewards	RWRD
Socialization	SOCN
Standard process	STDP
Team size	TSIZ
Top management attention	MGAT

Table 12: Construct acronyms for PLS modeling

Multi-group analysis (MGA). The basic structural model is also used to test hypotheses *H12a*, *H12b* and *H12c* related to the differences between high and moderate velocity markets. Following the MGA procedure, a subsample of observations from moderate-velocity markets will be compared with a subsample of observations from high-velocity markets.[105] To test hypothesis *H12a*, the path relationship between knowledge integration and product development performance is compared between the two subsamples. To test hypotheses *H12b*, each path pointing at knowledge integration is compared between the two subsamples. To test hypothesis *H12c* the total effects between team structures, rewards and management attention, respectively, and product development performance are compared between the two subsamples.

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[105] See section 4.4.2.4 for references

6.1.3   Specification of the moderated structural models

6.1.3.1   Moderated structural model I: Distance

Hypotheses *H10a-10f* are concerned with the different facets of the context factor distance and their associations with the constructs of the basic model. A moderated structural model is set up to test these associations. Hypotheses *H10a, H10c* and *H10d* represent direct path relationships pointing from the exogenous constructs expressing distance to the associated endogenous constructs. Hypotheses *H10b* and *H10e* suggest moderated relationships. They require inserting interaction terms into the PLS model, and linking these terms with the endogenous construct of the moderated relationship.[106]

Table 13 lists acronyms for the different constructs related to distance. These acronyms are used below in figure 31 to depict the moderated structural model where all moderating relationships are characterized by dotted arrows. In order to keep the moderated model simple, all constructs of the basic model which are not affected by moderating relationships are disposed of.

Construct	Acronym
Cultural distance	C-DIST
Linguistic distance	L-DIST
Physical distance	PH-DIST

Table 13: Acronyms for PLS modeling of the moderator variable distance

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[106] Cf. section 4.4.2.4 for references
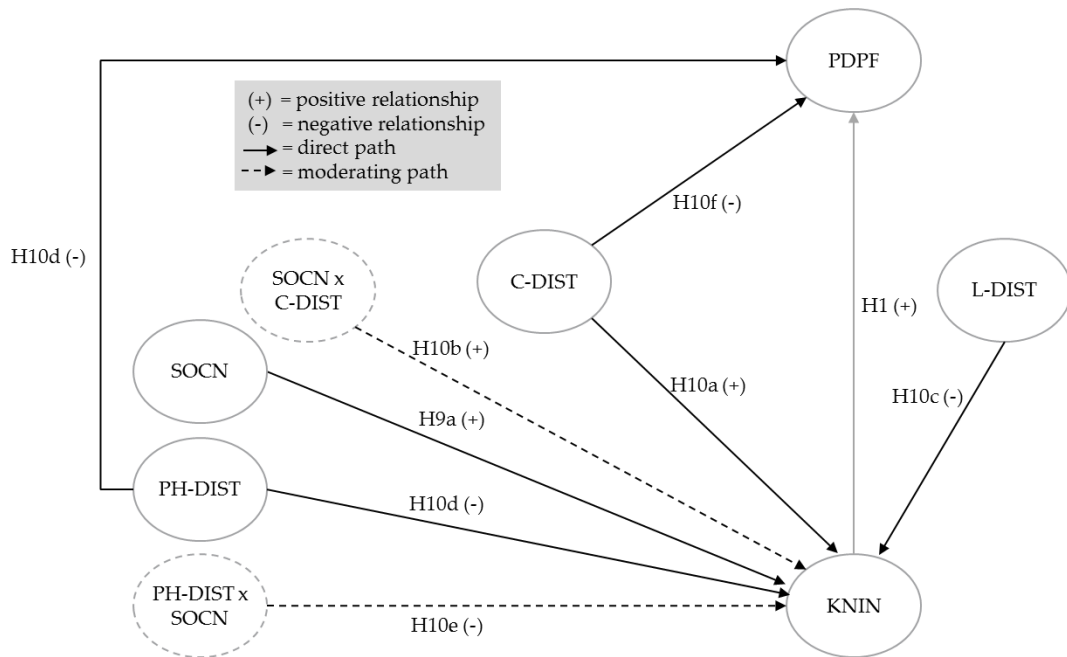
Figure 31: Moderated structural model I (distance)

6.1.3.2   Moderated structural model II: Tacitness

Hypotheses *H11a* and *11b* deal with the context factor tacitness. A second moderated structural model is developed to test these hypotheses. Hypothesis *H11a* is operationalized via a direct path relationship between tacitness and knowledge integration. Hypothesis *H11b* represents a moderated relationship which, again, requires entering an interaction term into the PLS model.

Figure 32 depicts this second moderated structural model, introducing TACT as an additional acronym for the construct *tacitness*. Again, all constructs of the basic model which are not affected by moderated relationships are disposed of.
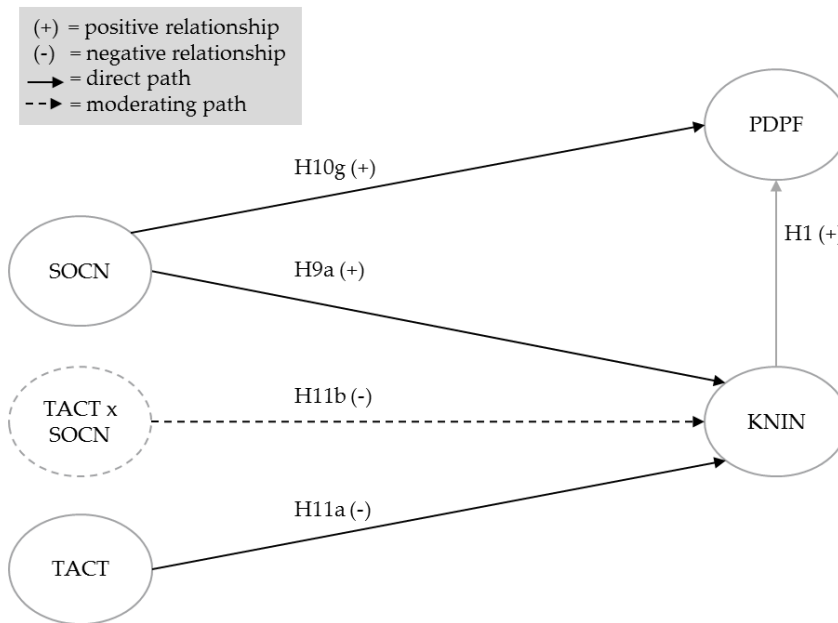
Figure 32: Moderated structural model II (tacitness)

6.1.4 Specification of the measurement models[107]

6.1.4.1 *Measurement models for product development performance, knowledge integration and individual absorptive capacity*

Product development performance measures the success of a global product development project. Following the qualitative research findings[108], the construct has to include pre-launch criteria in order to ensure that product development managers can assess it. The major pre-launch performance criteria identified in literature and mentioned by the interviewed experts include adherence to schedule and budget, achievement of quality objectives. Additionally, the overall satisfaction of the organization with the project results is

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[107] Unless otherwise noted, all of the indicators mentioned hereafter are measured on a Likert scale from one (fully disagree) to seven (fully agree) (Bortz & Döring 2009, p.224; Brace 2008, pp.73–76). The choice between the two most common Likert scales (five or seven response alternatives) is almost arbitrary (Weathers et al. 2005). This dissertation uses seven-point scales for all questions measured on Likert scales as it is most common in related research.

[108] Cf. section 5.4.2

taken into consideration. This operationalization follows existing approaches (Bonner et al. 2002). As the indicators express different objectives of product development performance which not necessarily correlate (cf. section 2.1.2), the construct is measured formatively. Table 14 depicts the measurement model including the acronyms for the construct and related indicators.

Construct		Indicators (formative)	
PDPF	Product development performance	PDPF_01	The project adhered to the pre-defined project timeline.
		PDPF_02	The project operated in a cost efficient manner.
		PDPF_03	The development results met the pre-defined quality targets.
		PDPF_04	Overall, our organization considers this project a success.

Table 14: Operationalization of product development performance

Knowledge integration measures how successfully the international team members' knowledge is integrated in a global product development project. In line with the qualitative research findings that knowledge integration is hardly measured in practice, the operationalization follows the proposition of Chini (2004, pp.79–80) to use "a self-perception measure […], which aims to capture the perceived benefits" of knowledge integration.[109] The resulting reflective measurement model contains different potential benefits of international knowledge exchange, as presented in table 15.

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[109] A similar approach is proposed by Sabherwal & Becerra-Fernandez (2003).

Construct		Indicators (reflective)	
KNIN	Successful knowledge exchange	KNIN_01	Staffing this project with members from different countries led to knowledge and ideas that we would not have had if the project team had been staffed from only one country.
		KNIN_02	Misunderstandings between the international project members were a frequent issue that would not have come up in a project team staffed from only one country. (reverse-coded)
		KNIN_03	Project members from different countries jointly developed new knowledge in this project.
		KNIN_04	Knowledge from different locations was integrated effectively in this project.
		KNIN_05	The project team could access knowledge from different countries when needed.

Table 15: Operationalization of knowledge integration

Individual absorptive capacity is measured via the *motivation* and *capability* of the international team members, based on the qualitative research findings which identify these two aspects as key contributing factors and the previous study of Minbaeva et al. (2003). As motivation and capability are also constructs rather than measurable indicators, iCAP is measured as a second order construct. The two first order constructs team member motivation and team member capability are linked to iCAP in a reflective secondn order measurement model. The operationalization of team member motivation follows the approach of Minbaeva et al. (2003). Team member capability is measured based on the operationalization of intellectual capital of product development employees as proposed by Hsu & Fang (2009). Both constructs are measured by reflective measurement as the indicators are outcomes of the construct and are likely to correlate. Table 16 presents the operationalization of the second and first order constructs.

Second order construct	First order constructs (reflective)		Indicators (reflective)	
ICAP Individual absorptive capacity	MOTI	Team member motivation	MOTI_01	Project team members immersed themselves in the project.
			MOTI_02	Project team members showed continuously high interest in the project.
	CAPB	Team member capabilities	CAPB_01	Project members brought excellent professional skills to the project.
			CAPB_02	Project members brought unique and new ideas to the project.

Table 16: Operationalization of individual absorptive capacity

6.1.4.2   Measurement models for governance mechanisms

Headquarter involvement, according to the findings of the expert interviews, is mainly exercised via financing and project prioritization. Accordingly, three indicators are applied to measure the construct: Firstly, the extent to which headquarters have instructed the project, following the earlier operationalization of Ciabuschi et al. (2010); and secondly, the extent to which headquarters are actively involved and support project financing, following the earlier operationalization of Huth (2008, p.85). The hierarchical coordination mechanism of headquarter involvement is measured reflectively as the expert interviews suggest that the indicators correlate. Table 17 presents the construct and its indicators.

Construct		Indicators (reflective)	
HQIN	Headquarter involvement	HQIN_01	Corporate headquarters have formally instructed this project.
		HQIN_02	Corporate headquarters themselves have been actively involved in this project.
		HQIN_03	Corporate headquarters have financed this project.

Table 17: Operationalization of headquarter involvement

Top management attention measures the extent to which top management is involved in and provides support to a global product development project. The hierarchical coordination mechanism is measured by three indicators adapted from the operationalization of top management support by Huth (2008) and the use of steering committees which were frequently quoted in the expert interviews. The construct is measured reflectively as it is perceived a trait of its indicators and it is assumed that the indicators are correlated (Chin 1998a). Table 18 presents the construct and its reflective indicators.

Construct		Indicators (reflective)	
MGAT	Top management attention	MGAT_01	The steering committee involved top managers of the global organization.
		MGAT_02	Top management continuously personally showed that this project was of high priority to them (e.g., by high personal involvement, provision of sufficient resources).
		MGAT_03	A steering committee regularly checked on the project's progress.

Table 18: Operationalization of top management attention

Heavyweight team structures exist when project managers have better access to their international team members than their local line managers. Following the definition of Clark & Wheelwright (1992), the construct is developed based on two reflectively measured indicators expressing different facets of the authority the project manager has over the team members. This measurement approach suggests a reflective measurement model.

Construct	Indicators (reflective)	
HEVY Heavyweight team structure	HEVY_01	The project manager had direct access to and responsibility for the work of the project team members.
	HEVY_02	The project team reported directly to the project manager.

Table 19: Operationalization of heavyweight teams tructures

Knowledge management systems are knowledge encapsulation systems making previous product development knowledge explicit. The construct is measured as a single-item construct. While these single-item measures reduce the complexity of data gathering, they increase the risk of measurement error and increase the PLS-SEM bias (cf. section 4.4.2.3). Diamantopoulos et al. (2008) provide the guideline that single-item constructs may be used if sample sizes are small (n<50), expected path coefficients are weak (p<0.30), items are highly homogenous (inter-item correlations >0.80) and items are semantically redundant. While the first criterion (sample size) cannot be fulfilled[110], the further criteria are all expected to hold true empirically, as the construct is not complex or multi-faceted and SEM studies in the area of international knowledge flows arrives at low path coefficients (Chini 2004). Furthermore, the related hypothesis assumes a low path relationship. Hence, a single-item construct is defined as depicted in table 20

Constructs	Indicators (reflective, single-item)	
KMSY Knowledge management systems	KMSY_01	Frequency of utilization of internationally accessible knowledge management databases

Table 20: Operationalization of knowledge management systems

Process standardization describes in how far a standardized stage gate process including clear specifications of the deliverables is applied in the project.

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[110] The number of constructs exceeds a threshold at which 50 observations would suffice; cf. sample size consideration in section 4.4.2.3.

The operationalization of the construct is based on the idea that a number of factors render a process "standardized". These include a formal business plan with the product specifications, and the measurement of project progress against pre-defined performance criteria at stage gates. All indicators used to measure this construct have been applied in previous studies on standard development processes (Salomo et al. 2007; Huth 2008). The indicators should be correlated, as the ideal development process should involve all of them. The operationalization is therefore reflective. Table 21 displays the construct and its reflective indicators. The indicators aim to measure the actual application of standard processes in the project rather than their mere existence in the company, as pointed out by Markham & Lee (2013) in previous research.

Construct	Indicators (reflective)	
STDP Process standardization	STDP_01	The project adhered to our organization's global standard product development process.
	STDP_02	A formal (written) business plan clearly stated the project objectives, resources, budget and time frame.
	STDP_03	The project progress was frequently measured against pre-defined performance indicators (budget, time, quality).

Table 21: Operationalization of standard processes

Rewards measure the extent to which international project team members are rewarded, financially or non-financially, for their contribution to the team. The expert interviews reveal that contribution to the overall project success is more common than rewards for specific aspects such as knowledge integration which are hard to measure. The construct is thus operationalized similarly to the previous operationalization of Gooderham et al. (2011) based on the types of rewards applied: consideration in formal appraisals, increments and bonuses, acknowledgement for promotion or internal communication. As these indicators add to each other and need not be correlated, they measure the construct formatively. Table 22 presents the construct and its formative indicators.

Construct	Indicators (formative)	
RWRD Incentives	RWRD_01	The achievement of project objectives was part of the formal appraisal of project members.
	RWRD_02	Project members' contribution to the project was acknowledged by increments / bonuses.
	RWRD_03	Project members' contribution to the project was acknowledged by promotion.
	RWRD_04	Project members' contribution to the project was acknowledged in internal communication (e.g., newsletter, intranet, employee magazine).

Table 22: Operationalization of rewards

Socialization expresses the degree to which international project team members have been socialized to understand each other's norms, values and ideologies. Hypothesis *H9b** lists individual mechanisms contributing to this objective: Team members' international experience from expatriation or short-term foreign assignments, their involvement in international groups (committees) and trainings, their previous collaboration experience and the extent of rich personal communication via physical meetings or advanced video conferencing systems.[111] These mechanisms are operationalized as indicators contributing to the formative construct socialization. Many of these indicators have been used in previous studies on MNC knowledge exchange (Gupta & Govindarajan 2000; Becerra-Fernandez & Sabherwal 2001; Mahnke et al. 2005). Table 23 summarizes the indicators measuring informal socialization. As they need not be correlated, the construct is measured formatively.

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[111] The Likert scales measuring the indicators related to long-term assignments, short-term assignments, international corporate networks and international trainings range from 1 (true for no project member) to 7 (true for all project members). The Likert scales measuring the two indicators "Frequency of physical meetings" (SOCN_06) and "Frequency of advanced video conferences" (SOCN_07) ranges from 1 = very unfrequently/never to 7 = very frequently.

Construct		Indicators (formative)	
SOCN	Informal socialization	SOCN_01	Project members have been on long-term assignments abroad (more than 6 months).
		SOCN_02	Project members have been on short-term assignments abroad (less than 6 months).
		SOCN_03	Project members are part of international corporate networks.
		SOCN_04	Project members have participated in international trainings.
		SOCN_05	The international project members had worked with each other before this project.
		SOCN_06	Frequency of physical meetings of the project team
		SOCN_07	Frequency of advanced video conferences with the project team

Table 23: Operationalization of socialization

6.1.4.3   *Measurement models for context factors*

Physical distance combines the geographic and temporal distance between the project team members. *Geographical distance* is measured in a three-step approach: Firstly, the distance between the project manager and the team members located in another country is measured by determining the distance between the geographic centers of these two countries on a map. If the project team members are located in more than one country other than the project manager's country, the distances are added. Figure 33 provides an example for this procedure with a sample project managed from Germany with project team members in France and the UK: The distance between Germany and the UK is represented by the arrow A and the distance between Germany and France is represented by the arrow B.
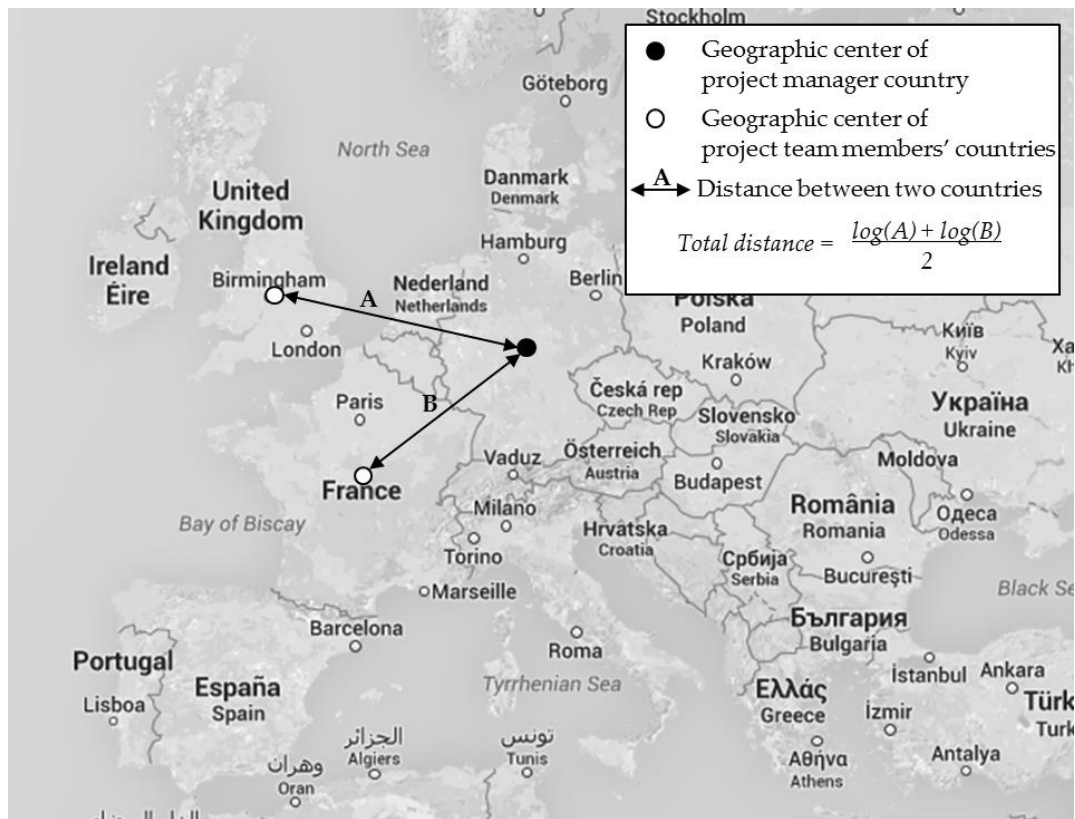
Figure 33: Assessing geographic distance

Secondly, the logarithm of the distance measure calculated to account for the fact that individuals typically "do not perceive that the burdens of travel increase linearly with air miles" (Ambos & Ambos 2009, p.6). Thirdly, the sum of the logged distances is divided by the number of countries involved minus one, to arrive at the average geographic distance within the team.

Temporal distance is measured likewise without step two: the data is not logged as each additional hour of time zone-related distance makes communication more difficult. As the measures are likely to be highly correlated, the construct is modeled reflectively. Table 24 summarizes the operationalization of the construct physical distance.

Construct		Indicators (reflective)	
PH-DIST	Physical distance	G-DIST	Geographical distance
		T-DIST	Temporal distance

Table 24: Operationalization of physical distance

Measurements of **cultural distance** in management research are typically based on studies of cultural dimensions such as those of Hofstede (1980), Trompenaars & Hampden-Turner (1998) or the GLOBE study (House et al. 2004) of societies (Maseland & Van Hoorn 2009; Taras et al. 2009; Hofstede 2010; Shi & Wang 2011). Hofstede (1980; 1994) is the first and nowadays most widely cited scholar of cultural distance (Shenkar 2001). He uses five cultural dimensions or scales alonog which members of different (national) cultures differ. These comprise:

1) *Power distance* describes the distribution of power, where high power distance characterizes an uneven distribution of power that lies with the highest ranked individuals whereas low power distance indicates a more evenly spread distribution of power within an organization

2) *Individualism versus collectivism* captures how much importance is attached to individual values (e.g., self-responsibility, self-realization) as compared to collective, group values

3) *Masculinity versus femininity* contrasts values typically attached to males, such as competitiveness and self-awareness to "typical" female values such as caring and cooperation

4) *Uncertainty avoidance* measures the degree of ease or difficulty with which individuals deal with unforeseen situations and to which they require fixed rules and regulations

5) *Long-term orientation*[112] assesses the planning horizon of a society (long-term or short-term).

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[112] This dimension was added by Hofstede later than the previous dimensions (Hofstede 1994).

Hofstede's cultural dimensions appeal to management scholars because related quantitative measures are readily available for a wide range of countries and easy to apply (Shenkar 2001; Kogut & Singh 1988). Yet, Hofstede's work has been criticized for not considering the influences of corporate culture and intra-national cultures, and for the lack of consideration of changes in culture over time (Berry et al. 2010; Shenkar 2001; Søndergaard 1994). These criticisms related to the influences of corporate, intra-national and time-related differences have been refuted by numerous empiric studies confirming Hofstede's dimensions based on different data sets (Maseland & van Hoorn 2009). Hofstede's cultural measures remain the most widely applied in management literature including studies on global teams (Ambos & Schlegelmilch 2007; Ambos & Ambos 2009; Böhm et al. 2009; Berg & Holtbrügge 2010; Sarala & Vaara 2010). Consequently, this dissertation measures cultural distance by a composite index developed by Kogut & Singh (1988) based on Hofstede's cultural dimensions.[113] The distance between the project team members and the project manager, respectively, is measured. The following formula represents the measurement approach for the composite index:

$$C\_DIST_j = \sum_{i=1}^{5}\{(I_{ij} - I_{ip})^2 / V_i\}/5$$

where I_{ij} is the index for the ith cultural dimension and jth country, I_{ip} is the index for ith cultural dimension of the country p where the project manager resides and V_i is the variance of the index of the ith dimension. If the project team members are located in more than one country other than the project manager's country, the index scores for the distance between each team member location and the project manager location are added. Like in the measurement of physical distance, the sum of the distances between the team members and the project manager is divided by the number of countries involved in the project. C-DIST is derived from this procedure as a single-item construct.

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[113] While the original index developed by Kogut & Singh (1988) is based on Hofstede's four initial cultural dimensions, this dissertation uses all five of Hofstede's cultural dimensions.

Linguistic distance is measured following the approach pursued by Chen et al. (1995; 2004) who measure the distance between an individual's mother tongue and a focal language. In this dissertation, the focal language is the language used primarily for the project member interaction. The distance between this focal language and the project participants' national languages is measured by counting the number of branches on Grimes' hierarchy of languages (cf. Graham & West 2004). Again, the sum of the distances between the team members and the project manager is divided by the number of countries involved in the project. Linguistic distance (L-DIST) is a single-item construct.

Tacitness. The degree of tacitness of the knowledge involved in a development project is frequently measured empirically and the construct can be derived from previously used indicators (Simonin 1999; Subramaniam & Venkatraman 2001) including knowledge complexity, codifiability, amount of previous knowledge required and knowledge specificity. Table 25 displays the respective reflective indicators.

Construct	Indicators (reflective)	
TACT Tacitness	TACT_01	The knowledge shared between the team members was complex.
	TACT_02	The knowledge shared between the team members can be written down, e.g. in a manual.
	TACT_03	Project members required significant previous knowledge to participate effectively in this project.
	TACT_04	Project members could not be easily replaced during the project because they developed or acquired specific knowledge.

Table 25: Operationalization of tacitness

Industry velocity. Slater (1993) associates the need to invest heavily in, e.g., R&D, to succeed in a high velocity industry. The typical R&D investment intensity of an industry will therefore be used to identify high-velocity industries. The survey population of companies comprises companies from eight industry

categories as classified by Standard & Poor's Global Industry Classification Standard (GICS) on the four-digit aggregation level (Standard & Poor's 2010).[114] Table 26 presents the average R&D quota of the companies in the population[115] for each GICS category. The R&D quota equals the annual R&D expenditure in percentage of annual sales in the financial year 2011; for each category, the unweighted average of all companies in the population allocated to the respective category is provided.

CIGS category	Number of companies in population	Average R&D quota of the category
1510 Materials	23	3.1%
2010 Capital Goods	34	4.7%
2510 Automobiles & Components	19	5.1%
3510 Health Care Equipment & Services	4	5.6%
3520 Pharmaceuticals & Biotechnology	3	11.4%
4510 Software & Services	2	10.8%
4520 Technology Hardware & Equipment	8	9.7%
4530 Semiconductors & Equipment	3	11.9%
Total	**96**	**5.4%**

Table 26: Industry R&D quotas

Table 26 displays average R&D quotas below 6% for the first four categories (materials, capital goods, automobiles & components, health care equipment & services), and average R&D quotas above 9.5% for the last four categories (pharmaceuticals & biotechnology, software & services, technology hardware & equipment, semiconductors & equipment). The difference in R&D quotas between these two groups is larger than the difference in R&D quotas within each

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[114] See Appendix C: GICS categories

[115] The same population of companies applies for the quantitative study as for the qualitative pre-study. Cf. section 5.1 for details on the identification of a population of 96 German-based MNCs.

of these two groups. Due to this clear distinction, the first group of categories is regarded as *moderate* whereas the second group is regarded as *high* in terms of industry velocity. The construct industry velocity is thus expressed by a nominal variable that indicates to which of these two groups the respective company belongs.

6.1.4.4   *Measurement models for control variables and marker variable*

The expert interviews revealed development cycle time and project team size as variables that differ considerably across companies and might have an impact on product development performance. These two variables are therefore added to the model as control variables. Additionally, project manager attitude is selected as a marker variable to identify and, if necessary, control for potential common method bias in the observed data.

Control variables. Development cycle time is translated into project duration and measures an individual project's duration in months. Project team size is measured by the number of team members regularly contributing to the project. Both control variables are measured as single-item constructs on ratio scales. Table 27 lists the constructs and associated indicators.

Construct		Indicators (reflective)	
PRDU	Project duration	PRDU_01	Number of months the project lasted
TSIZ	Team size	TSIZ_01	Number of employees who regularly contributed to the project

Table 27: Operationalization of the control variables

Marker variable. While some authors argue that the actual impact of social desirability on survey results is often marginal and should not be overpronounced (Spector 2006), this survey is designed in a way that allows post hoc testing for common method variance arising from social desirability, following Lindell and Whitney's method (Lindell & Whitney 2001) of including a

marker variable. Accordingly, project manager attitude is entered into the model as a marker variable that is theoretically unrelated to the other constructs in the model. The construct provides a measure for the overall attitude of the respondent towards global development teams. The underlying reasoning is that if respondents report a very optimistic attitude towards global teams, they tend to overinflate their performance. The construct PMAT is operationalized reflectively by two indicators which enquire whether the respondent likes working in global teams and whether the respondent believes that global teams can be more effective than teams staffed from only one country (cf. table 28).

Construct (marker variable)	Indicators (reflective)	
PMAT Project manager attitude	PMAT_01	I enjoy working with international teams
	PMAT_02	I believe international teams can be more effective than teams staffed from only one country.

Table 28: Operationalization of project manager attitude (marker variable)

6.2   OPERATIONALIZATION OF THE ONLINE SURVEY

6.2.1   Unit of analysis and sample size requirements

Unit of analysis. Product development activities largely consist of development projects (Donnellan & Fitzgerald 2004). Therefore, this dissertation uses global product development projects as a research unit to collect information of global product development teams. To meet this dissertation's research focus, these global product development projects must be conducted by German-based MNCs in the B2B sector. The list of 96 large German-based MNCs in the B2B sector with considerable international product development activities generated

for the qualitative study (cf. section 5.1) serves as a basis from which a sample of global product development projects needs to be drawn.[116]

Sample size requirements. To meet the minimum requirements of PLS-SEM, the sample size should be at least ten times the largest number of formative indicators required to measure a single construct, or ten times the largest number of structural paths pointing at a particular construct in the structural model (Bontis 1998; Hair et al. 2014), whatever is the larger number. In the basic structural model specified in section 6.1.2, the formative construct SOCN is defined by the largest number of formative indicators (seven indicators), and the largest number of structural paths points at the construct PDPF (eight arrows including control and marker variables). The minimum sample size is therefore 80 (cf. figure 30 above). The same applies to the moderated structural model where eight arrows point at the construct KNIN (cf. figure 32 above). In conclusion, a minimum sample size of 80 is required to derive valid results from the PLS-SEM algorithm. To conduct the MGA required for testing hypothesis *H12* on industry velocity as a moderating variable, a sample size of 80 is required in each subsample. Alternatively, insignificant paths can be removed from the basic model, thus reducing the model's complexity and the resulting sample size requirements (Huber et al. 2007, p.45).

6.2.2   Development and pre-testing of the online questionnaire

The questionnaire is designed following the tailored design method put forward by Dillman et al. (2009) as outlined in section 4.4.1. Based on the specification of the structural and measurement models developed in section 6.1, an initial questionnaire is developed to gather data. Particular attention is taken to control ex ante for **common method bias** derived from the risk that survey participants provide socially desirable answers and thereby overinflate the mean

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[116] Cf. Appendix B: Leading German-based MNCs in the B2B sector

when rating the overall performance of their projects (Podsakoff & Organ 1986; Meade et al. 2007). Thus, while the survey generally includes category sub-headings to guide the respondent through the questionnaire, the section on *performance* intentionally omits any such sub-headings in order not to hint at this section's relevance. Particular care is taken at the neutral and objective phrasing of items measuring performance (Podsakoff et al. 2003; Dillman et al. 2009). Respondents are not asked to rate performance per se but based on specific project characteristics such as adherence to budget, schedule and quality targets.

The questionnaire is implemented in an HTML online format using SoSci Survey (Leiner 2013). On March 16, 2013, the initial online questionnaire is released for a pre-test at www.soscisurvey.de/internationalproductdevelopment/. While the qualitative pre-study is intended to ensure the feasibility of the operationalization of the constructs, the pre-test of the online survey is intended to ensure that the proposed questions and procedure are understandable and implemented in a technically correct manner (Dillman et al. 2009, p.228). Thirteen individuals complete the online pre-test between March 16 and April 2 2013, including six researchers familiar with survey design, five researchers familiar with SEM techniques and two practitioners in global product development. The pre-testing follows the "think-aloud" method discussed in section 4.4.1 where respondents express their concerns as they answer the questionnaire. Each pre-test participant's remarks are validated and implemented during the pre-test phase to ensure that the subsequent pre-testers work with and evaluate the version improved by the previous pre-tester (Collins 2003). The pre-test participants' feedback is gathered online, via email and telephone.

As the questionnaire is implemented in German and English, the pre-test participants include native speakers of both languages who are asked to pay attention to correct phrasing and wording. The pre-test participants are furthermore asked to focus on the methodological and statistical soundness of the

questionnaire as well as on the completeness and practical relevance of the questions.

The questionnaire is finalized in May 2013. After welcoming the participants and outlining the survey objectives, the questionnaire asks respondents to confirm they have managed a global product development project for a German-based MNC. Only respondents who confirm are forwarded to the actual questionnaire. This ensures that only eligible respondents take part in the survey. The survey then starts with general questions about the characteristics of the project, its context and its team members. This is followed by questions on the application of governance mechanisms and performance criteria. The questionnaire ends by thanking the respondents for their time and offering them the opportunity to leave remarks or enter email addresses of further potential participants to be invited.[117]

6.2.3   Survey launch and data collection

Identification of the sample. A three-step procedure is applied to identify the sample: Firstly, the most senior R&D managers of the 96 companies in the population are identified via internet research and email contact with the companies' public relations departments. Secondly, contact to the experts interviewed in the qualitative pre-study is re-established. Thirdly, the international business network LinkedIn (www.linkedin.com) and the German business network XING (www.xing.com) are used to identify further project managers and senior staff with product development responsibility within the target companies.[118]

Survey launch. The finalized survey questionnaire is published online between May 21, 2013 and July 10, 2013. The invitation to participate in the online

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[117] See Appendix F: Online questionnaire
[118] See Brettel et al. (2011, p.256) for this sampling approach

survey is sent via email.[119] Invitees are asked to participate in the online survey by following a hyperlink provided in the email, or alternatively to forward the link within their organization, following the methodological approach of *snowball sampling* which is applicable when the population of respondents is unknown (Biernacki & Waldorf 1981; Malhotra & Birks 2006, pp.364–365; Babbie 2012, p.192).[120]

Following the approach of tailored survey design, the survey launch requires survey participants to perceive *rewards*, to keep *participation costs* low and establish *trust* Dillman et al. (2009, pp.23–40). This is established as follows:

- **Rewards** for the participants are created by explaining the academic and managerial importance of the topic to the invitees, addressing the invitees personally as subject matter experts and offering them to share the results of the study. Reminders sent out to invitees mention the number of responses that has already been received by that point in time, and – if available – the number of responses from the same industry received so far. To improve response rates, invitees are offered a summary of the results and, upon request, a bespoke benchmark report of the results for their industry, provided they participate in the survey.

- **Participation costs** are kept low by limiting the questionnaire to eight pages which can be answered within 15 minutes. Also, the questionnaire is structured simply and unambiguously following the suggestions of Dillman et al. (2009, chap.4) on crafting good questions.

- **Trust** is established by guaranteeing anonymity to the respondents and providing them with the research context. The survey does not require

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[119] See Appendix F: Online questionnaire

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[120] The email invitation to participate in the survey contains a hyperlink to the survey, and a universal password to start the survey which restricts random visitors of the survey website to access the survey. For details, see Appendix G: Invitation and reminder to participate in quantitative online survey.

providing any personal data, and all questions hinting at the participants' identity (e.g., number of years worked for the company) are designed as optional. The email addresses of the participants interested in receiving the survey results are automatically saved in a different database than the response data so that no link can be established between the responses and respondents. To provide the respondents with the broader research context, the survey invitation provides details about the research project, the contact details of the researcher are provided both in the invitation and at the start of the survey. Additionally, a presentation is attached to the invitation email introducing the research project in more detail and providing the background of the researcher.

Data collection process. Between May 21, 2013 and July 14, 2013, a total of 476 identified project managers and senior product development managers from 91 German-based MNCs[121] are contacted and invited to participate in the survey. During the period of data collection, the response status is updated on a daily basis. After the initial invitation, up to three personalized reminders are sent to those participants who have not yet responded. The reminders contain a condensed version of the information provided in the initial survey invitation (Sue & Ritter 2007, p.93) and additional information on the survey status, including the current number of responses received from the respective invitee's industry.[122]

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[121] For 5 companies in the sample of 96 German-based MNCs, relevant individuals could not be identified.

[122] See Appendix G: Invitation and reminder to participate in quantitative online survey

6.3 CHARACTERIZATION OF THE SAMPLE

6.3.1 Response rate

In the time between May 21 and July 14, 2013, the online questionnaire is invoked 200 times (42% gross response rate). 19 individuals lack international project management experience in product development and thus do not qualify to participate in the survey. Of the remaining 181 respondents invoking the survey, 136 individuals complete the questionnaire (75% completion rate). Out of these completed cases, 16 cases either lack more than 15% of the required responses, or do not include answers for all indicators required to measure a certain construct. These cases are deleted as they cannot be processed in PLS-SEM (Hair et al. 2014, pp.51–52). The remaining 120 complete, usable cases constitute an adjusted response rate of 25%. This equals an average response rate for written surveys in international management research (Yang et al. 2006).[123] When measuring the response rate by participation of companies, usable data was received from 60 of 91 contacted companies. This equals an exceptionally high response rate of 66% which exceeds average response rates by far (Yang et al. 2006; Baruch & Holtom 2008). Figure 34 depicts the response rate statistics.

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[123] Yang et al. (2006, p.611) report a mean response rate for mail surveys in international business journals of 27%
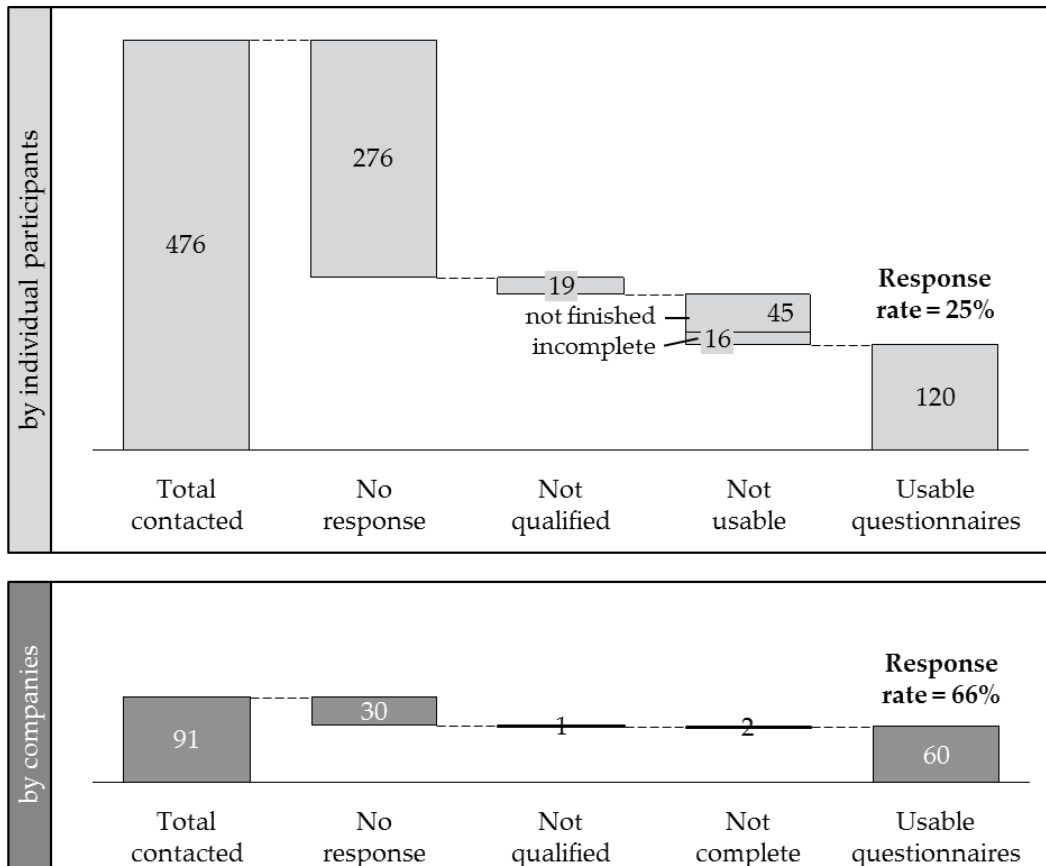
Figure 34: Response rates by individual participants and companies

6.3.2   Representativeness

The objective of the quantitative survey is to generate representative data which allows for a generalization of the results to the population of German-based MNCs in the B2B sector. To test for representativeness of the sample, its industry representativeness is considered, and tests for key informant bias and non-response bias are conducted.

Industry representativeness. Samples that allow for a generalization of the results represent the characteristics of the population (Hair et al. 2010, p.700). Industry affiliation is a commonly used criterion to test for sample representativeness in business studies (Homburg & Giering 1996). This criterion

is available both for the population from which the sample was drawn[124] and for the sample. A chi-square (χ^2) test is applied to test the homogeneity of the population and sample (Bortz & Schuster 2009, pp.137–142). With a χ^2 value of 35.5, the null-hypotheses that the sample distribution equals the population distribution must be rejected at the 0.05 significance level, pointing towards a lack of representativeness of the sample distribution for the industry. Figure 35 depicts the distribution of industry affiliation among the population and the sample and indicates that the difference between the population and the sample is largely driven by the underrepresentation of the industry cluster *materials* and the overrepresentation of industry cluster *software* in the sample. This is plausible as the materials cluster is characterized by the lowest R&D quota whereas the software cluster has one of the highest R&D quotas (cf. table 26 above). The chi-square test is repeated to test the representativeness of the sample taking into consideration the R&D intensity of the industry by weighing the number of companies in each industry cluster in the population with the R&D intensity of this industry category. The resulting χ^2 value is 17.386, implying that the null hypotheses can be accepted at the 0.05 significance level, thus accepting the representativeness of the sample.

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[124] Cf. Appendix A
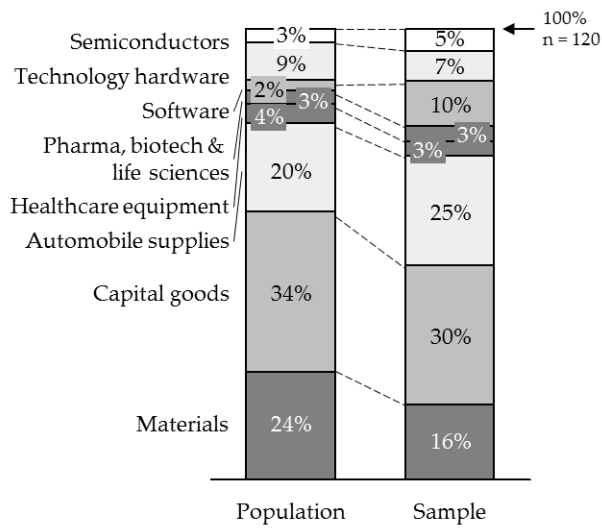
Figure 35: Distribution of the population and sample by industry

Key informant bias is a potential source for systematic measurement error which occurs if a respondent lacks sufficient knowledge of the topic he or she is enquired about (Phillips 1981; Kumar et al. 1993). All usable responses confirm that the respondent works for a German-based MNC and has managed at least one product development project with international project members. Furthermore, data gathered on the respondents' experience shows that respondents have managed on average 6.9 global product development project teams throughout their career, and have substantial knowledge of the companies they work for with an average of 10.8 years working experience with their current employer (see figure 36). Key informant bias is therefore not perceived to be an issue in this study (Phillips 1981).

Number of product development projects managed by the respondents

> 10
16%

< 3
23%

6 - 10 20%

45%
3 - 5

n = 120
Mean = 6.9
Median = 4.5

Number of years the respondents have worked for their current employer

< 3
8%

3 - 5
18%

> 10 45%

28%
6 - 10

n = 120
Mean = 10.8
Median = 10
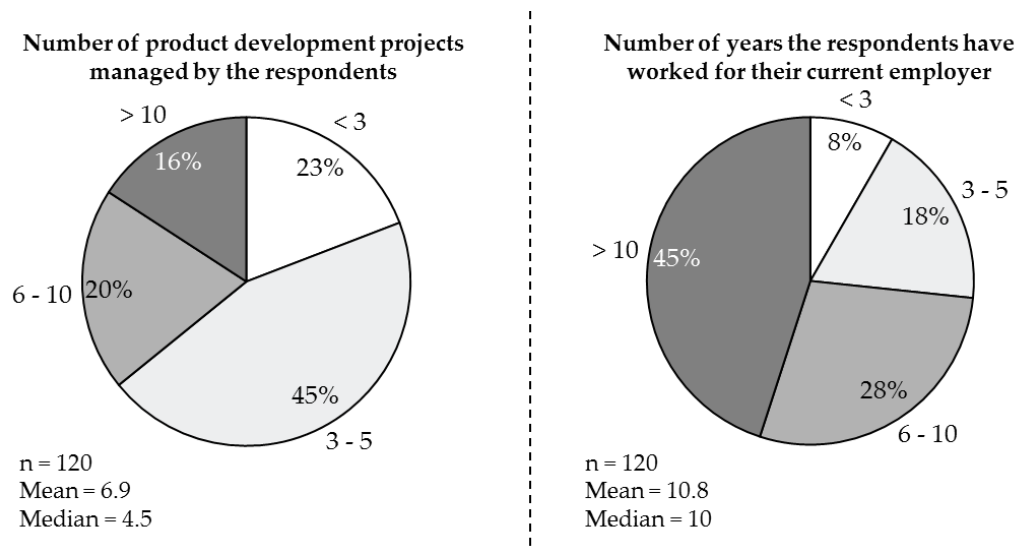
Figure 36: Characteristics of key informants

Non-response bias. Furthermore, survey results can be biased by non-response rates, and systematic measurement errors occur when "persons who respond differ substantially from those who do not" (Armstrong & Overton 1977, p.396). A *time trend extrapolation test* (Armstrong & Overton 1977, p.396) is applied to test ex-post for potential non-response bias by comparing answers from respondents who answered to the survey late to those who answered early, assuming that the answers of late respondents (who have, assumedly, a less favorable attitude to participating in such a survey), are similar to the assumed answers of non-respondents (Oppenheim 1966). A t-test is therefore applied to all Likert-scaled questionnaire items in order to identify potential non-respondent bias (Bortz & Schuster 2009, pp.120–124), with the 20 last responses marked as "late respondents". Only two out of a total of 53 Likert-scale items contained in the survey reveal a p-value below 0.05 which points at potential non-response error (Pérez-Nordtvedt et al. 2008; Lawson et al. 2009). The means of these two items differ between the early and late respondents by less than one point on the seven-point Likert scale. Due to the small proportion of items prone to non-response error and the small variance, non-response bias is not considered to be of concern for this dissertation's survey results.

6.3.3   Descriptive statistics

Product development performance. The observed projects are rated as rather successful with average indicator values well above the mid-point of 4 on the seven point Likert scale (see figure 37).

PDPF_01	The project adhered to the pre-defined project timeline.	4.76	n = 120; sd = 1.83
PDPF_02	The project operated in a cost efficient manner.	4.68	n = 120; sd = 1.64
PDPF_03	The development results met the pre-defined quality targets.	5.76	n = 118; sd = 1.10
PDPF_04	Overall, our organization considers this project a success.	5.60	n = 120; sd = 1.47
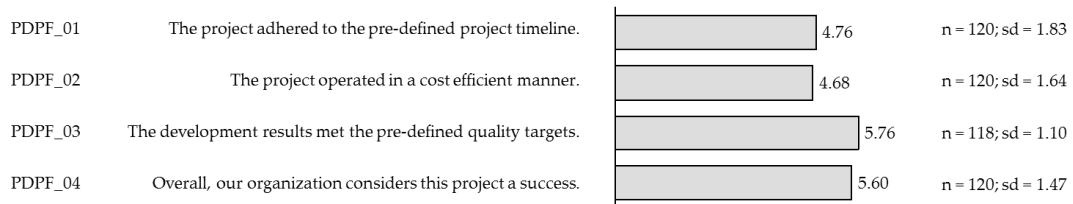
Figure 37: Descriptive statistics for product development performance

Knowledge integration between the members of global product development teams is likewise perceived as high with one exception: Misunderstandings between project team members appear to happen more often than not in global teams (see figure 38).

KNIN_01	Staffing this project with members from different countries led to knowledge and ideas that we would not have had if the project team had been staffed from only one country.	4.83	n = 119; sd = 2.01
KNIN_02	Misunderstandings between the international project members were a frequent issue that would not have come up in a project team staffed from only one country. (reverse-coded)	3.17	n = 120; sd = 1.89
KNIN_03	Project members from different countries jointly developed new knowledge in this project.	5.17	n = 120; sd = 1.42
KNIN_04	Knowledge from different locations was integrated effectively in this project.	5.14	n = 118; sd = 1.42
KNIN_05	The project team could access knowledge from different countries when needed.	5.69	n = 118; sd = 1.33

Figure 38: Descriptive statistics for knowledge integration

Individual absorptive capacity as assessed by the motivation and capability of the team members is rated high: The contribution of unique and new ideas is the only indicator with an average rating below 5 on the seven-point Likert scale (see figure 39).

MOTI_01	Project team members immersed themselves in the project.	5.18	n = 118; sd = 1.34
MOTI_02	Project team members showed continuously high interest in the project.	5.61	n = 120; sd = 1.27
CAPB_01	Project members brought excellent professional skills to the project.	5.48	n = 120; sd = 1.13
CAPB_02	Project members brought unique and new ideas to the project.	4.86	n = 120; sd = 1.35
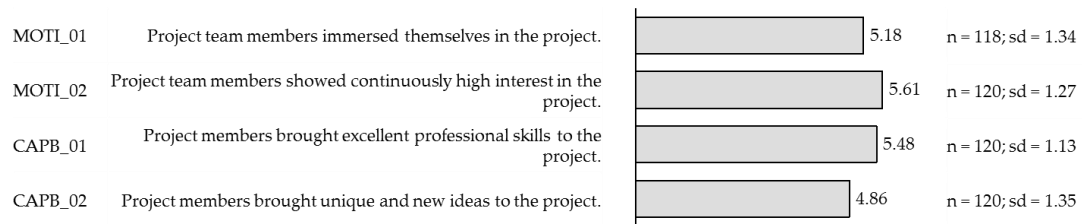
Figure 39: Descriptive statistics for individual absorptive capacity

Governance mechanisms. The descriptive statistics on governance mechanisms answer the first research question by providing an overview of the extent to which the different governance mechanisms previously identified are applied in practice by German-based MNCs in the B2B sector.

Hierarchical governance mechanisms are applied rather frequently with all but one indicator receiving an average rating above 5 on the seven-point Likert scale. Standard processes are even more frequently applied with all indicators achieving an average rating above 5.5 on the seven-point Likert scale. Knowledge management systems, rewards and socialization are applied least with the majority of indicators rated on average below 4 on the seven-point Likert scale, as summarized in figure 40.[125] These findings are not surprising given the previous feedback from the qualitative interviews where standard processes were discussed very frequently while rewards were hardly applied and the different mechanisms contributing to socialization were applied to very different extents by the interviewed experts' companies (see figure 40). This findings is also in line with the theoretic proposition that cost efficiency is a key criterion for selecting and applying governance mechanisms in practice, as put forward in TCE (Klein et al. 1978; Williamson 1999) and the KGA (Foss 2011).

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[125] Note that the scales for KMSY_01, SOCN_06 and SOCN_07 are rated on a scale from 0 to 7 whereas all other scales range from 1 to 7.

HQIN_01	Corporate headquarters have formally instructed this project.	5.34	n = 118; sd = 1.87
HQIN_02	Corporate headquarters themselves have been actively involved in this project.	5.62	n = 119; sd = 1.53
HQIN_03	Corporate headquarters have financed this project.	5.26	n = 118; sd = 2.01
MGAT_01	The steering committee involved top managers of the global organization.	5.64	n = 119; sd = 1.54
MGAT_02	Top management continuously showed that this project was of high priority.	4.93	n = 119; sd = 1.60
MGAT_03	A steering committee regularly checked on the project's progress.	5.86	n = 120; sd = 1.38
HEVY_01	The project manager had direct access to and responsibility for the work of the project team members.	5.03	n = 120; sd = 1.65
HEVY_02	The project team reported directly to the project manager.	5.15	n = 120; sd = 1.88
KMSY_01	Frequency of utilization of internationally accessible knowledge management databases	2.68	n = 120; sd = 2.30
STDP_01	The project adhered to our organization's global standard product development process.	5.78	n = 117; sd = 1.56
STDP_02	A formal (written) business plan clearly stated the project objectives, resources, budget and time frame.	5.68	n = 118; sd = 1.51
STDP_03	The project progress was frequently measured against pre-defined performance indicators (budget, time, quality).	5.84	n = 120; sd = 1.42
RWRD_01	The achievement of project objectives was part of the formal appraisal of project members.	4.92	n = 114; sd = 1.96
RWRD_02	Project members' contribution to the project was acknowledged by increments / bonuses.	3.51	n = 110; sd = 2.04
RWRD_03	Project members' contribution to the project was acknowledged by promotion.	3.87	n = 108; sd = 1.86
RWRD_04	Project members' contribution to the project was acknowledged in internal communication.	4.58	n = 117; sd = 1.83
SOCN_01	Project members have been on long-term assignments abroad (more than 6 months).	2.13	n = 115; sd = 1.51
SOCN_02	Project members have been on short-term assignments abroad (less than 6 months).	2.96	n = 116; sd = 1.62
SOCN_03	Project members are part of international corporate networks.	3.44	n = 111; sd = 1.85
SOCN_04	Project members have participated in international trainings.	3.55	n = 109; sd = 1.60
SOCN_05	The international project members had worked with each other before this project.	3.33	n = 120; sd = 2.00
SOCN_06	Frequency of physical meetings of the project team	5.03	n = 120; sd = 1.83
SOCN_07	Frequency of advanced video conferences with the project team	1.98	n = 120; sd = 2.24

Figure 40: Descriptive statistics for governance mechanisms

Context factors. On average, 4.5 countries are involved in a global product development team in the sample. Table 29 depicts the descriptive statistics of the different dimensions of distance.

	Geographic distance	Temporal distance	Linguistic distance	Cultural distance	Countries involved
Mean	0.52	2.01	2.17	1.14	4.47
Minimum	0.07	0	0	0.02	2
Maximum	1.01	7.33	5	4.22	10

Table 29: Descriptive statistics for different dimensions of distance

The descriptive statistics for the context factor *tacitness* reveal that all indicators are rated above the mid-point of the seven-point Likert scale (see figure 41). This finding does not come as a surprise given the generally high level of tacitness associated with product development knowledge (cf. section 2.3.1).

TACT_01	The knowledge shared between the team members was complex.	5.80	n = 120; sd = 1.23
TACT_02	The knowledge shared between the team members can be written down, e.g. in a manual.	4.56	n = 119; sd = 1.64
TACT_03	Project members required significant previous knowledge to participate effectively in this project.	5.65	n = 120; sd = 1.07
TACT_04	Project members could not be easily replaced during the project as they developed or acquired specific knowledge.	5.41	n = 119; sd = 1.37

Figure 41: Descriptive statistics for tacitness

The descriptive statistics for industry velocity are provided in figure 35 above. The sample contains 90 cases from moderate-velocity industries and 30 cases from high-velocity industries. The low number of cases from high-velocity industries is representative for the population but has significant implications on the applicable PLS-SEM model for the multi-group analysis (MGA) which requires a sample of 80 cases for each data subset, as outlined in section 6.2.1. This challenge is revisited when analyzing the MGA (cf. section 6.6.1).

Control variables. The projects in the sample take an average *duration* of 31 months to complete with the largest share of projects (25%) lasting between two and three years. Overall, the sample includes projects lasting as short as 1 month and as long as seven years. The average *team size* registered for the projects in the sample is 35.5. Team sizes of more than 35 occur mainly in the software industry, and the sample's median value of 12 indicates a skewed data distribution.[126] Figure 42 presents the descriptive statistics of the two control variables.
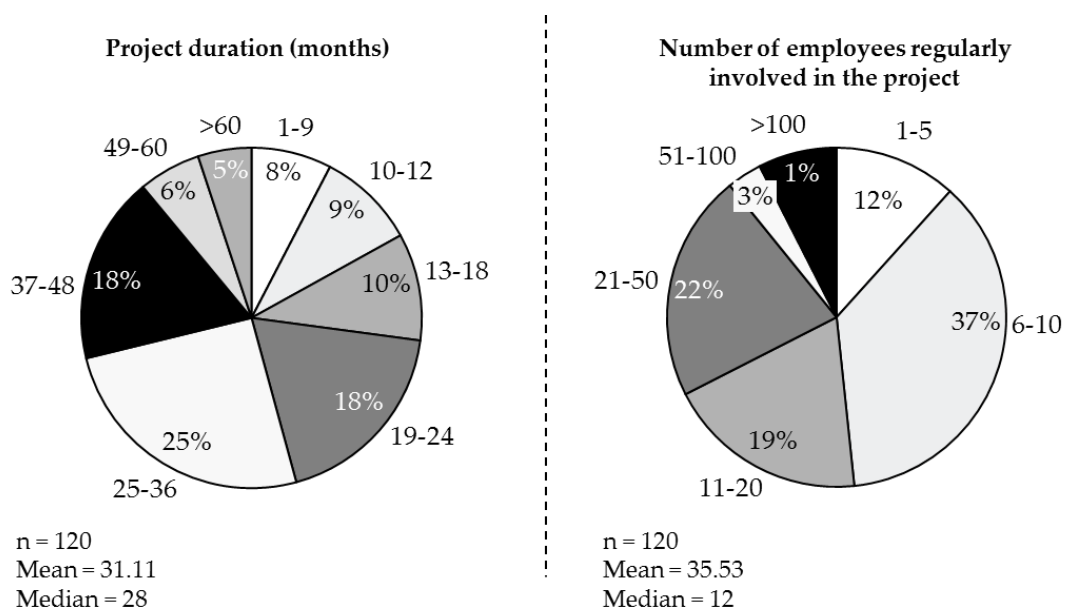
Figure 42: Descriptive statistics for project duration and number of employees

Marker variable. The indicators constituting the marker variable *project manager attitude* are among the highest rated values in the survey. Mean values on the seven-point Likert scale of 6.53 and 5.24, respectively, indicate that the surveyed managers have an overall very positive attitude towards global product development projects (figure 43).

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[126] See section 6.3.4 below for the treatment of non-normal data.

| PMAT_01 | I enjoy working with international teams | | 6.53 | n = 120; sd = 0.74 |
| PMAT_02 | I believe international teams can be more effective than teams staffed from only one country. | | 5.24 | n = 120; sd = 1.77 |
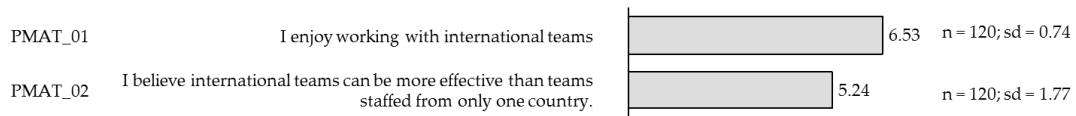
Figure 43: Descriptive statistics for project manager attitude

This raises the questions whether (1) the respondents' positive attitude derives from having managed a global team successfully, (2) a response bias exists as only those project managers responded who have a particularly positive attitude towards global teams or (3) project managers with positive attitudes towards global teams are more likely to be selected to manage these teams. Question (1) can be answered by conducting a chi-square test comparing the responses for PDPF_04 ("Our organization considers project an overall success.") with the responses for PMAT_01 and PMAT_02, respectively. With χ^2 values of 68.034 for PMAT_01 and 19.338 for PMAT_02 the null hypotheses that project success does not influence project manager attitude can be accepted at the 0.05 confidence level. Question (2) is answered by entering the construct PMAT into the PLS-SEM model and assessing cross correlations.[127] Answering question (3) requires further research. Existing empiric evidence suggests that affective commitment (such as a positive attitude towards global teams) significantly contributes to knowledge sharing in product development (Matzler et al. 2011) which this study views as a key contributing factor to product development success. This potential explanation would render project managers with a positive attitude towards global teams the preferred choice for global product development projects. To understand whether this is a potential source of respondent bias, further research would be required.

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[127] Cf. section 4.4.2.4 for the methodology of this procedure known as Lindell-Whitney test (Lindell & Whitney 2001) and section 6.4.2 for the empirical results.

6.3.4   Data preparation for PLS analysis

Before applying PLS-SEM statistics, the gathered data must be carefully examined for missing values, outliers and non-normal data distribution. Each of these can substantially influence the interpretability of statistical results (Hair et al. 2014; Tenenhaus et al. 2005).

Missing values are treated according to the procedure suggested by Hair et al. (2014, pp.51–52): Firstly, cases which lack more than 15% of required responses, or do not include answers for all indicators required to measure a certain construct, are excluded from the sample as they cannot be processed in PLS-SEM (see section 6.3.1). Secondly, the dataset is checked indicator-wise. Whenever less than 5% of data for an indicator are missing, data is completed by mean replacement (Hair et al. 2010, chap.2), i.e. the mean value of the completed caess is inserted. This technique is applied to 23 indicators in the sample. Five indicators related to two constructs display more than 5% missing data. These indicators deal with project members' incentives and socialization outside the project[128], and are thus related to facts that might not be known to a project manager since they are not in his or her direct responsibility. At the same time, these indicator values can be assumed to be rather homogenous across projects for the same company. Therefore, all cases where this data point is missing are compared to peer-cases from the same company, and the missing values are replaced by the mean values for the peer group, following the "hot deck imputation" method (Hair et al. 2010, chap.2).

Outliers. The sample data is carefully screened for potential outliers. As the applied survey software SoSci Survey (Leiner 2013) provides data on the amount of time needed by each participant to complete each page of the survey, the cases of participants that answered the survey particularly quickly are screened for

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[128] This pertains to the indicators SOCN_03, SOCN_04, RWRD_01, RWRD_02 and RWRD_04.

inconsistent data entries. This approach reveals no abnormalities. Subsequently, all scores are normalized to their z-score where z equals the score x less the mean of the sample divided by the standard deviation of the sample. Cases with z-scores above 3 or below -3 are deemed outliers, and the cases that contain a significant number of outliers are checked for potential need for elimination. Only one case is identified to contain a significant amount of outliers but displays internal consistency. It is retained as the risk of deleting meaningful cases is deemed too high as to delete it (Hair et al. 2010, chap.2).

Normal distribution. PLS scholars frequently cite the ability of PLS-SEM to deal with non-normally distributed data as one of the main reasons for applying PLS-SEM instead of CB-SEM (Reinartz et al. 2009).[129] However, extremely non-normally distributed data inflate standard errors and decrease the likelihood to discover significant relationships (Hair et al. 2014, p.54). Furthermore, tests such as the Levene's test to assess the results of the MGA cannot be applied with non-normally distributed data (Hair et al. 2014, p.277; Levene 1960). The raw data is therefore examined for skewness and kurtosis, and indicators displaying values of skewness and kurtosis larger than 1 or smaller than -1 are transformed into normal data (Hair et al. 2014, pp.54–55).[130] The normalized indicators pass the tests for extreme non-normality, allowing to proceed with the PLS-SEM analysis using the SmartPLS software (Ringle et al. 2005).

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[129] Cf. section 4.4.2.3

[130] For details on the transformation of non-normally distributed data, see Appendix H: Treatment of non-normally distributed data

6.4   EVALUATION AND DISCUSSION OF THE BASIC MODEL

6.4.1   Evaluation of the measurement models

6.4.1.1   Evaluation of the reflective measurement models

Using the basic structural model, the PLS-SEM algorithm converges after 9 iterations, indicating a sufficient sample size and sufficient variability in the data (Hair et al. 2014, p.109). The model can thus be assessed, starting with the reflective measurement models.[131] Three indicators' outer loadings do not exceed the threshold value of 0.708 (see table 30). Of these three indicators, MOTI_01 is retained as it does meet the threshold for its first order construct MOTI and falls only marginally below the threshold for its second order construct CAPB. KNIN_01 and KNIN_02 are deleted.

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[131] Cf. section 4.4.2.4 for the evaluation procedure and criteria

Outer loadings λ	CAPB	HEVY	HQIN	KNIN	MGAT	MOTI	PMAT	STDP
CAPB_01	.8811							
CAPB_02	.8867							
HEVY_01		.9211						
HEVY_02		.7820						
HQIN_01			.8640					
HQIN_02			.7624					
HQIN_03			.7605					
KNIN_01				.6260				
KNIN_02				.5488				
KNIN_03				.7713				
KNIN_04				.8617				
KNIN_05				.7611				
MGAT_01					.8150			
MGAT_02					.8577			
MGAT_03					.7346			
MOTI_01						.8568		
MOTI_02						.9074		
PMAT_01							.8429	
PMAT_02							.8476	
STDP_01								.7140
STDP_02								.8648
STDP_03								.8209

Table 30: Initial outer loadings of reflective measurement models

Table 31 summarizes the results of the evaluation of the reflective measurement models after the initial deletion of the two indicators KNIN_01 and KNIN_02. For the remaining reflective indicators, the threshold values suggested for internal consistency (composite reliability) all exceed the threshold value of $\rho_\eta > 0.6$ and the threshold value for convergent validity of AVE > 0.5. Testing for discriminant validity likewise shows acceptable results for all indicators.[132] All reflective measurement models are accepted.

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[132] Only the second order construct ICAP shows strong cross-loadings with each of its two first order constructs CAPB and MOTI. This is acceptable given the reflective second order measurement model.

Con-structs	Indicators	Outer loadings λ	Composite reliability ρ_η	Convergent validity AVE	Discriminant validity	
					Construct (Fornell-Larcker)	Indicator (Cross loadings)
CAPB	CAPB_01	0.8812	0.8772	0.7813	✓*	✓
	CAPB_02	0.8866				✓
HEVY	HEVY_01	0.9232	0.8425	0.7292	✓	✓
	HEVY_02	0.7786				✓
HQIN	HQIN_01	0.8376	0.8384	0.6340	✓	✓
	HQIN_02	0.7726				✓
	HQIN_03	0.7768				✓
ICAP	CAPB_01	0.7831	0.8658	0.6186	✓*	✓
	CAPB_02	0.8002				✓
	MOTI_01	0.6976				✓
	MOTI_02	0.8569				✓
KNIN	KNIN_03	0.8326	0.8725	0.6955	✓	✓
	KNIN_04	0.8668				✓
	KNIN_05	0.8012				✓
MGAT	MGAT_01	0.8141	0.8455	0.6468	✓	✓
	MGAT_02	0.8567				✓
	MGAT_03	0.7373				✓
MOTI	MOTI_01	0.8566	0.8755	0.7787	✓*	✓
	MOTI_02	0.9075				✓
PMAT	PMAT_01	0.8602	0.8332	0.7142	✓	✓
	PMAT_02	0.8297				✓
STDP	STDP_01	0.7039	0.8427	0.6427	✓	✓
	STDP_02	0.8635				✓
	STDP_03	0.8288				✓

* Permissible cross loadings between higher and lower order constructs

Table 31: Results summary of reflective measurement models

6.4.1.2   Evaluation of the formative measurement models

Next, the formative measurement models contained in the basic model are assessed. These measure the constructs rewards (RWRD), socialization (SOCN) and product development performance (PDPF).

Convergent validity. Due to the fact that the operationalization of the construct is based on experts' judgments, content validity is accepted (Götz et al. 2010; Kline 2011).

Collinearity. The VIFs, based on regressing each formative indicator with the other formative indicators associated with the same construct, reveal no collinearity. Table 32 displays the VIF values for each formative indicator which are all far below the threshold value of 5.

RWRD			SOCN			PDPF	
Indicators	**VIF**		**Indicators**	**VIF**		**Indicators**	**VIF**
RWRD_01	1.3694		SOCN_01	1.3288		PDPF_01	1.0125
RWRD_02	1.5003		SOCN_02	1.2156		PDPF_02	1.0067
RWRD_03	1.6205		SOCN_03	1.5831		PDPF_03	1.0149
RWRD_04	1.3464		SOCN_04	1.6220		PDPF_04	1.0134
			SOCN_05	1.0687			
			SOCN_06	1.0975			
			SOCN_07	1.0641			

Table 32: Variance inflation factors of formative indicators

Significance and relevance. To evaluate significance and relevance of the three formative measurement models, the bootstrapping algorithm is run with 5,000 subsamples drawn from the sample of 120 valid observations. Table 33 presents the results including the outer weights and outer loadings with their respective t-values. All four indicators measuring PDPF display significant outer weights and relevant and significant outer loadings. Only one of the four indicators measuring the construct RWRD displays significant outer weights; two indicators display no relevant outer loadings, but all outer loadings are significant, and therefore retained. Among the seven indicators measuring the construct SOCN, three indicators (SOCN_01, SOCN_02 and SOCN_06) do not meet the thresholds for any of the three evaluation criteria. These deal with long-

and short-term foreign assignments and with physical meetings, and are removed from the model. The bootstrapping algorithm is then re-run with 5,000 subsamples. Table 33 summarizes the results.

Con-struct	Indicator	Outer weight π	t-value of outer weight	Signifi-cance	Outer loading	Rele-vance	t-value of outer loading	Signifi-cance
PDPF	PDPF_01	0.5174	2.0097	**	0.6910	yes	5.1482	***
	PDPF_02	0.3364	2.1710	**	0.7607	yes	6.8296	***
	PDPF_03	0.2867	2.1061	**	0.6276	yes	5.0289	***
	PDPF_04	0.2141	1.8049	*	0.8060	yes	7.2473	***
RWRD	RWRD_01	0.1738	1.0144	NS	0.4882	no	3.2953	***
	RWRD_02	0.1377	0.7832	NS	0.4531	no	3.4257	***
	RWRD_03	0.2701	1.5810	NS	0.7441	yes	7.7196	***
	RWRD_04	0.7167	5.8630	***	0.9095	yes	13.6655	***
SOCN	SOCN_03	0.7085	2.1852	**	0.8450	yes	4.3049	***
	SOCN_04	0.0416	0.1106	NS	0.5109	yes	1.9391	*
	SOCN_05	0.4092	1.4953	NS	0.5444	yes	2.1174	**
	SOCN_07	0.3487	1.3191	NS	0.4510	no	1.8372	*

NS = not significant; * significant at $p < 0.1$; ** significant at $p < 0.05$; *** significant at $p < 0.01$

Table 33: Evaluation of the adjusted formative measurement models

6.4.2   Evaluation of the structural model

Firstly, the data set is assessed for collinearity. For each endogenous construct, collinearity (variance inflation) with the subset of related exogenous constructs (predictors) is evaluated. Table 34 presents the results. With all VIF values significantly below the threshold value of 5.00, collinearity is not considered an issue in the data set.

Predictors	Endogenous constructs			
	ICAP	KNIN	PDPF	STDP
HEVY	1.1102	-	1.1746	-
HQIN	-	1.0002	1.0066	-
ICAP	-	1.2369	1.2480	-
KNIN	-	-	1.1468	-
KMSY	-	1.0153	-	-
MGAT	1.1741	-	-	1.0870
PDPF	-	-	-	-
PMAT	-	-	1.0135	-
PRDU	-	-	1.1165	-
RWRD	1.4063	-	-	-
SOCN	-	1.0856	-	-
STDP	-	1.0120	1.0992	-
TSIZ	-	-	1.0000	-

Table 34: Variance inflation factors of constructs

Secondly, the path coefficients are evaluated for relevance and significance. Table 35 shows the path coefficients of the basic model as well as the t-statistics and the resulting significance levels of the paths. The measurement model for the second order construct ICAP can be accepted based on these results. Furthermore, the results provide evidence to accept twelve out of the fourteen hypotheses tested in the basic model. Additionally, the results show an unexpected strongly negative, highly significant path relationship between the control variable project duration (PRDU) and PDPF. This result can be traced back to a considerable correlation between the indicator PDPF_01 (adherence to schedule) and the control variable PRDU.

Path relationships	Path coefficients γ	t-value of path coefficients	Signifi-cance	Interpretation
Measurement model 2nd order construct				
ICAP → CAPB	0.8957	44.8155	***	Measurement model accepted
ICAP → MOTI	0.8878	33.9990	***	
Hypotheses testing				
KNIN → PDPF	0.2579	2.1910	**	H1 supported
ICAP → KNIN	0.4206	4.3628	***	H2a supported
ICAP → PDPF	0.2742	2.6192	***	H2b supported
HQIN → KNIN	-0.1119	0.8907	NS	H3a* partly supported
HQIN → PDPF	-0.0357	0.3322	NS	H3b* rejected
MGAT → ICAP	0.2953	3.8220	***	H4a supported
MGAT → STDP	0.2892	2.7581	***	H4b supported
HEVY → PDPF	0.2057	2.5274	**	H5a supported
HEVY → ICAP	0.2133	2.9527	***	H5b supported
KMSY → KNIN	-0.0032	0.0304	NS	H6 not supported
STDP → KNIN	0.0238	0.2284	NS	H7a supported
STDP → PDPF	0.2496	2.8186	***	H7b supported
RWRD → ICAP	0.4005	5.5051	***	H8 supported
SOCN → KNIN	0.2136	2.1950	**	H9a supported
Control variables				
PRDU → PDPF	-0.3685	3.5871	***	Strong, significant influence on PDPF
TSIZ → PDPF	0.0360	0.4312	NS	No significant influence
Marker variable				
PMAT → PDPF	-0.1594	1.3217	NS	No significant common method bias

NS = not significant; * significant at $p < 0.1$; ** significant at $p < 0.05$; *** significant at $p < 0.01$

Table 35: Evaluation of path coefficients in original basic model

The control variable TSIZ is not significantly related to PDPF and has no impact on the model.

Common method bias. The marker variable PMAT is neither significantly related to the PDPF. To assess the potential risk of common method bias, the correlation and shared variance of the marker variable PMAT with all constructs is assessed. Following Lindell & Whitney (2001), the shared variance of the marker variable should not exceed 50% with any other construct. The squared correlation between the constructs is a proxy for the shared variance between the constructs. In the basic model, PMAT shares the highest shared variance with KNIN (30%; cf. table 36). For all other constructs, shared variance with PMAT is below 10%. These results indicate that the risk of the results being flawed due to common method bias can be disregarded.

	Correlation	Shared variance		Correlation	Shared variance
EMPL	-0.0409	0.0017	MGAT	0.2451	0.0601
HEVY	0.0621	0.0039	PDPF	0.1217	0.0148
HQIN	-0.0735	0.0054	PRDU	-0.1036	0.0107
ICAP	0.2255	0.0509	RWRD	0.0295	0.0009
KMSY	0.0195	0.0004	SOCN	0.1168	0.0136
KNIN	0.5522	0.3049	STDP	0.0856	0.0073

Table 36: Impact of marker variable PMAT

Total effects. Besides the path coefficients, the total effects are analyzed in order to identify the sum of the indirect and direct effects.[133] Table 37 shows the results. ICAP has the highest individual impact on PDPF, supporting the basic assumption of the KGA. Four governance mechanisms have a significant total effect on product development performance: Heavyweight team structure, management attention, rewards and standard product processes. In spite of the significant, positive paths both between socialization and knowledge integration, and knowledge integration and product development performance, the total effect between socialization and product development performance is very weak

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[133] Cf. section 4.4.2.4 for the evaluation procedure and criteria

and not significant. Considering the total effect of the other constructs on product development performance, project duration stands out as a control variable with a strong and highly significant total negative effect on product development performance (see table 37).

Exogenous construct	Total effect on PDPF		
	Total effect	t-value	Significance
Individual absorptive capacity and knowledge integration			
ICAP	0.3827	3.8003	***
KNIN	0.2579	2.1492	**
Governance mechanisms			
HEVY	0.2873	3.4487	***
HQIN	-0.0646	0.6112	NS
KMSY	-0.0008	0.0294	NS
MGAT	0.1862	3.5615	***
RWRD	0.1533	3.2235	***
SOCN	0.0551	1.5003	NS
STDP	0.2531	2.9037	***
Control variables			
PRDU	-0.3685	3.6554	***
TSIZ	-0.0360	0.4367	NS

NS = not significant; * significant at p < 0.1; ** significant at p < 0.05; *** significant at p < 0.01

Table 37: Total effects on PDPF

Predictive relevance. To assess the predictive relevance and accuracy of the model, R^2 values are assessed and Q^2 values are generated using the blindfolding

procedure, performed with an omission distance of seven.[134] The path model has a high predictive accuracy if the prediction error identified in the blindfolding process is small, that is, if Q^2 is larger than zero.[135] All Q^2 values presented in table 38 are above zero, indicating that the model has predictive relevance for the endogenous variables. The R^2 values show that the model provides moderate predictive accuracy for the key endogenous variable PDPF. This is acceptable based on the argument that this dissertation does not seek to identify the main influence factors for product development performance but to assess the comparative influence of different governance mechanisms.[136]

Endogenous construct	R^2 value	Predictive accuracy	Q^2 value	Predictive relevance
ICAP	0.4021	moderate	0.2375	✓
KNIN	0.2469	weak	0.1686	✓
PDPF	0.4693	moderate	0.3967	✓
STDP	0.0837	low	0.0537	✓

Table 38: R^2 and Q^2 values of endogenous variables

To assess the relative impact of the different constructs and their predictive relevance for product development performance, the effect sizes f^2 and q^2 are calculated. Table 39 displays the effect sizes obtained from the model, considering only the values for the significant path relationships with the key endogenous variable PDPF. Effect sizes f^2 all indicate a weak relative impact of the considered constructs on PDPF, with the exception of project duration which has a moderate impact. All variables with significant effects on product development

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[134] As the blindfolding procedure can only be performed to evaluate reflectively measured constructs, a second version of the model is generated in which the formatively measured endogenous constructs (RWRD and PDPF) are transformed into single-indicator constructs where the construct scores derived from the PLS algorithm are used as indicator values. The cross-validated redundancy approach to blindfolding is applied which is recommended for PLS-SEM (Hair et al. 2014, p. 183).

[135] Cf. section 4.4.2.4 for the evaluation procedure and criteria

[136] Cf. section 4.4.2.4 for references

performance have predictive relevance based on their q^2 values greater than zero.[137]

Exogenous construct	Total effect on PDPF	Effect sizes for PDPF			
		f^2	Relative impact	q^2	Predictive relevance
Individual absorptive capacity and knowledge integration					
ICAP	0.3827***	0.0888	weak	0.0933	✓
KNIN	0.2579**	0.0791	weak	0.0418	✓
Governance mechanisms					
HEVY	0.2873***	0.0675	weak	0.0453	✓
MGAT	0.1862***	-0.0017	weak	0.0023	✓
RWRD	0.1533***	-0.0004	weak	0.0003	✓
STDP	0.2531***	0.1018	weak	0.0812	✓
Control mechanisms					
PRDU	-0.3685***	0.1864	moderate	0.2819	✓

*** significant at $p < 0.01$

Table 39: Effect sizes

6.4.3   Discussion of results

The descriptive statistics on the application of governance mechanisms have contributed to answering the first research question. The basic structural model adds to answering the second research question on the impact these governance mechanisms have on product development performance, either directly or indirectly.

The evaluation of the basic model shows an overall good model fit. Common method bias is not found to be a concern for the interpretation of the results. The majority of the hypotheses can be confirmed, and in spite of the

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[137] Cf. section 4.4.2.4 for references

manifold influences on product development performance, including factors not considered in this dissertation, the model explains 46.93% of the variance in product development performance and has predictive relevance for 39.67% of product development performance.

The model validates the cornerstones of the KGA: The empirical findings reveal strong and significant positive path relationships between iCAP, knowledge integration and product development performance. Thus they support hypotheses *H1*, *H2a* and *H2b* (see table 40). Furthermore, both iCAP and knowledge integration are found to have predictive relevance for product development performance. This confirms the theoretic framework of the KGA which emphasizes the individual micro-foundations of knowledge as a key source for performance and competitive advantage.

Tested hypotheses	Overall
H1: *Successfully integrating the knowledge of the members of a global product development project team is positively associated with the performance of the global product development project.*	✓
H2a: *Individual absorptive capacity (iCAP) is positively associated with knowledge integration in global product development teams.*	✓
H2b: *Individual absorptive capacity (iCAP) is positively associated with the performance of global product development teams.*	✓

- = rejected; (✓) = partly supported; ✓ = supported

Table 40: Results of hypothesis testing on product development performance, knowledge integration and iCAP

The second set of hypotheses tested in the quantitative survey deals with the extent to which the application of governance mechanisms impacts product development performance. The related descriptive statistics help answer *RQ1* on the extent to which German-based MNCs apply governance mechanisms to manage global product development teams. The PLS-SEM findings help answer *RQ2*, which enquires about the impact of these governance mechanisms on product development performance.

The descriptive statistics confirm that firms do not restrict themselves to one category of governance mechanisms but combine contractual and relational governance mechanisms (Poppo Zenger 2002). Judging from the descriptive statistics of the sample, the standard development process is the governance mechanism used most intensely by German-based MNCs. Hierarchical governance mechanisms rank second by frequency of application: Headquarter involvement, top management attention and heavyweight team structures are all very frequently applied. Rewards and socialization mechanisms are applied considerably less intensely. These findings draw a picture of German-based MNCs as hierarchical organizations seeking to avoid uncertainty via standardized procedures and central control. This picture is in line with the studies of Hofstede (1980, 1984) who characterizes German culture by high uncertainty avoidance. This empirical finding also validates the findings of the preceding qualitative survey in which almost all participants referred to standard development processes as a means to governing global teams. At the same time, the findings do not support the views of Hofstede (1980, 1984) that German companies are rather decentralized and with a low power distance.[138] While the subsequent findings partly question the effectiveness of hierarchical governance mechanisms, they are widely applied in the sample.

The results of the PLS-SEM analysis confirm the majority of the hypotheses related to the different governance mechanisms (see table 41). They thus validate the findings of the qualitative pre-study and confirm the research model.

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[138]Egelhoff (1984) supports the findings of Hofstede (1980, 1984).

Tested hypotheses	Results
Hierarchical governance mechanisms	
H3a*: Headquarter involvement is negatively associated with knowledge integration in global product development projects.	(✓)
H3b*: Headquarter involvement is positively associated with the performance of global product development projects.	-
H4a: Top management attention is positively associated with individual absorptive capacity in global product development teams.	✓
H4b: Top management attention enforces the application of standard product development processes in global product development projects.	✓
H5a*: Heavyweight team structures are positively associated with the performance of global product development teams.	✓
H5b*: Heavyweight team structures are positively associated with individual absorptive capacity.	✓
Bureaucratic governance mechanisms	
H6: Knowledge management systems are positively associated with knowledge integration of global product development teams (it is low compared to other governance mechanisms).	-
H7a: Standard development processes are not associated with knowledge integration in global product development projects.	✓
H7b: Standard development processes are positively associated with the performance of global product development projects.	✓
Output-related mechanisms	
H8: Individual rewards for team members are positively associated with individual absorptive capacity in global product development teams.	✓
Socialization-based mechanisms	
H9a: Socialization is positively associated with knowledge integration in global product development teams.	✓
H9b*: Team members' international experience from expatriation or short-term foreign assignments, their involvement in international groups (committees) and trainings, their previous collaboration experience and the extent of rich personal communication all contribute to the socialization of global product development teams.	(✓)

- = rejected; (✓) = partly supported; ✓ = supported

Table 41: Results of hypothesis testing on governance mechanisms

More specifically, headquarter involvement is not found to be positively associated with product development performance, neither directly nor indirectly via knowledge integration. Top management attention is positively associated with product development performance as it drives the utilization of standard product development processes and iCAP. Heavyweight team structures are

positively associated with product development performance both directly and indirectly via iCAP. Figure 44 ranks the tested governance mechanisms by their total effect on product development performance.

***significant at p < 0.01
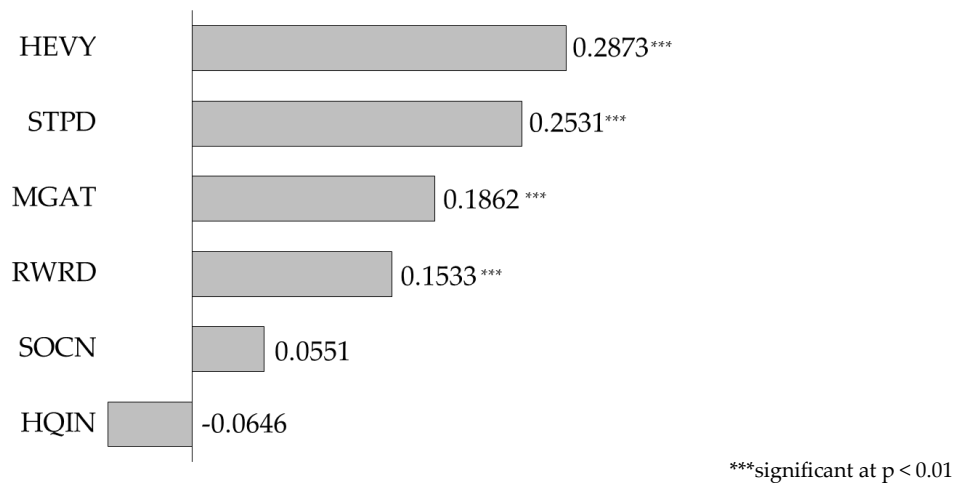
Figure 44: Ranking of governance mechanisms by total effect

Heavyweight team structures emerge as the mechanism most strongly associated with product development performance. Rewards, management attention and heavyweight team structures (in descending order) explain 40% of the variance in individual capacity and predict 25% of the value of this construct. These three governance mechanisms are thus relevant for driving knowledge integration and performance and each has a statistically significant total effect on product development performance.

Standard product development processes are also confirmed to be significantly positively associated with product development performance. In comparison to some previous studies with failed to confirm a positive association between standard product development processes and performance (Rundquist 2007; Sarin & O'Connor 2009; Im et al. 2013), this study explicitly measures the extent of application of standards rather than the mere existence (Christiansen & Varnes 2009). The focus of German MNCs on these mechanisms thus appears justified. Furthermore, the results confirm that management attention slightly

reinforces the application of standard processes, and is thus beneficial for performance. The results suggest that headquarters should pay management attention to success critical development projects rather than get operationally involved, as headquarter influence is not positively associated with performance.

The weak and insignificant path coefficient between headquarter involvement and product development performance confirms earlier empiric evidence (Bonner et al. 2002). This contradicts expert statements and is not in line with the high frequency with which headquarter involvement is applied in the sample. The statistical evidence suggests that headquarter involvement is overestimated by practitioners. Research in the area of corporate strategy actually confirms that corporate headquarters oftentimes overestimate the synergetic impact of headquarter involvement on operations (Goold et al. 1998). A potential reason for the low impact of headquarter involvement in the context of this study is that, if management attention and adequate team structures are given, corporate headquarter involvement does not add additional benefits to a project. For project participants, it might not matter whether corporate headquarters or division management supports their project operationally as long as sufficient resources are made available. Rewards, personal management attention and team structures which foster close collaboration between the project manager and the team members are considerably more strongly associated with project performance than headquarter involvement. This aspect is interesting given the high attention German-based MNCs place on headquarter involvement, as confirmed both by the qualitative interviews and descriptive statistics for the items measuring the construct.

The measurement model for socialization is amended substantially with only four out of seven initially outlined indicators contributing to the measurement of the construct. Long-term (expatriation) and short-term foreign assignments as well as physical meetings appear not to contribute to the socialization of the team. Further research is required to understand this

phenomenon and identify the impact of these three indicators on global product development teams, if any. While the remaining indicators measuring socialization represent a construct that is positively associated with knowledge integration, socialization does not have a significant total effect on product development performance. This may be due to the high cost associated with socialization which has a negative impact on the cost of a particular project. The frequency with which socialization-based mechanisms are studied (cf. section 3.2.2) seems to be inflated given their high cost and low effectiveness. As with knowledge integration, it would be interesting to study whether there is a cut-off point after which further socialization efforts reduce product development performance due to a sloping cost-benefit curve.

Furthermore, knowledge management systems reveal no significant association with knowledge integration. The descriptive statistics show that the application of knowledge management systems is very low. This indicates that not many companies apply these systems frequently. Experts have noted in the qualitative study that even if knowledge management systems are available, they are hard to apply in the project context as their timely maintenance requires a lot of documentation discipline which can interfere with current project challenges and deadlines. This study is thus not able to resolve the concern of Zhao & Luo (2005) about reverse causality about the utilization and effectiveness of knowledge management systems as discussed in section 3.2.3.2. Another potential reason for the lacking association between knowledge management systems and knowledge integration is the tacitness of knowledge which is rather high in the sample. The more tacit, the less codifiable the knowledge (Nonaka 1994; Goffin & Koners 2011) and thus the less applicable knowledge management systems unless very actively managed throughout the company (Zack 1999).

The costs of applying different types of governance mechanisms are not explicitly measured in this dissertation. However, the ranking of the total effects of the assessed governance mechanisms on product development performance

appears to parallel their costs as estimated by the experts in the qualitative research strand, ranking from lowest costs of hierarchical mechanisms to highest costs of socialization-based mechanisms. This is in line with the basic assumption of the KGA rooted in TCE that effective governance mechanisms are characterized by cost efficiency. This disproves the earlier criticism expressed by Ding et al. (2009) that TCE neglects governance mechanisms which are initially costly but profitable in the long run.

Eventually, the results for the control variables show that, while team size is not significantly associated product development performance, project duration does have considerable influence and predictive relevance for project development performance: The longer a project takes, the lower the project performance. While this considerable impact of project duration on performance has not been explicitly predicted for this dissertation's model, there is empiric evidence explaining the phenomenon: Long-term projects are typically complex, and face three typical risks: (1) Project managers cannot plan for all required activities ahead, (2) failure of the project participants to complete one activity can have devastating impact on other activities of the same project, and (3) the integration of the results of different work streams on time and in budget causes additional challenges (Matta & Ashkenas 2003). Also, in an increasingly dynamic environment, long-term projects run the risk of being outpaced by changing market needs (Stalk & Hout 1990; Chen et al. 2010). Reducing development cycle time has thus been for long perceived as a driver for effectiveness and efficiency in product development (Schmelzer 1990). The empiric results of this study are more linear than the early findings of Katz (1982) and Katz & Allen (1982) who identified a peak of team performance between 1.5 and 5 years of team permanence. The qualitative interviews provide support for this view, with Expert G pointing out the advantages of many short projects as compared to a large, pre-planned complex project. While project duration is not in the explicit focus of this dissertation, the study's results indicate that it is worthwhile reviewing the set-up of global product development projects in terms of their

planned time-span as well as the interdependencies of work streams and project sub-teams as a key influence factor for project performance.

6.5   EVALUATION AND DISCUSSION OF THE MODERATED MODELS

6.5.1   Evaluation of the moderated model I: Distance

To test the moderating impacts of distance, the moderated structural model is operationalized following the model specification provided in section 6.1.3.1.[139] In a first step, the PLS-SEM algorithm is run for the model without interaction terms. This way, the measurement models of all exogenous and endogenous constructs are tested.

The two formative constructs contained in the moderated model (PDPF, SOCN) are converted into single-indicator measurement models measured by the previously obtained construct scores for each case, as formative measurement models cannot be processed by PLS-SEM when entering moderating interaction terms (Hair et al. 2014, p.263). Hence, the evaluation of the measurement models only applies to the reflective measurement models for the constructs PHDI and KNIN (see table 42).

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[139] As an amendment to the moderated model specified in section 6.1.3.1, the control variable PRDU is added due to the strong association with PDPF identified revealed in the evaluation of the basic model (cf. section 6.4.2).

Outer loadings λ	KNIN	PH-DIST
G-DIST		-0.9990
T-DIST		-0.8936
KNIN_03	0.7975	
KNIN_04	0.8601	
KNIN_05	0.8424	

Table 42: Outer loadings of reflective measurement models

The assessment of the formative constructs' outer loadings is satisfactory. The constructs also meet the threshold criteria for internal consistency (composite reliability ρ_η) and convergent validity (AVE). Testing for discriminant validity likewise leads to accept the measurement models. Table 43 summarizes the results of the evaluation of the corrected reflective measurement models.

Con-structs	Indicators	Outer loadings λ	Composite reliability ρ_η	Convergent validity AVE	Discriminant validity	
					Construct (Fornell-Larcker)	Indicator (Cross loadings)
KNIN	KNIN_03	0.7975	0.8724	0.6952	✓	✓
	KNIN_04	0.8601				✓
	KNIN_05	0.8424				✓
PH-DIST	G-DIST	-0.9990	0.9463	0.8983	✓	✓
	T-DIST	-0.8936				✓

Table 43: Results summary of reflective measurement models

To test the unmoderated hypotheses, the structural paths are evaluated once before entering the interaction terms and assessing the moderating effects. Table 44 presents the results. The path model reconfirms the strong positive association between KNIN and PDPF (*H1*), between SOCN and KNIN (*H9a*) and the strong negative association between PRDU and PDPF. The following results apply with regard to the context variables included in the structural model: Cultural distance C-DIST is positively associated with knowledge integration and negatively associated with product development performance. The path between

C-DIST and KNIN is significant at the 0.1 level, thus supporting hypothesis *H10a.* The path linking C-DIST and PDPF is weak and non-significant, providing only limited empiric support for hypothesis *H10f*. L-DIST is negatively associated with KNIN with a significance at the 0.1 level, providing support for hypothesis *H10c*. PH-DIST is negatively associated with KNIN and PDPF, however the path coefficients are very weak and non-significant so *H10d* can only be partly confirmed.

Path relationships	Path coefficients γ	t-value of path coefficients	Signifi-cance	Interpretation
KNIN → PDPF	0.3008	3.3049	***	H1 reconfirmed
SOCN → KNIN	0.2720	2.8984	***	H9a reconfirmed
C-DIST → KNIN	0.2449	1.8332	*	H10a supported
L-DIST → KNIN	-0.2222	1.7873	*	H10c supported
PH-DIST → KNIN	-0.0516	0.4316	NS	H10d partly supported
PH-DIST → PDPF	-0.0661	0.6312	NS	H10d partly supported
C-DIST → PDPF	-0.0598	0.6266	NS	H10f partly supported
PRDU → PDPF	-0.4285	6.1342	***	n/a

NS = not significant; * significant at p < 0.1; ** significant at p < 0.05; *** significant at p < 0.01

Table 44: Path evaluation of the moderated structural model I without interaction terms

Eventually, the interaction terms are inserted into the model as specified in section 6.1.3. To test hypothesis *H10b*, the interaction term SOCN x C-DIST is inserted. Derived from the multiplication of two single-item constructs, the interaction term is a single-item construct and requires no further assessment of the measurement model. To test hypotheses *H10e*, the interaction term PHDI x SOCN is inserted. Table 45 shows the results of the evaluation of the reflective measurement model for this interaction term. Based on the high outer loadings, composite reliability (ρ_η) and convergent validity (AVE), the measurement model can be accepted.

Con-structs	Indicators	Outer loadings λ	Composite reliability ρ_η	Convergent validity AVE	Discriminant validity	
					Construct (Fornell-Larcker)	Indicator (Cross loadings)
SOCN * PH-DIST	SOCN * G-DIST	0.9630	.9744	.9501	✓	✓
	SOCN * T-DIST	0.9863				✓

Table 45: Results summary for reflective measurement model interaction term

Next, the bootstrapping algorithm is run to assess the significance of the structural model. Table 46 shows the results. The findings regarding the direct paths remain in line with the findings presented before adding the interaction terms. The model furthermore reveals no positive moderation of C-DIST on the relationship between SOCN and KNIN. The sign of the moderation is the opposite, indicating a non-significant negative moderating effect of C-DIST on the relationship between SOCN and KNIN. Hence, *H10b* must be rejected. *H10d* assesses the negative moderating impact of PH-DIST on the relationship between SOCN and KNIN. The model reveals this negative moderating effect at a very low significance level (p = 0.3117). Consequently, *H10e* is only partly supported.

Path relationships	Path coefficients γ	t-value of path coefficients	Signifi-cance	Interpretation
KNIN → PDPF	0.3008	3.2825	***	H1 reconfirmed
SOCN → KNIN	0.2557	2.8701	***	H9a reconfirmed
C-DIST → KNIN	0.2844	2.0830	**	H10a supported
C-DIST x SOCN → KNIN	-0.1269	1.071	NS	H10b rejected
L-DIST → KNIN	-0.2188	1.7108	*	H10c supported
PH-DIST → KNIN	-0.0286	0.2384	NS	H10d partly supported
PH-DIST → PDPF	-0.0662	0.6324	NS	
SOCN x PHDI → KNIN	-0.1246	1.0160	NS	H10e partly supported
C-DIST → PDPF	-0.0597	0.6247	NS	H10f partly supported
PRDU → PDPF	-0.4285	6.0863	***	n/a

NS = not significant; * significant at p < 0.1; ** significant at p < 0.05; *** significant at p < 0.01

Table 46: Path evaluation of the moderated structural model I with interaction terms

6.5.2   Evaluation of the moderated model II: Tacitness

To test the moderating impacts of tacitness (TACT), the moderated structural model is operationalized following the model specification provided in section 6.1.3.2. [140] To start with, the model is generated without the interaction terms and the measurement models for the constructs are tested: As in the case of the first moderated model (cf. section 6.5.1), the formative constructs (PDPF, SOCN) are converted into single-indicator measurement models. The assessment of the reflective measurement models' outer loadings reveals that the items measuring TACT are insufficiently correlated with three indicators revealing outer loadings (λ) below 0.708 (see table 47).

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[140] As an amendment to the moderated model specified in section 6.1.3.2, the control variable PRDU is added due to the strong association with PDPF identified revealed in the evaluation of the basic model (cf. section 6.4.2).

Outer loadings λ	KNIN	TACT
KNIN_03	0.8186	
KNIN_04	0.8518	
KNIN_05	0.8302	
TACT_01		0.8333
TACT_02		-0.6130
TACT_03		0.3720
TACT_04		0.5438

Table 47: Outer loadings of reflective measurement models

The measurement model is therefore simplified to a single-item construct based on the commonly used question on the extent to which knowledge is codifiable, based on the arguments of Reed & DeFillippi (1990), Simonin (1999) and Zander & Kogut (1995) who all state that the more codifiable, the less tacit the knowledge. Following this amendment, the remaining reflective measurement model for KNIN can be retained based on its acceptable outer loadings (λ), composite reliability ρ_η and convergent validity (AVE; see table 48).

Con-structs	Indicators	Outer loadings λ	Composite reliability ρ_η	Convergent validity AVE	Discriminant validity	
					Construct (Fornell-Larcker)	Indicator (Cross loadings)
KNIN	KNIN_03	0.7969	0.8723	0.6951	✓	✓
	KNIN_04	0.8588				✓
	KNIN_05	0.8442				✓

Table 48: Results summary of reflective measurement model KNIN

Before entering the interaction term, the structural paths are assessed. Table 49 presents the results. The path model reconfirms the strong positive association between KNIN and PDPF (*H1*), between SOCN and KNIN (*H9a*) and the strong negative association between PRDU and PDPF. Moreover, the negative

association between tacitness and knowledge integration is confirmed (*H11a* supported).

Path relationships	Path coefficients	t-value of path coefficients	Signifi-cance	Interpretation
KNIN → PDPF	0.2985	3.2217	***	H1 reconfirmed
SOCN → KNIN	0.2788	3.0140	***	H9a reconfirmed
TACT → KNIN	-0.1413	1.6692	*	H11a supported
PRDU → PDPF	-0.4261	5.9926	***	n/a

NS = not significant; * significant at p < 0.1; ** significant at p < 0.05; *** significant at p < 0.01

Table 49: Path evaluation of the moderated structural model II without interaction term

Finally, the interaction term TACT * SOCN is inserted into the model as specified in section 6.1.3.2 to test hypothesis *H11b*. The interaction terms' measurement model requires no further assessment as it is derived from the multiplication of two single-item constructs. The bootstrapping algorithm is run to assess the significance of the structural model. As presented in table 50, the findings regarding the direct paths remain in line with the findings presented before adding the interaction terms and a small, non-significant interaction effect with a path coefficient of -0.0532 is measured, leading to a very limited support of hypothesis *H11b*.

Path relationships	Path coefficients γ	t-value of path coefficients	Signifi-cance	Interpretation
KNIN → PDPF	0.2987	3.2393	***	H1 reconfirmed
SOCN → KNIN	0.2792	3.0895	***	H9a reconfirmed
TACT → KNIN	-0.1419	1.6846	*	H11a supported
TACT * SOCN → KNIN	-0.0532	0.5726	NS	H11b partly supported
PRDU → PDPF	-0.4263	5.9369	***	n/a

NS = not significant; * significant at p < 0.1; ** significant at p < 0.05; *** significant at p < 0.01

Table 50: Path evaluation of the moderated structural model II with interaction term

6.5.3   Discussion of results

The evaluation of the moderated models helps to answer this dissertation's third research question on the extent to which context factors influence the governance and performance of global product development teams. Table 51 summarizes the results of the tested hypotheses. The majority of the hypotheses is only marginally supported, as the predicted paths are observed but the path coefficients are tested as non-significant. Additional testing, e.g. with larger sample sizes, is required to further validate these hypotheses.

Hypothesis	Support
H10a: Cultural distance is positively associated with knowledge integration.	✓
H10b: Socialization positively moderates the relationship between cultural distance and knowledge integration: The higher the extent of socialization, the stronger the positive relationship between cultural distance and knowledge integration.	-
H10c: Linguistic distance is negatively associated with knowledge integration.	✓
H10d: Physical distance is negatively associated with knowledge integration and product development performance.	-
H10e: Physical distance negatively moderates the relationship between socialization and knowledge integration: The higher the physical distance, the lower the positive association between socialization and knowledge integration.	(✓)
H10f: Cultural distance is negatively associated with product development performance.	(✓)
H11a: Tacitness is negatively associated with knowledge integration.	✓
H11b: Socialization moderates the relationship between tacitness and knowledge integration: The higher the socialization, the weaker the negative relationship between tacitness and knowledge integration.	(✓)

- = rejected; (✓) = marginally supported (not significant) ✓ = supported

Table 51: Summary of hypothesis testing for moderated models

Cultural distance. The results support the hypothesis that cultural distance is positively associated with knowledge integration. This outcome supports the findings of Vaara et al. (2012) who state that cultural diversity boosts knowledge integration as it drives creativity and supports organizational studies on team performance arguing in favor of heterogeneous team compositions to drive creativity and effectiveness (Jackson et al. 1991; Jackson et al. 1995). This dissertation's data does not provide evidence, however, for a reinforcing moderating effect of socialization on the association between cultural distance and knowledge integration. This falls in line with earlier findings indicating the decreasing effect of personal coordination mechanisms with increasing distance (Ambos & Ambos 2009). A potential reason might be the fact that increasing the level of common socialization of a global team increases the homogeneity of the team and thus restricts the creative power derived from the cultural heterogeneity

which supports knowledge integration in global teams (Watson et al. 1993; Jackson et al. 1995). This assumption requires further data gathering and testing however.

This dissertation's empiric data provides very marginal, statistically non-significant support for the hypothesis that cultural distance is negatively associated with product development performance. The total effect of cultural distance on product development performance, consisting of both the direct (negative) association and the indirect (positive) association via knowledge integration, is almost neutral at a value of 0.0259. Consequently, this dissertation's data does not support previous scholarly arguments (Lucas 2006; Casey 2009) that cultural distance has an overall negative effect on product development performance due to its impeding impact on trust and joint team identity. The value added by integrating different cultural perspectives is partly compensated by *frictions* in intercultural communication which can result in a burden for the project performance (Shenkar et al. 2008). This potential interpretation –which requires further research–, could also explain why the item enquiring about misunderstandings between team members does not correlate with the other indicators measuring knowledge integration and had to be deleted from the measurement model for the construct knowledge integration (cf. section 6.4.1.1).

Linguistic distance. The negative association between linguistic distance and knowledge integration, which was frequently mentioned in expert interviews, is also supported by the quantitative study. The results indicate that language is the dimension of distance which hinders collaboration in global teams most significantly. This finding occurs although English, deemed as a global language, is the project language in 112 of the 120 surveyed projects. The strength and significance of the observed negative effect of linguistic distance on knowledge integration are almost as strong as the positive effect of cultural distance. This finding suggests that language training and the inclusion of team members who speak the project language fluently can help to achieve the full

benefits of knowledge integration. The results quantitatively confirm previous scholarly propositions based on qualitative research (Marschan-Piekkari et al. 1999; Welch & Welch 2008) that language is a largely underestimated obstacle for intra-MNC collaboration.

Physical distance is only marginally negatively associated with knowledge integration. This finding provides limited support for the concept of Allen's curve (Allen 1977) which postulates that communication and knowledge integration decrease as the physical distance between team members increases (cf. section 2.2.4). The distance discussed by Allen (1977) concerns the distance between rooms in the same building and is relatively short compared to the distance experienced by members of international product development teams who need to bridge distances between countries or even continents. It can therefore be argued that the critical level of physical distance which hinders communication is exceeded in all border-spanning product development activities. A potential interpretation of this dissertation's empiric findings is that the impact of physical distance is marginal when comparing the effectiveness of global teams as their intra-team distance always exceeds a certain threshold for team collaboration. To validate this interpretation, it would be interesting to compare the effectiveness of global teams directly against the impact of co-located teams in future studies.

This dissertation's empirical results indicate that physical distance tends to negatively moderate the relationship between socialization and knowledge integration. This finding supports the previous study of Ambos & Ambos (2009) on the decreasing impact of personal coordination mechanisms with increasing distance. Yet, more observations would be required to review statistical significance.

Overall, the study results show that it is worthwhile to measure the distance between the members of global teams in different dimensions. Decreasing language barriers and leveraging the benefits of cultural distance can boost

product development performance in a global team and make a dispersed team more effective than a team experiencing short distances.

Tacitness. The descriptive statistics related to tacitness indicate a very high level of tacitness for the sampled projects (cf. section 6.3.3). The variance in the data is so low that only one out of originally four indicators can be used to measure tacitness, resulting in a transformation of the reflectively specified construct into a single-item construct. The resulting empiric findings confirm the negative association between tacitness (measured as non-codifiability) and knowledge integration. Further research should however be conducted on this relationship to assure the absence of systematic measurement error.

The data provides insufficient evidence to support the relationship suggested by Nonaka's learning cycle, according to which increasing levels of socialization support the transfer of tacit knowledge (Nonaka 1991). The data provides very weak support for this notion with a weak and non-significant moderating effect. This finding raises the question whether knowledge-based theories such as the learning cycle and the KBV apply mainly to transferring existing knowledge throughout the MNC. This study's findings suggest that knowledge-based theories such as the KBV do not sufficiently serve to explain how to foster the creation of new knowledge, which is a prerequisite in (new) product development.

6.6   EVALUATION AND DISCUSSION OF THE MULTI-GROUP ANALYSIS

6.6.1   Model simplification

To test hypothesis *H12* on the moderating effect of industry, a multi-group analysis (MGA) is conducted based on the basic, unmoderated model discussed

in section 6.4.[141] One subset of data consists of 90 cases from moderate-velocity industries (subset A); the other subset of data consists of 30 cases from high-velocity industries (subset B).

Due to the low number of cases in subset B, the path model has to be simplified by eliminating paths. Huber et al. (2007, p.45) suggest to remove all insignificant paths from a PLS-SEM model. Accordingly, the path STDP → KNIN is removed because the hypothesis has been confirmed that there is no association between these two constructs. In addition, the constructs (and related paths) HQIN, TSIZ and PMAT are removed from the model as they are not significantly related to PDPF in the full data set. The resulting path model is displayed in figure 45.
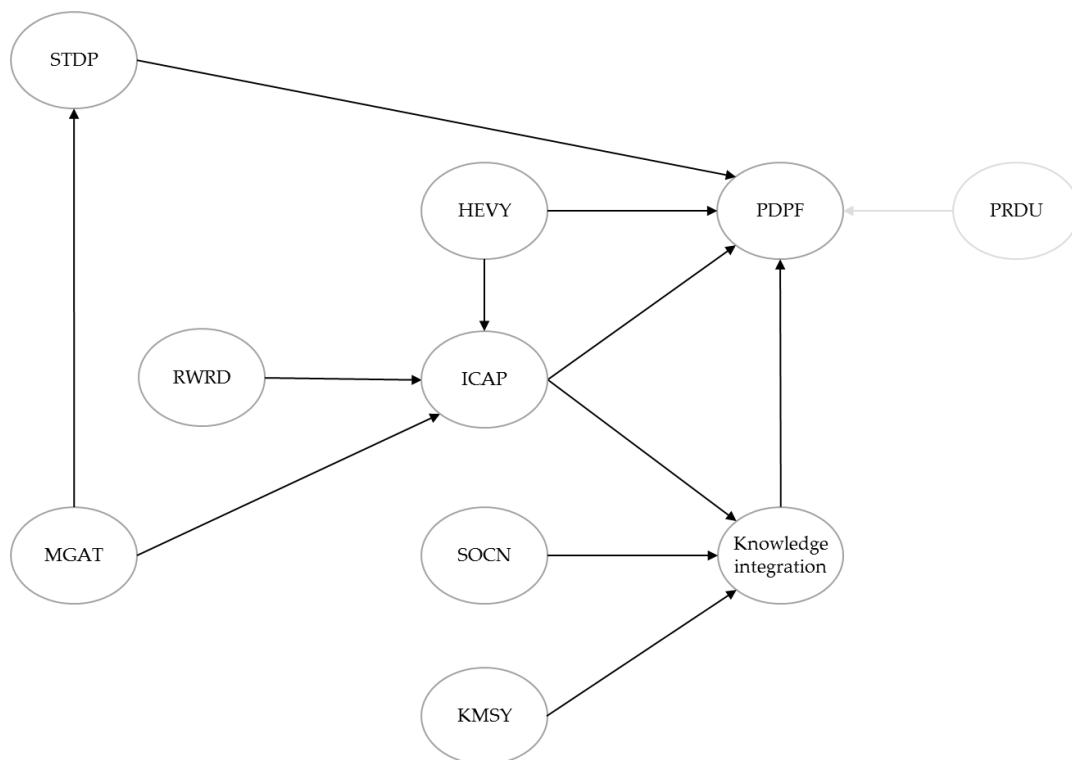
Figure 45: Simplified path model for the MGA

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[141] Cf. section 4.4.2.4 for the approach of conducting an MGA and respective references

The simplified model presented in figure 45 still violates the rules for sample size in PLS-SEM for the second subset as it still contains too many paths pointing at PDPF (five paths instead of the admissible three paths for a sample size of thirty), and the number of indicators measuring the formative variables yet has to be limited to three instead of four. While the number of indicators can be reduced by deleting the least relevant indicator for each formatively measured construct, the number of paths is retained to test for group differences. This has to be considered when interpreting the data, where the PLS bias[142] is likely to underestimate path relationships when sample sizes are too small.

6.6.2   Evaluation of the measurement models

Reflective measurement models. To start the MGA, the reflective measurement models are evaluated for the smaller subset B. With an outer loading (λ) considerably below the threshold value of 0.7 indicator MGAT 02 has to be removed from the model for both subsets (see table 52). Four more indicators are marked in grey in table 52 as they display outer loadings (λ) below 0.7. These indicators however meet the minimum threshold value for outer loadings of 0.4 suggested by Hair et al. (2014, p.104) and are retained.

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[142] Cf. section 4.4.2.3

Outer loadings λ	CAPB	HEVY	KNIN	MGAT	MOTI	STDP
CAPB_01	.8772					
CAPB_02	.8397					
HEVY_01		.9683				
HEVY_02		.8786				
KNIN_03			.7861			
KNIN_04			.7876			
KNIN_05			.8634			
MGAT_01				.4722		
~~MGAT_02~~				~~.0241~~		
MGAT_03				.8522		
MOTI_01					.8225	
MOTI_02					.9064	
STDP_01						.8729
STDP_02						.8389
STDP_03						.6346

Table 52: Initial outer loadings of reflective measurement models (subset B)

The remaining indicators for the reflective measurement models can be retained based on the values retrieved for outer loadings (λ), composite reliability (ρ_η) and convergent validity (AVE). This applies to both data subsets as presented in table 53 (subset B) and table 54 (subset A).

Con-structs	Indicators	Outer loadings λ	Composite reliability ρ_η	Convergent validity AVE	Discriminant validity	
					Construct (Fornell-Larcker)	Indicator (Cross loadings)
CAPB	CAPB_01	0.8775	0.8487	0.7373	✓	✓
	CAPB_02	0.8394				✓
HEVY	HEVY_01	0.9682	0.9216	0.8549	✓	✓
	HEVY_02	0.8789				✓
KNIN	KNIN_03	0.7859	0.8539	0.6612	✓	✓
	KNIN_04	0.7877				✓
	KNIN_05	0.8635				✓
MGAT	MGAT_01	0.5977	0.7617	0.6269	✓	✓
	MGAT_03	0.9469				✓
MOTI	MOTI_01	0.8226	0.8563	0.7491	✓	✓
	MOTI_02	0.9064				✓
STDP	STDP_01	0.8970	0.8277	0.6208	✓	✓
	STDP_02	0.8185				✓
	STDP_03	0.6227				✓

Table 53: Results summary of reflective measurement models (subset B)

Con-structs	Indicators	Outer loadings λ	Composite reliability ρ_η	Convergent validity AVE	Discriminant validity	
					Construct (Fornell-Larcker)	Indicator (Cross loadings)
CAPB	CAPB_01	0.8877	0.8831	0.7906	✓	✓
	CAPB_02	0.8907				✓
HEVY	HEVY_01	0.9152	0.8125	0.6869	✓	✓
	HEVY_02	0.7323				✓
KNIN	KNIN_03	0.8514	0.8775	0.7050	✓	✓
	KNIN_04	0.8605				✓
	KNIN_05	0.8061				✓
MGAT	MGAT_01	0.8650	0.8671	0.7654	✓	✓
	MGAT_03	0.8846				✓
MOTI	MOTI_01	0.9094	0.9161	0.8453	✓	✓
	MOTI_02	0.9293				✓
STDP	STDP_01	0.6539	0.8445	0.6482	✓	✓
	STDP_02	0.8309				✓
	STDP_03	0.9092				✓

Table 54: Results summary of reflective measurement models (subset A)

Formative measurement models. Testing the indicators of the formative constructs for VIF reveals no indications for multicollinearity. The bootstrapping algorithm is thus run to assess the significance of the outer weights and outer loadings. Starting again with the smaller data subset B, the first run of the bootstrap algorithm reveals low and insignificant outer weights and outer loadings for PDPF_01, PDPF_02, SOCN_03 and SOCN_04. Hence, these four indicators are eliminated from the model for both subsamples. To reduce the number of indicators for each formative measurement model to a maximum of three in order to meet the sample size requirements, the indicator RWRD_03 is deleted as it shows the lowest association with RWRD.

Having deleted these five indicators, the model is rerun for both subsets and the formative measurement models are accepted (see table 55 for subset B and table 56 for subset A[143]).

Con-struct	Indicator	Outer weight	t-value of outer weight	Signifi-cance	Outer loading	Rele-vance	t-value of outer loading	Signifi-cance
PDPF	PDPF_03	0.9255	2.3050	**	0.9970	yes	5.0289	***
	PDPF_04	0.1050	0.2124	NS	0.7351	yes	7.2473	***
RWRD	RWRD_01	0.6012	1.2269	NS	0.8722	yes	3.2953	**
	RWRD_02	0.4465	1.3828	NS	0.6395	yes	3.4257	**
	RWRD_04	0.3474	0.8469	NS	0.5472	yes	13.6655	*
SOCN	SOCN_05	0.5520	1.6955	*	0.5826	yes	2.1174	*
	SOCN_07	0.8133	3.0600	***	0.8341	yes	1.8372	***

NS = not significant; * significant at p < 0.1; ** significant at p < 0.05; *** significant at p < 0.01

Table 55: Evaluation of the adjusted formative measurement models (subset B)

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[143] In subset A, the indicator SOCN_07 fails to meet any of the criteria of fit relating to formative indicators. This indicator is deliberately maintained, however, on the basis of content validity (Hair et al. 2014130).

Con-struct	Indicator	Outer weight	t-value of outer weight	Signifi-cance	Outer loading	Rele-vance	t-value of outer loading	Signifi-cance
PDPF	PDPF_03	0.3589	1.5377	NS	0.7448	yes	5.2604	***
	PDPF_04	0.7709	4.2855	***	0.9505	yes	11.5136	***
RWRD	RWRD_01	0.2834	1.2987	NS	0.5626	yes	3.0971	***
	RWRD_02	0.1890	0.9709	NS	0.387	no	2.2313	**
	RWRD_04	0.8355	6.1804	***	0.9185	yes	9.9052	***
SOCN	SOCN_05	0.8832	2.1651	**	0.8967	yes	2.2326	**
	SOCN_07	0.4428	0.9702	NS	0.4697	no	1.0614	NS

NS = not significant; * significant at p < 0.1; ** significant at p < 0.05; *** significant at p < 0.01

Table 56: Evaluation of the adjusted formative measurement models (subset A)

6.6.3   Evaluation of the structural models

To evaluate the structural model for each subset, firstly the VIF are calculated. Judging from the regression results, multicollinearity is neither an issue for subset A nor for subset B. The assessment of the structural model reveals considerable differences between the two subsets displayed in table 57 and figure 46.

Path relationships	Subset A (moderate velocity)			Subset B (high velocity)		
	Path coeffi- cients γ	t-values	Signifi- cance	Path coeffi- cients γ	t-values	Signifi- cance
Second order measurement model						
ICAP → CAPB	0.9030	43.4516	***	0.8180	4.1139	***
ICAP → MOTI	0.9045	31.1055	***	0.8605	11.8484	***
Path relationships						
PRDU → PDPF	-0.3012	3.0219	***	-0.2859	1.7431	*
HEVY → ICAP	0.2457	2.9379	***	0.1293	0.5477	NS
HEVY → PDPF	0.1708	1.6527	NS	0.0339	0.1474	NS
ICAP → KNIN	0.4330	4.6117	***	0.4217	2.4247	**
ICAP → PDPF	0.3773	3.1740	***	-0.082	0.3834	NS
KMSY → KNIN	0.0440	0.3983	NS	0.0194	0.1027	NS
KNIN → PDPF	0.0610	0.4481	NS	0.6524	3.6785	***
MGAT → ICAP	0.3213	3.9556	***	-0.0716	0.3686	NS
MGAT → STDP	0.4076	3.8911	***	-0.3020	0.7187	NS
RWRD → ICAP	0.3292	3.9315	***	0.4707	1.7270	*
SOCN → KNIN	0.1363	1.0747	NS	0.3001	1.8647	*
STDP → PDPF	0.1457	1.2228	NS	0.2762	1.0886	NS

NS = not significant; * significant at $p < 0.1$; ** significant at $p < 0.05$; *** significant at $p < 0.01$

Table 57: Path coefficients in MGA
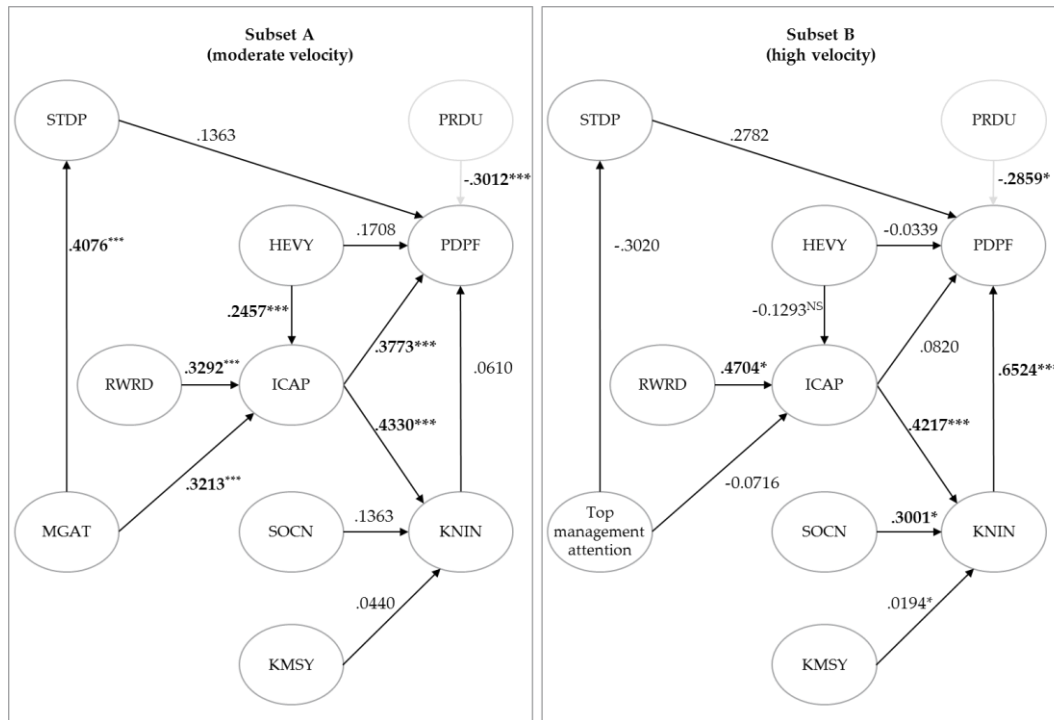
* significant at p < 0.1; ** significant at p < 0.05; *** significant at p < 0.01

Figure 46: Path models for subsets of moderate and high velocity industries

MGAT, RWRD and HEVY are significantly associated with ICAP and PDPF in moderate velocity industries. In high velocity industries, RWRD and SOCN are the only governance mechanisms displaying significant path relationships with ICAP and PDPF, respectively. The fact that STDP are not related to PDPF in either subset in contrast to the total sample might relate to the adjusted measurement model for product development performance, where the indicators relating to adherence to budget and schedule had to be deleted from the measurement model.

Likewise, the total effects of the constructs in each subset on PDPF show noticeable dissimilarities: The difference between the subsets regarding total effects on PDPF exceeds 0.2 for ICAP, KNIN, HEVY and MGAT (see figure 47).
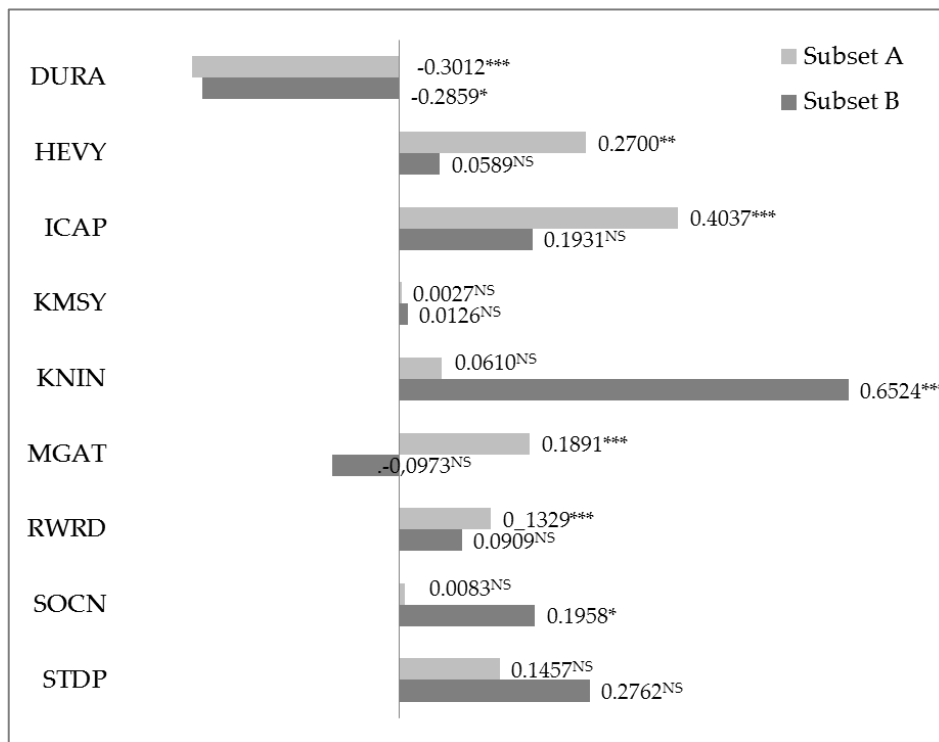
NS = not significant; * significant at p < 0.1; ** significant at p < 0.05; *** significant at p < 0.01

Figure 47: Total effects on product development performance by subgroup

To test hypotheses *H12a*, *H12b* and *H12c*, Levene's test is applied which assesses the significance of the different path relationships in the two subsets by comparing their variance (Levene 1960).[144]

Hypothesis *H12a* proposes that knowledge integration is more strongly associated with product development performance in high-velocity markets than in moderate-velocity markets. Levene's test confirms a significant difference between the two subgroups (see table 58). The moderating effect of industry is confirmed for this path relationship. *H12a* is accepted.

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[144] Cf. section 4.4.2.4 for the test statistics.

Path relationship	Subset A: moderate velocity		Subset B: high velocity		Subset A vs. subset B			
	p^A	Std. error (p^A)	p^B	Std. error (p^B)	$|p^A-p^B|$	t-value	Signifi-cance	p-value
KNIN → PDPF	.061	.136	.652	.177	.591	2.679	***	0.022

*** significant at p < 0.01

Table 58: PLS-MGA results for hypothesis H12a

Hypothesis *H12b* suggests that governance mechanisms targeted at knowledge integration are either directly or indirectly more strongly associated with knowledge integration in high-velocity markets than in moderate-velocity markets. This effect is tested by comparing the total effects of the relevant governance mechanisms SOCN, KMSY, RWRD and MGAT on KNIN. For SOCN and RWRD the data reveals higher total effects in subset B. Levene's test identifies the difference as non-significant, however. The effect of KMSY is close to zero and non-significant in both subsets. For MGAT, the direction of the moderating effect on KNIN turns out to be higher in subset A than in subset B, with significant measurement results. In conclusion, hypotheses *H12b* has to be rejected. Table 59 summarizes the test results.

Total effects	Subset A: moderate velocity		Subset B: high velocity		Subset A vs. subset B			
	p^A	Std. error (p^A)	p^B	Std. error (p^B)	$|p^A-p^B|$	t-value	Signifi-cance	p-value
SOCN → KNIN	.136	.127	.300	.161	.025	.809	NS	.421
KMSY → KNIN	.044	.111	.019	.189	.078	.113	NS	.911
RWRD → KNIN	.143	.046	.199	.155	.056	.351	NS	.728
MGAT → KNIN	.139	.051	-.030	.089	.169	1.663	*	0.099

NS = not significant; * significant at p < 0.1; ** significant at p < 0.05; *** significant at p < 0.01

Table 59: PLS-MGA results for hypothesis H12b

Hypothesis *H12c* states that governance mechanisms targeted at ICAP that can be applied flexibly (namely HEVY, RWRD and MGAT) have a stronger impact on ICAP in high-velocity markets than in moderate-velocity markets. Accordingly, the path relationships between each of these governance mechanisms and the endogenous variable ICAP are compared among the two subsets. The directionality of the moderating effect is confirmed for RWRD only, while HEVY and MGAT have a stronger impact on ICAP in moderate velocity industries. Again, only the difference in the path between MGAT and iCAP is significant. Table 60 presents the results.

Path relation-ships / total effects	Subset A: moderate velocity		Subset B: high velocity		Subset A vs. subset B			
	p^A	Std. error (p^A)	p^B	Std. error (p^B)	$\lvert p^A\text{-}p^B \rvert$	t-value	Signifi-cance	p-value
HEVY → iCAP	.246	.084	.129	.084	.116	.996	NS	.322
RWRD → iCAP	.329	.084	.471	.084	.142	1.209	NS	.230
MGAT → iCAP	.321	.081	-.072	.194	.393	1.894	*	.066

NS = not significant; * significant at $p < 0.1$; ** significant at $p < 0.05$; *** significant at $p < 0.01$

Table 60: PLS-MGA results for hypothesis H12c

6.6.4   Discussion of results

The MGA helps to answer this dissertation's third research question on the extent to which context factors, in particular industry, influence the governance and performance of global product development teams.

The empiric results show a considerable difference between German MNCs from moderate and high velocity industries: The data for moderate-velocity industries indicates a strong link between individual absorptive capacity and product development performance but provides hardly any evidence for a positive link between knowledge integration and product development

performance. On the contrary, the data for high-velocity industries shows a strong and significant association between knowledge integration and product development performance, and a weak direct path between individual absorptive capacity and product development performance. In this subset, the total effect of individual absorptive capacity on product development performance is weak and non-significant. Consequently, governance mechanisms impacting knowledge integration such as socialization are very relevant in high-velocity industries while their impact is negligible in moderate-velocity industries. These results explain the popularity of studying socialization-based mechanisms as identified in section 3.2.3.4 in spite of their low, non-significant total effect on product development performance in the total sample.

Earlier findings regarding hierarchical governance are confirmed: Sarin & O'Connor (2009) find evidence that project managers' impact in organizations with a strong line hierarchy diminishes. Likewise, this study finds that strong project structures are applied more often in moderate-velocity industries where they also have a much higher impact.

This study's findings imply that it is worthwhile extending the KGA which enquires about knowledge governance mechanisms to industry dynamics. Industry dynamics represent a context factor which has been hitherto largely neglected by KGA scholars. The results indicate that knowledge-based theories such as the KBV which defines knowledge integration as the source for competitive advantage (Kogut & Zander 1992; Kogut & Zander 1993; Grant 1996b) apply to high-velocity markets where the creation of new knowledge plays a considerably higher role than in moderate-velocity markets. While DC recognize market dynamics as an important input factor, this study does not provide support for its proponents' assumptions that high-velocity markets require simple experimental routines rather than detailed analytic routines (Grant 1996a; Eisenhardt & Martin 2000). This study rather suggests that high-velocity industry require both: Strong standardized product

development processes and socialization mechanisms. A possible interpretation could be that high-velocity markets put high pressure on product development projects to succeed in time and in budget, as these industries face shorter product life cycles and higher development budgets. While socialization is critical to combine knowledge and create new knowledge, standard processes are vital to ensure that these creative development activities are economical. Another potential interpretation is that global teams in high-velocity industries do not only work on *radical innovation* which requires less routines (Christiansen & Varnes 2009), but also on constant incremental improvements which benefit from process standards. Combining this study's quantitative results with the expert statements of the qualitative research stream (cf. section 5.4.4.3), it appears that standard product development processes can be successfully applied in global teams in high-velocity industries if they provide for the flexibility to make decisions quickly when needed.

The results for moderate-velocity markets support the arguments of Darby et al. (1999) and Felin & Hesterly (2007) who challenge the KBV and DC by arguing that influencing the capabilities and motivation of individuals is more vital for creating competitive advantage than creating company knowledge via knowledge management mechanisms. The study results indicate that hierarchical mechanisms such as heavyweight team-structures and management attention are the most impactful governance mechanisms in this industry cluster.

6.7   IMPORTANCE-PERFORMANCE MATRIX

The MGA points out significant heterogeneity between moderate and high-velocity industries. In order to develop practically relevant advice to managers, the IPMA is hence conducted for each industry subsample rather than for the total sample.

The constructs' index values are generated from the PLS model generated for the MGA, following the procedure outlined in section 4.4.2.5. Table 61 shows the results, combined with the total effects indexed via multiplication with 100.

Governance mechanism	Subset A (moderate velocity)		Subset B (high velocity)	
	Performance (extent of application)	Importance (total effect on PDPF)	Performance (extent of application)	Importance (total effect on PDPF)
Heavyweight team structures	69	27	65	6
Top management attention	71	19	73	-10
Standard product development processes	68	15	63	28
Rewards	55	13	71	9
Socialization	32	1	24	20

Table 61: IPMA values by industry subset

Figure 48 depicts the results for the two data subsets in the IPMA grid. A gray diagonal bar is depicted in each diagram to indicate the area where a balance between extent of application and effectiveness is achieved. Governance mechanisms to the top left of this bar tend to be over-applied in spite of their comparably low impact, while mechanisms to the bottom right of the bar are under-applied given their high effectiveness.
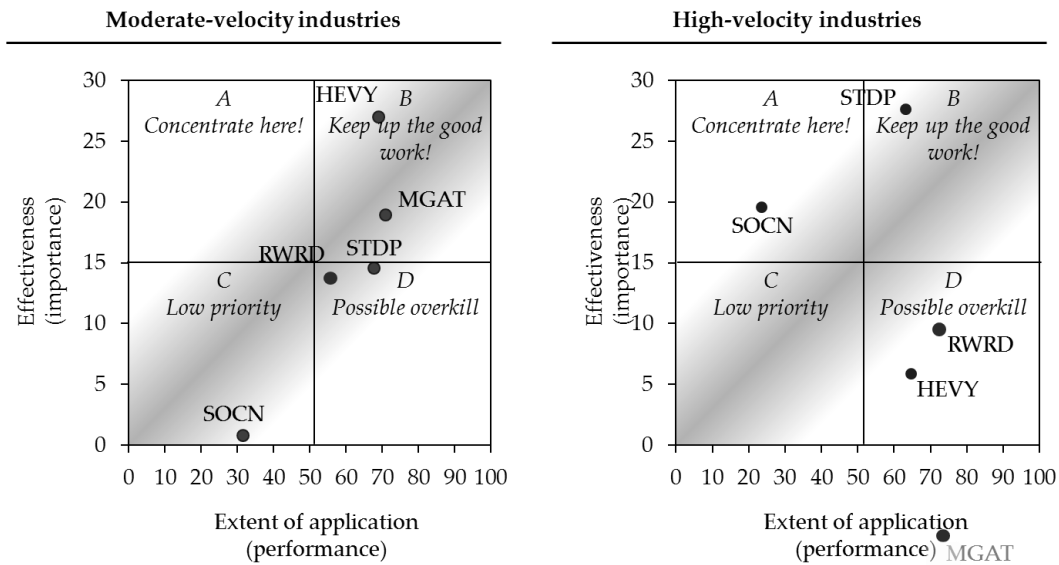
Figure 48: Importance-performance matrix for moderate and high velocity industries

This depiction helps answer the fourth research question of this dissertation which enquires how governance mechanisms can increase the performance of global product development teams. The data suggests that in moderate-velocity industries, there is almost equilibrium between the extent of application and effectiveness of different governance mechanisms. The extent of application of governance mechanisms hardly varies between the two data subsets, but the effectiveness differs notably, leading to a less effective application of governance mechanisms in high-velocity markets. In these markets, management attention is strongly overemphasized: Given its even negative impact on product development performance, it comes closest to the "possible overkill" zone and should be significantly reduced. The effect of rewards and heavyweight team structures is slightly overstated whereas socialization mechanisms are underapplied compared to their strong impact on knowledge integration which is material for development performance in this industry cluster. They constitute an area on which manager in high-velocity markets should concentrate.

7 CONCLUSIONS

7.1 CONCLUSIONS AND MANAGEMENT IMPLICATIONS

This dissertation researches the effectiveness of governance mechanisms for global product development teams in German-based MNCs in the B2B sector. It is the first study to assess the comparative performance of a wide range of governance mechanisms with regard to global product development projects. It takes into consideration a wider scope of context factors than previous studies and thus allows for a more differentiated interpretation and management recommendations tailored to the specific situation of global product development contexts. At the same time, the study tests a relatively new theoretic approach, the KGA, and thereby contributes to the further advancement of this theory. The study combines theory – focusing on the Knowledge Governance Approach (KGA) – and existing empiric evidence to develop a comprehensive set of hypotheses on the relationships between governance mechanisms, individual absorptive capacity, knowledge integration and product development performance. In addition, the study identifies relevant context factors for these relationships and assesses their impact. Applying a mixed methods approach, this dissertation gathers and analyses qualitative information from 10 industry experts and quantitative data from 120 global product development project teams to refine and test its hypotheses and thus answer the research questions.

The first research question has an explorative character and enquires about the application of governance mechanisms:

RQ1: Which governance mechanisms are applied to govern global product development teams, and to what extent?

Methodology. This dissertation adopts the framework for governance mechanisms developed by (Harzing 1999) and fills this framework with governance mechanisms tested empirically by previous studies. The actual application of these governance mechanisms is then tested in the two empiric research streams based on qualitative expert feedback and the frequency distribution of the quantitative data.

Findings. The qualitative and quantitative data gathered for this dissertation suggest that German-based MNCs in the B2B sector apply a wide range of mechanisms to govern global product development teams including hierarchical, bureaucratic-formalized, output-related and socialization-based mechanisms. The bureaucratic-formalized mechanism of standard product development processes is applied most intensely. Other bureaucratic-formalized mechanisms (i.e. top-management attention, headquarter involvement and heavyweight team-structures) are also very frequently applied. Person-based governance mechanisms such as socialization and (financial as well as non-financial) rewards are applied considerably less frequently. This finding is in line with the theoretical propositions of TCE and the KGA suggesting that cost efficiency is a key criterion for organizations to select applicable governance mechanisms (Klein et al. 1978; Williamson 1999; Foss 2011), as socialization is described by respondents as a very costly mechanism and is at the same time found to be the least applied mechanism.

The findings on the application frequency of governance mechanisms by German-based MNCs support earlier characterizations of German organizations as uncertainty-avoiding and preferring rules and regulations over other forms of coordination (Hofstede 1980; Hofstede 1994). This confirms the assumption that MNC home culture has a strong influence on MNC organization and managerial style also outside the home country (Egelhoff 1984, p.73). The findings are likely to differ for MNCs headquartered outside Germany. Besides by nationality, the findings also differ by industry: Within this dissertation's quantitative data

sample, companies from the cluster of high-velocity industries comprising biotechnology, software, technology equipment and semiconductors apply rewards most frequently. Companies in the cluster of moderate-velocity industries comprising material, capital goods, automobile components and healthcare equipment rely most heavily on hierarchical governance mechanisms. Across the board, knowledge management systems and socialization-based mechanisms are the least applied form of governance. Knowledge management systems are applicable to product development only to a limited extent as they support capturing existing knowledge rather than creating new knowledge which is key to (new) product development. The low level of application of socialization-based mechanisms can be attributed to two reasons: Firstly, the expert interviews indicate that socialization-based mechanisms such as international assignments or physical meetings are costly to apply. Secondly, it is likely that German MNCs' preference of direct over indirect governance mechanisms such as socialization is culturally rooted in uncertainty avoidance.

Figure 49 summarizes the main findings related to *RQ1*.

Figure 49: Summary conclusions to research question 1

Having identified the applied governance mechanisms, the second research question enquires about their effectiveness can be answered:

RQ2: What impact do these governance mechanisms have on successful product development performance, either directly or indirectly?

Methodology. This dissertation applies the Knowledge Governance Approach (KGA) as a framework for governing product development as a knowledge-intense business process. The KGA focuses on the micro-foundations of knowledge. In the context of this study, this implies that, governance mechanisms can influence product development performance directly or indirectly, driving the application of knowledge at the micro (individual) or macro (team/organizational) level. Hypotheses on the relationships between governance mechanisms, micro-level individual absorptive capacity, macro-level knowledge integration and product development performance are derived from theory and literature, refined via qualitative research and tested empirically in the quantitative research stream applying PLS-SEM.

Findings. The results of the quantitative study mostly confirm the research model derived from theory, literature and qualitative primary findings: Governance mechanisms impact the performance of global product development teams both directly and indirectly. The effects of individual absorptive capacity and knowledge integration on product development are positive and significant, thus confirming the basic propositions of the KGA. Rewards, management attention and heavyweight team structures impact individual absorptive capacity which is positively associated with knowledge integration and product development performance. Socialization is positively associated with knowledge integration. Moreover, standard development processes and heavyweight team structures directly impact product development performance. Knowledge management systems and headquarter involvement are hardly associated with product development performance. Heavyweight team structures have the highest total effect on product development performance, followed by standard development processes and management attention. The total effect of socialization-based governance is positive but non-significant in spite of its significant association with knowledge integration. The subsequent analysis of industry differences explains this phenomenon. Figure 50 summarizes the main findings related to *RQ2*.

Research question	Methodology	Key findings
RQ 2: What impact do these governance mechanisms have on successful product development performance, either directly or indirectly?	Hypothesis testing using data from quantitative survey, applying PLS-SEM analyses	Top 5 governance mechanisms by total effect on product development performance *(moderate velocity industries/high velocity industries; indexed scores on scale from 1-100)* 1. Standard product development processes *(15/28)* 2. Heavyweight team structures *(27/6)* 3. Rewards *(13/9)* 4. Socialization *(1/20)* 5. Top management attention *(19/-10)*

Figure 50: Summary conclusions to research question 2

The third research question examines this aspect more closely and asks:

RQ3: Which context factors influence the governance and performance of global product development teams, and to what extent?

Methodology. Three context factors for designing governance mechanisms for global teams are identified from theory, existing studies and expert interviews: (1) Distance between team members, which is an inherent feature of global teams and can be further subdivided into physical, linguistic and cultural distance, (2) tacitness, which characterizes the type of knowledge involved in product development and (3) industry which impacts the R&D intensity and thus the relevance of product development for a company. Hypotheses regarding the impact of these context factors on the governance and performance of global product development teams are derived from literature and discussed with experts. The derived research model is tested with quantitative data using moderated PLS-SEM.

Findings. The study results confirm a heterogeneous impact of the different facets of distance on knowledge integration and performance of global teams: *Physical distance* has a weak, yet non-significant negative impact on both knowledge integration and performance. This result raises the question in how far co-location of international teams – a costly endeavor – pays off in terms of product development performance. The results also indicate that socialization as a governance mechanism for knowledge integration tends to slightly lose

effectiveness with increasing physical distance. *Cultural distance* has a significant positive effect on knowledge integration. This can be explained by the positive impact on creativity which results from combining (culturally) different ways of thinking when developing new products. This assumption is further supported by this dissertation's finding that socialization slightly negatively moderates the positive relationship between cultural distance and knowledge integration: When cultural distance decreases by means of socialization, so does the creativity derived from this source of heterogeneity as if "wearing off". The third dimension of distance, *language*, has a negative impact on knowledge integration – this result confirms the expert views and supports previous qualitative scholarly findings indicating that language is largely underestimated as an obstacle for intra-MNC collaboration (Marschan-Piekkari et al. 1999).

The study results validate the hypothesis that *tacitness* is negatively associated with knowledge integration. Socialization, the governance mechanism directly targeted at knowledge integration, hardly moderates this negative association. While tacitness is a common characteristic of product development knowledge, this study's results indicate that socialization is no remedy for the associated challenges. This contradicts the basic propositions of the Nonaka's (1991, 1994) SECI model and supports the arguments of opponents of the SECI model who argue that it lacks empiric evidence (Gourlay 2006).

Figure 51 summarizes the conclusions to *RQ3* regarding the performance impact of distance and tacitness.

Research question	Methodology	Key findings
RQ 3: Which context factors influence the governance and performance of global product development teams, and to what extent?	Hypothesis testing using data from quantitative survey, applying moderated PLS-SEM analyses following qualitative content analysis of expert interviews	Impact of key context factors on knowledge integration / product development performance (-- = *strongly negative, o = no impact, ++ = strongly positive*) Physical distance -/- Cultural distance ++/- Linguistic distance --/not applied Tacitness --/not applied

Figure 51: Summary conclusions to research question 3 for distance and tacitness

Industry characteristics are found to cause some key differences in the effectiveness of governance mechanisms for global product development teams: In high-velocity industries characterized by high R&D spending, knowledge integration plays a crucial role for product development performance. In moderate-velocity industries, individual absorptive capacity is a key success factor. While the direct effects of governance mechanisms hardly differ between the industry clusters, this distinction leads to different total effects of the governance mechanisms, where socialization proves more effective in high velocity industries due to its impact on knowledge integration. In comparison, management attention, rewards and heavyweight team structures have more impact in moderate-velocity markets as they directly influence individual absorptive capacity. The differences are summarized in the industry-specific data provided in figures 50 and 51

The fourth research question seeks to derive practical implications for managers from the study findings and asks:

RQ4: How can governance mechanisms be utilized to increase the performance of global product development teams?

Before answering this question, it should be noted that studies of organizational performance are relevant to management practice but have been criticized by academics for their tendency to oversimplify explanations of performance variance, for neglecting unobserved data heterogeneity, and being

self-confirmatory (Kieser & Nicolai 2005). To avoid these risks, this dissertation follows research recommendations for organizational performance studies (Haenecke & Forsmann 2006; Wolf & Rosenberg 2012): Existing theories such as the KBV and KGA, and related research findings from the areas of product development and MNC governance, are considered and (re)tested. To reduce the impact of unobserved heterogeneity, the scope of the study is limited to German-based MNCs in the B2B sector, and context variables are explicitly modeled and integrated into the research model. Additionally, the research approach is designed in a way that seeks to overcome the risk of common method bias in order to ensure objectivity and reliability of the findings. Post-hoc statistical testing confirms that common method bias is not a risk to the validity of this study's quantitative findings.

The statistical tests of the research model developed in this dissertation ascertain that governance mechanisms can contribute significantly to explaining performance differences among global product development projects. Heavyweight team structures where project managers have direct access to their project team members emerge as the governance mechanism with the highest overall association with product development performance. Standard product development processes which follow and review a formal project plan and clearly defined milestones similarly support the performance of global development projects. Highly capable and motivated team members are a prerequisite for product development performance, and while they have not been the focus of this study, it is obvious that HR processes for selecting and training staff are key to achieving a high level of individual capability and motivation in global teams. The study results indicate that governance mechanisms can further positively influence the team's motivation: Directing management attention on the global development project and rewarding team members financially and non-financially leads to higher levels of absorptive capacity of global teams, specifically in moderate-velocity industries. Socialization can support the integration of the knowledge of individuals and matters particularly in high-

velocity industries where the combination of different types of existing knowledge is relevant to the successful development of new products in short cycle times.

The statistic results suggest that practitioners should avoid a high level of headquarter involvement as it is negatively associated with the performance of global product development teams, and that the knowledge management systems currently in use provide little added value for global product development projects.

The results of the IPMA indicate that overall, practitioners apply governance mechanisms effectively. Particularly in high-velocity markets, performance could be further boosted by increasing the application of socialization-based mechanisms and reducing top management attention.

Furthermore, the research model identifies project duration as a variable which has both relevant and significant impact on product development performance although it has not been established as a governance mechanism: The study results indicate that shorter projects perform considerably better than longer projects. These findings suggest that when designing a global development project, it is worthwhile considering to cut it into several short (sub-)projects rather than one long project, and subsequently define the applicable governance mechanisms for each sub-project.

Further recommendations for practitioners derived from the study include the recommendation to view cultural distance as an opportunity rather than a threat, particularly when seeking to develop new ideas, and to take utmost care at reducing language barriers between global team members in order not to hamper knowledge integration. According to expert statements, this is best achieved by selecting bi-lingual project members who are confident in communicating in the

primary project language and are patient in dealing with project members with limited skills in the project language.

7.2 LIMITATIONS OF THE STUDY AND SUGGESTIONS FOR FURTHER RESEARCH

As all empiric research, this dissertation has limitations which relate to the research focus, theoretic framework and the methodological approach. These limitations can be overcome by future research. Furthermore, the findings of the study raise new questions which provide opportunities for further studies, as outlined below.

Research focus. The empiric scope of this dissertation is deliberately limited to German-based MNCs from the B2B sector in order to reduce the spurious effects stemming from home culture and to limit the extent of variance caused by industry. This dissertation's research results confirm that this focus is viable: A comprehensive model can be developed and is for the most part empirically confirmed. The empiric findings however raise the question whether the model is universally applicable: Qualitative and quantitative data gathered for this study indicate that German-based MNCs prefer direct (explicit) governance mechanisms, and that these mechanisms generally outperform indirect (implicit) governance mechanisms. Intercultural management studies suggest that this preference of direct over indirect governance mechanisms is related to the tendency towards uncertainty avoidance inherent in German national culture (Hofstede 1994; Trompenaars & Hampden-Turner 1998). To arrive at study results that are generalizable on an international scale, it would be interesting to test the research model developed in this dissertation with non-German MNCs and assess potential MNC home-country effects.

Furthermore, the empiric results of this study indicate that the industry in which an MNC operates has a significant moderating impact on the path coefficients in the research model. Against this background, it would be

interesting to expand the research focus further and test the model with observations from the business-to-consumer or business-to-government context. In addition, this dissertation focuses on global product development teams *within* an MNC. Research on product development however increasingly emphasizes the virtues of *open innovation* which extends beyond the boundaries of one organization and can include suppliers, customers, third party research institutes or companies with complementary skills and capabilities (Chesbrough 2003; Enkel et al. 2009). This new form of collaboration impacts the application of governance mechanisms (Grönlund et al. 2010). Extending this dissertation's research model and adding context factors which apply specifically to open innovation would be another interesting direction for future studies.

Reaching beyond the functional scope of product development, future research could also test the applicability of governance mechanisms in different functional contexts, e.g. production or marketing, in order to understand in how far governance mechanisms for global teams need to be tailored to the functional context.

Theoretic framework. This dissertation builds mainly on the KGA as a theoretic framework which explains how structures and mechanisms can influence processes of knowledge sharing and creation. This approach is rather new and has been deemed under-researched (Michailova & Foss 2009). This dissertation helps underpin this new approach with empiric data. The empiric findings support the key assumptions of the KGA and aid to expand this rather new theoretic approach with regard to context factors for knowledge governance. The findings on the moderating impact of industry provide empiric evidence to justify the different views taken by proponents of the different KBV schools including DC which – according to this study's results – fits the context of high-velocity industries better than the context of moderate-velocity industries. Still more research is required to establish the KGA as a theoretic framework. While this dissertation is concerned with projects and the governance of global project

teams, further KGA-related research could shed further light on the governance mechanisms, processes and organizational structures which help create and develop *individual* absorptive capacity and behavior. Identifying the most promising HRM processes and practices for recruiting, developing and retaining highly capable and motivated talent, also with regard to global product development, would be an interesting direction for future research in order to better understand the micro-foundations of knowledge sharing and creation and thus further underpin the KGA. In this context, it would also be interesting to follow the approach of Husted & Michailova (2009) who discuss different employee attitudes and suggest governance mechanisms to influence them. Furthermore, the model could be extended by (moderating) factors which have been lately discussed as influence factors for knowledge in- and outflows such as the mandates and linkages of global R&D sites within MNC networks (Monteiro et al. 2010; Belderbos et al. 2011; Alcácer & Zhao 2012).

Research methodology. This dissertation applies a mixed-methods study design where qualitative interviews are used in a pre-study to sharpen the research model which is then quantitatively tested with data from an online survey. The qualitative study is designed as a compact pre-study based on ten expert interviews using directed qualitative content analysis to interpret the findings and arrive at a refined research model that enables a comparative study of many governance mechanisms. In order to understand individual governance mechanisms better, future research could go into more detail and explore the facets and success factors of applying individual governance mechanisms based on broader qualitative research.

Data gathered for the quantitative research stream is analyzed using PLS-SEM which is an appropriate analysis tool for studies with an exploratory character. Having explored general relationships between governance mechanisms, knowledge integration and product development performance, future studies could apply CB-SEM to validate these links and identify potential

PLS-bias in the present study. Collecting even more data would furthermore result in a sufficient sample size to test cascaded moderator effects which could not be explored in this study due to sample size constraints.[145]

From a methodological viewpoint, it would also be interesting to test alternative operationalizations of this dissertation's key endogenous variable, product development performance, which is measured as one construct in this study. As discussed in section 2.1.2, product development performance is a multi-faceted variable. Future studies could deconstruct this variable into its individual items and measure the relative impact of each governance mechanism on the different dimensions of performance such as time, quality and cost, in order to derive even more differentiated suggestions practitioners tailored to the specific objectives of their project. In this context, it would also be interesting to involve sales managers into future studies of product development performance in order to include more indicators of post-launch performance into the measurement of product development performance.

7.3   OUTLOOK

Product development remains one of the least internationalized functions of multinational companies (Narula & Zanfei 2005; Belderbos et al. 2011) and German MNCs which are the focus of this study only started to internationalize their R&D activities in the 1990s, about ten to thirty years later than their peers from smaller European countries (Ambos 2005; Gammeltoft 2005). Two major external influence factors are likely to drive further internationalization of German MNCs' development activities: Firstly, the German home market, both as a consumer and industrial market, continues to lose its (relative) importance as compared to emerging economies due to their market size and continuing growth potential. Developments for these emerging markets will, in the long run,

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[145] A cascaded moderator effect exists when the strength of a moderating effect is influenced by another moderator variable (Hair et al. 2014, p.278).

increasingly demand decentralized development activities. Secondly, the increasing difficulty to hire qualified developers in Germany and the increasing cost competition on the global market forces MNCs to employ development talent abroad.

Global project teams play a key role in internationalizing MNCs' product development activities (Ambos & Schlegelmilch 2004). This dissertation provides a thorough, theoretically and empirically founded understanding of how to govern such global teams effectively. It provides practical recommendations on how to successfully manage the required further internationalization of German MNCs' product development via global teams by assessing the effectiveness of governance mechanisms – variables that practitioners can influence. In order to develop practical recommendations for executives, this dissertation follows advice for relevant research to retest existing findings and seek dialog with practitioners in the course of the study (Wolf & Rosenberg 2012, pp.184–190).

This is the first study which holistically analyzes the comparative effectiveness of a wide range of governance mechanisms for global product development teams, applying both qualitative and quantitative field research in a mixed-methods study design. With its research framework, the study aids to underpin a rather new theory, the Knowledge Governance Approach, with empiric research in order to develop this theoretic framework further. A key contribution is the identification and evaluation of context factors for knowledge governance which KGA proponents have hitherto discussed only vaguely.

A range of suggestions to further develop this research approach is provided: future studies on governing inter-organizational product development teams (open innovation), on governance mechanisms in different industries, different MNC home countries, or knowledge intense business processes other than product development can all build upon and expand the research framework developed and tested in this dissertation and the KGA in general.

Combining knowledge-based theory with organizational economics will remain relevant in today's knowledge economy (Drucker 1994; Kessels 2001; Foss 2005) where firms' strategic focus continues to shift from capital and labor towards the combination of knowledge embodied in products and processes.

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APPENDICES

APPENDIX A: POSITIONING OF GERMANY IN GLOBAL R&D RANKINGS

R&D EXPENDITURE BY COUNTRY, 2011-2013

R&D expenditure	Absolute (in bn US$)				Relative (in % of GDP)			
	2011	2012	2013	CAGR	2011	2012	2013	CAGR
1. USA	412	419	424	1.4%	2.70%	2.68%	2.66%	-0.7%
2. China	177	197	220	11.5%	1.55%	1.60%	1.65%	3.2%
3. Japan	156	160	162	1.9%	3.47%	3.48%	3.48%	0.1%
4. Germany	90	91	91	0.9%	2.85%	2.87%	2.85%	0.0%
5. South Korea	54	56	58	3.9%	3.40%	3.45%	3.45%	0.7%
6. France	50	50	51	1.0%	2.21%	2.24%	2.24%	0.7%
7. India	38	40	45	8.5%	0.85%	0.85%	0.90%	2.9%
8. United Kingdom	41	42	42	1.3%	1.81%	1.84%	1.84%	0.8%
9. Russia	36	37	39	3.8%	1.48%	1.48%	1.48%	0.0%
10. Brazil	28	30	32	6.9%	1.20%	1.25%	1.30%	4.1%
Others	313	347	333	3.0%				
World (total)	*1,394*	*1,469*	*1.496*	*3.6%*	*1.76%*	*1.77%*	*1.77%*	*0.3%*
Note: Europe (aggregated):	343	347	349	0,9%	1,87%	1,88%	1,88%	0,3%

Source: author, based on data provided by Grueber & Studt 2012, p. 32

All data provided by the quoted study of Grueber & Studt (2012) includes all national spending on R&D, including spending by government, companies, academia, non-government-organizations and others. In the Western industrialized nations, corporate R&D spending accounts for app. 60-65% of total R&D spending. Corporate spending covered in Grueber and Studt's (2012) survey

includes all spending of companies based in the respective country, even if spent outside the country's borders.

LEADING R&D COUNTRIES BY INDUSTRY

Sector	Rank	1	2	3	4	5
Agriculture & Food		US	China	Germany	Australia	Brazil
Automotive & Other Vehicles		Germany	Japan	US	South Korea	China
Commercial Aerospace, Rail & Other Non-Automotive Transport		US	France	Germany	China	Japan
Military Aerospace & Defense		US	China	Russia	UK	France
Chemicals, Nano-Tech and Advanced Materials		US	Japan	Germany	China	UK
Energy Generation & Efficiency		US	Germany	Japan	China	UK
Environmental & Sustainability		Germany	US	Japan	UK	Sweden
Healthcare, Life Science & Biotech		US	UK	Germany	Japan	Switzerland
Information & Communication Technology (ICT)		US	Japan	China	Germany	South Korea
Instruments & Non-ICT Electronics		US	Germany	Japan	China	South Korea

Source: Global researcher rating published by Grueber & Studt 2012, p. 62

APPENDIX B: LEADING GERMAN-BASED MNCS IN THE B2B SECTOR

All company data based on financial year 2011; derived from "Die Welt" Top 500 (2011), EU R&D Scoreboard (2012),

company websites accessed in December 2012

Code	Name	Sales (m €)	Employees	R&D expenditure (m €)	R&D quota (% of sales)	Industry (GICS)
1	ADVA Optical	311	1,304	60	19.4%	Technology Hardware & Equipm.
2	Aixtron	611	978	48	7.9%	Capital Goods
3	Altana	1,617	5,124	88	5.4%	Materials
4	Aurubis	13,336	6,279	8	0.1%	Materials
5	B. Braun	4,609	43,676	192	4.2%	Health Care Equipm. & Services
6	BASF	73,497	111,141	1,622	2.2%	Materials
7	Bayer	36,528	111,800	3,045	8.3%	Pharma, Biotech. & Life Sciences
8	Behr	3,706	17,400	217	5.8%	Automobiles & Components
9	Benteler	7,106	25,848	107	1.5%	Automobiles & Components
10	Brose	4,500	17,565	230	5.1%	Automobiles & Components
11	Carl Zeiss	4,237	23,383	355	8.4%	Technology Hardware & Equipm.
12	Claas	3,304	9,060	144	4.4%	Capital Goods
13	Continental	30,505	163,788	1,693	5.5%	Automobiles & Components

Code	Name	Sales (m €)	Employees	R&D expenditure (m €)	R&D quota (% of sales)	Industry (GICS)
14	Daimler	31,389	80,519	1,197	3.8%	Capital Goods
15	Deutz	1,529	4,060	110	7.2%	Capital Goods
16	DHS	2,499	6,082	77	3.1%	Materials
17	Diehl	2,929	13,455	287	9.8%	Capital Goods
18	Dräger	2,256	11,924	161	7.1%	Health Care Equipm. & Services
19	Dräxlmaier	2,300	48,000	117	5.1%	Automobiles & Components
20	EADS	49,128	133,115	3,249	6.6%	Capital Goods
21	Eberspächer	1,934	5,637	98	5.1%	Automobiles & Components
22	Elmos	988	988	35	3.5%	Semiconductors & Equipm.
23	Elster	1,444	7,000	79	5.5%	Capital Goods
24	Evonik Industries	14,540	33,556	365	2.5%	Automobiles & Components
25	Festo	22,400	16,200	1,792	8.0%	Capital Goods
26	Freudenberg	6,007	36,101	169	2.8%	Materials
27	Friedhelm Loh Group	2,200	11,500	106	4.8%	Capital Goods
28	Fuchs Petrolub	1,668	3,680	28	1.6%	Materials
29	Gea Group	5,417	23,834	84	1.6%	Capital Goods
30	Gerresheimer	1,095	11,000	4	0.4%	Materials
31	Getrag	3,000	12,520	153	5.1%	Automobiles & Components
32	Giesecke & Devrient	1,635	10,554	119	7.3%	Technology Hardware & Equipm.
33	Gildemeister	1,688	6,032	53	3.1%	Capital Goods
34	Grammer	1,093	8,429	38	3.5%	Automobiles & Components

Code	Name	Sales (m €)	Employees	R&D expenditure (m €)	R&D quota (% of sales)	Industry (GICS)
35	Hager	1,263	9,720	61	4.8%	Technology Hardware & Equipm.
36	HeidelbergCement	12,902	53,889	79	0.6%	Materials
37	Hella	3,550	22,852	374	10.5%	Automobiles & Components
38	Henkel	15,605	47,265	396	2.5%	Materials
39	Heraeus	26,183	13,185	76	0.3%	Capital Goods
40	Infineon Technologies	3,997	25,720	499	12.5%	Semiconductors & Equipm.
41	Jungheinrich	2,116	10,711	38	1.8%	Capital Goods
42	K+S	5,151	14,496	20	0.4%	Materials
43	Karl Storz	1,037	4,999	51	4.9%	Health Care Equipm. & Services
44	the Kion Group	4,368	20,797	110	2.5%	Capital Goods
45	Knorr-Bremse	4,241	17,303	209	4.9%	Automobiles & Components
46	Koenig & Bauer	1,167	6,401	58	5.0%	Capital Goods
47	Kontron	590	3,057	60	10.1%	Technology Hardware & Equipm.
48	Körber	1,943	9,595	104	5.4%	Capital Goods
49	KSB	2,091	15,674	42	2.0%	Capital Goods
50	KUKA	1,436	6,589	46	3.2%	Capital Goods
51	KWS SAAT	855	3,560	114	13.3%	Materials
52	Possehl Group	2,493	9,310	120	4.8%	Capital Goods
53	Lantiq	550	1,000	109	19.7%	Semiconductors & Equipm.
54	Lanxess	8,775	16,390	144	1.6%	Materials
55	Leoni	3,701	60,745	84	2.3%	Automobiles & Components
56	Kostal	1,623	13,503	118	7.3%	Automobiles & Components

Code	Name	Sales (m €)	Employees	R&D expenditure (m €)	R&D quota (% of sales)	Industry (GICS)
57	Linde	13,787	49,542	145	1.1%	Materials
58	Mahle	6,002	47,641	323	5.4%	Automobiles & Components
59	MAN	16,500	52,542	677	4.1%	Capital Goods
60	Mann+Hummel	2,473	14,338	126	5.1%	Automobiles & Components
61	Merck	10,276	40,676	1,517	14.8%	Pharma, Biotech. & Life Sciences
62	Messer Group	1,029	5,251	32	3.1%	Materials
63	MTU Aero Engines	2,932	8,202	124	4.2%	Capital Goods
64	Nordex	921	2,640	59	6.4%	Capital Goods
65	Otto Fuchs	3,000	9,000	93	3.1%	Materials
66	Pfleiderer	1,199	3,100	37	3.1%	Materials
67	Q-Cells	1,023	2,000	34	3.3%	Capital Goods
68	Qiagen	904	3,938	101	11.2%	Pharma, Biotech. & Life Sciences
69	Rehau	2,800	17,000	87	3.1%	Materials
70	Renolit	900	4,000	28	3.1%	Materials
71	Rheinmetall	4,454	21,516	208	4.7%	Capital Goods
72	Robert Bosch	51,494	302,519	4,242	8.2%	Automobiles & Components
73	Rohde & Schwarz	1,800	8,700	264	14.7%	Technology Hardware & Equipm.
74	SAP	14,233	55,765	1,939	13.6%	Software & Services
75	Sartorius	733	4,887	47	6.4%	Health Care Equipm. & Services
76	Schaeffler	10,700	74,000	482	4.5%	Automobiles & Components
77	Schmitz Cargobull	1,638	3,076	150	9.2%	Capital Goods
78	SEW-Eurodrive	2,500	15,000	133	5.3%	Capital Goods

Code	Name	Sales (m €)	Employees	R&D expenditure (m €)	R&D quota (% of sales)	Industry (GICS)
79	Sick	903	5,463	81	9.0%	Technology Hardware & Equipm.
80	Siemens	73,515	402,000	4,278	5.8%	Capital Goods
81	SMS Group	3,500	9,000	168	4.8%	Capital Goods
82	Software AG	1,098	5,535	88	8.0%	Software & Services
83	SolarWorld	1,047	2,701	27	2.6%	Capital Goods
84	Symrise	1,584	5,557	106	6.7%	Materials
85	ThyssenKrupp	43,356	180,050	248	0.6%	Capital Goods
86	Tognum	2,972	9,821	180	6.1%	Capital Goods
87	Trumpf	1,340	7,979	158	11.8%	Capital Goods
88	Knauf	5,700	24,000	177	3.1%	Materials
89	Voith	5,594	41,937	162	2.9%	Capital Goods
90	Vossloh	1,197	5,011	20	1.6%	Capital Goods
91	Wacker Chemie	4,910	17,168	173	3.5%	Materials
92	Webasto	2,305	1,045	95	4.1%	Automobiles & Components
93	Schott	2,881	17,019	101	3.5%	Materials
94	Wincor Nixdorf	2,328	9,257	100	4.3%	Technology Hardware & Equipm.
95	Xella	1,300	6,950	40	3.1%	Materials
96	ZF Friedrichshafen	15,509	68,164	732	4.7%	Automobiles & Components
Total		768,980	2,954,283	36,820		

Note: EADS renamed Airbus Group in 2014

GICS category	Subgroups included in category
1510 Materials	Chemicals: Commodity chemicals, diversified chemicals, fertilizers & agricultural chemicals, industrial gases, specialty chemicals Metals & mining: Gold, precious metals and minerals, steel Other: Construction materials, metal & glass containers, paper packaging, paper & forest products
2010 Capital Goods	Aerospace & defense, building products, construction & engineering, electrical components & equipment, heavy electrical equipment, industrial conglomerates, construction & farm machinery & heavy trucks, industrial machinery
2510 Automobiles & Components	Auto parts & equipment, tires & rubber
3510 Health Care Equipment & Services	Healthcare equipment & supplies, health care technology
3520 Pharmaceuticals and Biotechnology	Biotechnology, pharmaceuticals, life sciences tools
4510 Software & Services	Internet software, application software, systems software
4520 Technology Hardware & Equipment	Communications equipment, networking equipment, telecommunications equipment, computer hardware, computer storage & periphals, electronic equipment & instruments, electronic components, office electronics
4530 Semiconductors & Equipment	Semiconductors and semiconductor equipment

APPENDIX D: EXPERT INTERVIEWS: INTERVIEW REQUEST AND GUIDELINE

This interview guideline was provided to interview participants upfront. Depending on the previous contact with the expert, the guideline was adapted to either request a telephone interview or face-to-face meeting.

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Essen, December 2012

Dear Sir,

I am contacting you as you were referred to me as an **expert practitioner** in the area of **international transfers of product development knowledge**. I am currently writing my doctoral thesis in this area, focusing on German-based multinational companies with B2B activities.

I would be most grateful if you were available for a **60 minutes telephone conversation** to discuss your experience with international knowledge transfers in product development.

The objective of my doctoral thesis is to identify *best practices* **of how to coordinate effective international transfers of product development knowledge.**

Specific questions for our interview would include:

- Which types of international knowledge transfers are relevant for product development in your company?
- How do you coordinate international knowledge transfers within your company?
- Which factors do you perceive as relevant when designing coordination mechanisms for international knowledge transfers?
- Which specific objectives does your company pursue when supporting international knowledge transfers in product development? (How) is the achievement of these objectives measured?
- Based on your experience, what do you perceive as critical success factors for effective international knowledge transfers?

Please let me know whether I can contact you to schedule a telephone conversation to discuss these questions. Our conversation should take no longer than 60 minutes and should ideally take place in **January 2013**. Do not hesitate to contact me should you have any questions prior to our conversation.

I will gladly provide you with the results of the series of expert interviews I am going to conduct with German-based multinational companies from different industries. The results shall contain interesting insights and best practices for the design of international knowledge transfers in product development.

Thank you for considering my request. I am looking forward to speaking to you in the near future.

Best regards

Britta Müller

**APPENDIX E: INITIAL HYPOTHESES AND AMENDMENTS BASED ON THE
FINDINGS OF THE QUALITATIVE STUDY**

Original hypotheses	Amendments based on qualitative study
H1: *Successfully integrating the knowledge of the members of a global product development project team is positively associated with the performance of the global product development project.*	
H2a: *Individual absorptive capacity (iCAP) is positively associated with knowledge integration in global product development teams.*	
H2b: *Individual absorptive capacity (iCAP) is positively associated with the performance of global product development teams.*	
H3a: *Operational headquarter involvement is negatively associated with knowledge integration in global product development projects.*	H3a*: *Headquarter involvement is negatively associated with knowledge integration in global product development projects.*
H3b: *Operational headquarter involvement is negatively associated with the performance of global product development projects.*	H3b*: *Headquarter involvement is positively associated with the performance of global product development projects.*
H4a: *Top management attention is positively associated with individual absorptive capacity in global product development teams.*	
H4b: *Top management attention is positively associated with the application of standard product development processes in global product development projects.*	

Original hypotheses	Amendments based on qualitative study
H5: *Heavyweight team structures are positively associated with the performance of global product development teams.*	H5a*: *Heavyweight team structures are positively associated with the performance of global product development teams.* H5b*: *Heavyweight team structures are positively associated with individual absorptive capacity.*
H6: *Knowledge management systems are positively associated with knowledge integration of global product development teams (it is low compared to other governance mechanisms).*	
H7a: *Standard development processes are not associated with knowledge integration in global product development projects.*	
H7b: *Standard development processes are positively associated with the performance of global product development projects.*	
H8: *Individual rewards for team members are positively associated with individual absorptive capacity in global product development teams.*	
H9a: *Socialization is positively associated with knowledge integration in global product development teams.*	

Original hypotheses	Amendments based on qualitative study
H9b: *Team members' involvement in international groups (committees) and trainings, their expatriation experience and collaboration experience contribute to the socialization of global product development teams.*	H9b*: *Team members' international experience from expatriation or short-term foreign assignments, their involvement in international groups (committees) and trainings, their previous collaboration experience and the extent of rich personal communication all contribute to the socialization of global product development teams.*
H10a: *Cultural distance is positively associated with knowledge integration.*	
H10b: *Socialization positively moderates the relationship between cultural distance and knowledge integration: The higher the extent of socialization, the stronger the positive relationship between cultural distance and knowledge integration.*	
H10c: *Linguistic distance is negatively associated with knowledge integration.*	
H10d: *Physical distance is negatively associated with knowledge integration and product development performance.*	
H10e: *Physical distance negatively moderates the relationship between socialization and knowledge integration: The higher the physical distance, the lower the positive association between socialization and knowledge integration.*	
	H10f: *Cultural distance is negatively associated with product development performance*

Original hypotheses	Amendments based on qualitative study
	H10g: Socialization moderates the relationship between cultural distance and product development performance: The higher the extent of socialization, the weaker the negative relationship between cultural distance and product development performance.
H11a: Tacitness is negatively associated with knowledge integration.	
H11b: Socialization moderates the relationship between tacitness and knowledge integration: The higher the socialization, the weaker the negative relationship between tacitness and knowledge integration.	
H12a: Knowledge integration is more strongly associated with product development performance in high-velocity markets than in moderate-velocity markets.	
H12b: Governance mechanisms targeted at knowledge integration either directly or indirectly (i.e., socialization, KMS, rewards and top management attention) are more strongly associated with knowledge integration in high-velocity markets than in moderate-velocity markets.	
	H12c: Governance mechanisms targeted at individual absorptive capacity that can be applied flexibly such as team structures, rewards and management attention have a stronger impact in high-

	velocity markets than in moderate-velocity markets.

Appendix F: Online questionnaire

Page 01

Dear survey participant,

Thank you for taking some time to answer this survey. You have been asked to participate in this survey to share your experience as a project manager in an international product development project.

This survey aims at identifying success factors for such projects. By sharing your personal experience, you help to research the drivers for successfully managing international product development projects.

The survey is part of my PhD project at the German University of Applied Sciences FOM (Hochschule für Oekonomie & Management) in cooperation with Spain's Catholic University San Antonio.

It will take about 15 minutes to answer all questions. To achieve valid research results, it is important that you answer all questions honestly to your best knowledge. There is no "right" or "wrong" answer, and your responses will be treated anonymously. If you are interested in a free summary of the survey results, you can leave your email address at the end of the questionnaire or contact me directly.

I highly appreciate that you take the time to participate in this survey. Your perspective is an invaluable contribution towards understanding international product development projects.

Kind regards,

Britta Müller

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Page 02
FJ

This survey is targeted at managers of international product development projects who work(ed) for a multinational company headquartered in Germany.

Please answer the following two questions to check whether you belong to the survey's target group.

	no	yes
I have been in charge of a product development project with project members from different countries.	○	○
The organization for which I managed this project (my employer) is headquartered in Germany.	○	○

Survey is ended if one of these questions is answered "no"

1. Project status

What is the status of the project?

[Please select from dropdown menu] ⌄

2. Project type

What was developed in your project? You can select more than one option if applicable.

☐ A product

☐ A component

☐ A process (supply chain or manufacturing)

☐ A technology

☐ A methodology

☐ Other (please specify your answer): [   ]

What best describes the "newness" of the development in this project? You can select more than one option if applicable.

What we developed was...

☐ new to the world

☐ new to my organization

☐ an improvement of a previous version

☐ an adaptation to a local market

☐ a customized solution for a specific customer

3. Project manager home base

In which country were you based as a project manager for this project?

[Please select from dropdown menu] ⌄

4. International project team

The project involved a cooperation between employees based in different countries within your organization. Please tick the countries where project members were based. Only consider project members who contributed to this project on a regular basis.

☐ **Europe**

☐ **Africa**

☐ **Asia**

☐ **Americas**

☐ **Australasia/Pacific**

Menu with list of countries per continent expands upon selection

5. Project language(s)

Please select the language officially used for project team communication.

The official project language used in documents and spoken in project team meetings was...

[Please select from dropdown menu] ⌄

6. General project statistics

In which year was the project started?   [____] [YYYY]

What was the project duration from its start date until its completion or cancellation?   [____] months

How many employees regularly contributed to this project?   [____] employees

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7. Reasons for international project staffing

Why did the project include project members from different countries? You can select several options if applicable.

☐ Access to local market knowledge

☐ Access to expert knowledge (e.g., technical)

☐ Not enough resources in one location

☐ Training employees in another country on-the-job

☐ Lower development cost abroad

☐ Proximity to customer location(s)

☐ Proimity to supplier location(s)

☐ Other (please specify): [_____]

8. Acquired entities

Were any core project team members based in an entity that was acquired by your organization?

○ **No, none of the core team members was based in an entity that was acquired in a time period of five years before the project start**

○ **Yes, at least one core team member was based in an entity that was acquired...**

○ **Don't know / no response**

9. Project characteristics

Please indicate the extent to which you agree with the following statements about the project.

	Fully disagree	→	Fully agree	No response
The international project members had worked with each other before this project.	○ ○ ○ ○ ○ ○ ○			○
The project was of particular strategic importance to our organization.	○ ○ ○ ○ ○ ○ ○			○
Corporate headquarters were actively involved in this project.	○ ○ ○ ○ ○ ○ ○			○
Corporate headquarters formally instructed this project.	○ ○ ○ ○ ○ ○ ○			○
Corporate headquarters financed this project.	○ ○ ○ ○ ○ ○ ○			○
The customer(s) specified the project deliverables.	○ ○ ○ ○ ○ ○ ○			○
One or more customers were actively involved in the project operations.	○ ○ ○ ○ ○ ○ ○			○
One or more suppliers were actively involved in the project operations.	○ ○ ○ ○ ○ ○ ○			○
One or more external organizations (e.g., research institutes, universities) were actively involved in the project operations.	○ ○ ○ ○ ○ ○ ○			○

10. Knowledge characteristics

Please indicate the extent to which you agree with the following statements about the project.

	Fully disagree	→	Fully agree	No response
The knowledge shared between the team members was complex.	○ ○ ○ ○ ○ ○ ○			○
The knowledge shared between the team members can be written down, e.g. in a manual.	○ ○ ○ ○ ○ ○ ○			○
Project members required significant previous knowledge to participate effectively in this project.	○ ○ ○ ○ ○ ○ ○			○
Project members could not be easily replaced during the project because they developed or acquired specific knowledge.	○ ○ ○ ○ ○ ○ ○			○

Please indicate the extent to which you agree with the following statements regarding your project.

11. Project formalization

	Fully disagree — Fully agree	No response
The project adhered to our organization's global standard product development process.	○ ○ ○ ○ ○ ○ ○	○
A formal (written) business plan clearly stated the project objectives, resources, budget and time frame.	○ ○ ○ ○ ○ ○ ○	○
The project progress was frequently measured against pre-defined performance indicators (budget, time, quality).	○ ○ ○ ○ ○ ○ ○	○

12. Project organization

	Fully disagree — Fully agree	No response
Project manager		
As a project manager, I dedicated the majority of my working time to this project.	○ ○ ○ ○ ○ ○ ○	○
As a project manager, I had direct access to and responsibility for the work of the project team members.	○ ○ ○ ○ ○ ○ ○	○

	Fully disagree						Fully agree	No response

Steering Committee

A steering committee regularly checked on the project's progress.
○ ○ ○ ○ ○ ○ ○   ○

The steering committee involved top managers of the global organization.
○ ○ ○ ○ ○ ○ ○   ○

Top management continuously proved that this project was of high importance to them (e.g., by high personal involvement, provision of sufficient resources, ...).
○ ○ ○ ○ ○ ○ ○   ○

13. Project communication

Please indicate how frequently the following communication media and electronic support tools were utilized during the project.

	Very frequently						Very infrequently / rarely	Never

In-person project team meetings
○ ○ ○ ○ ○ ○ ○   ○

Conventional video conferencing
○ ○ ○ ○ ○ ○ ○   ○

Advanced video conferencing (telepresence)
○ ○ ○ ○ ○ ○ ○   ○

Conventional telephone conferences
○ ○ ○ ○ ○ ○ ○   ○

Web-supported telephone-conferences
○ ○ ○ ○ ○ ○ ○   ○

Instant messaging / online live chats
○ ○ ○ ○ ○ ○ ○   ○

Internationally accessible knowledge management databases
○ ○ ○ ○ ○ ○ ○   ○

14. Social capital

Before or during the project, project members have been involved in...

	True for no project member						True for all project members	No response

...long-term assignments abroad (greater than 6 months).
○ ○ ○ ○ ○ ○ ○   ○

...short-term assignments abroad (1-6 months).
○ ○ ○ ○ ○ ○ ○   ○

...international networks (e.g., corporate expert circles).
○ ○ ○ ○ ○ ○ ○   ○

...international trainings with colleagues from other countries.
○ ○ ○ ○ ○ ○ ○   ○

15. Rewards

Project members' contributions to the project were...

	True for no project member	True for all project members	No response
...part of the formal appraisal of project members.	○ ○ ○ ○ ○ ○ ○		○
...acknowledged by increments / bonuses.	○ ○ ○ ○ ○ ○ ○		○
...acknowledged by career advancements.	○ ○ ○ ○ ○ ○ ○		○
...acknowledged in internal communications	○ ○ ○ ○ ○ ○ ○		○

16. Team capability & motivation

Project team members...

	True for no project member	True for all project members	No response
...brought excellent professional skills to the project.	○ ○ ○ ○ ○ ○ ○		○
...brought unique and new ideas to the project.	○ ○ ○ ○ ○ ○ ○		○
...immersed themselves in the project.	○ ○ ○ ○ ○ ○ ○		○
...showed a continuously high interest in the project.	○ ○ ○ ○ ○ ○ ○		○

Please indicate the extent to which you agree with the following statements regarding your project.

Note: If your project is still in progress, please answer the following questions based on the current status.

	Fully disagree	Fully agree	No response
Staffing this project with members from different countries led to knowledge and ideas that we would not have had if the project team had been staffed from only one country.	○ ○ ○ ○ ○ ○ ○		○
Misunderstandings between the international project members were a frequent issue that would not have come up in a project team staffed from only one country.	○ ○ ○ ○ ○ ○ ○		○
Project members from different countries jointly developed new knowledge in this project.	○ ○ ○ ○ ○ ○ ○		○
Knowledge from different locations was integrated effectively in this project.	○ ○ ○ ○ ○ ○ ○		○
The project team could access knowledge from different countries when needed.	○ ○ ○ ○ ○ ○ ○		○

Please evaluate the (current) project results against the objectives (time, budget, quality) that were defined at the start of the project.

	Fully disagree	Fully agree	No response
The project adhered to the pre-defined project timeline.	○ ○ ○ ○ ○ ○ ○		○
The project exceeded the pre-defined budget.	○ ○ ○ ○ ○ ○ ○		○
The project operated in a cost efficient manner.	○ ○ ○ ○ ○ ○ ○		○
The developed product exceeded the anticipated production costs.	○ ○ ○ ○ ○ ○ ○		○
The development results met the pre-defined quality targets.	○ ○ ○ ○ ○ ○ ○		○
Overall, our organization considers this project a success.	○ ○ ○ ○ ○ ○ ○		○

You have almost completed the survey. Before finishing, please provide some information about yourself and your organization. Answering these questions is not mandatory but the information helps to evaluate the overall validity and reliability of this study.

17. Experience

How many international project teams have you managed during your career?   ☐ teams

How long have you worked abroad during your career?   ☐ years

For how many years have you worked for the organization for which you managed this project?   ☐ years

18. Perception of international projects

To what extent do you agree with the following statements?

	Fully disagree — Fully agree	No response
I enjoy working in international teams.	○ ○ ○ ○ ○ ○	○
I believe international teams can be more effective than teams staffed from only one country.	○ ○ ○ ○ ○ ○	○

If you would like to receive a summary of the results of this survey via email, please tick the box below. Your email address will be stored separately from your survey responses. It is not possible to link your email address to your survey response.

☐ I am interested in **the results of this study**. Please send me an abstract by e-mail

You can contribute further to the success of this survey by inviting people you know to participate in the survey. By entering the email addresses of potential participants below, these people will receive an automatic email invitation to this survey. The email addresses will not be stored in the data set.

Email (contact) 1: [_____]

Email (contact) 2: [_____]

Email (contact) 3: [_____]

Email (contact) 4: [_____]

You have reached the end of this survey. I highly appreciate that you took the time to answer the questions.

Would you like to leave any remarks regarding this survey? Do you have any suggestions or questions? Please feel free to use the space below for your input.

Last page

Thank you for participating in this survey!

Should you have any questions about the PhD project this survey is part of, please do not hesitate to contact me via email (britta.mueller@fom.de).

Close window

APPENDIX G: INVITATION AND REMINDER TO PARTICIPATE IN QUANTITATIVE

ONLINE SURVEY

The following text is an example of the invitations emailed to the target group for the quantitative survey:

Dear [TITLE] [NAME],

I am contacting you for your experience in **international product development**, a topic on which I am currently doing my **PhD**.

I am researching **success factors and best practices in managing international product development teams**. You can find further details on the research project in the attached PDF file.

I am conducting an online survey targeted at **project managers** of internationally staffed product development projects to validate the link between international project coordination and project performance. Given your experience and profile, I believe you can contribute valuable insights to this survey. Please follow the subsequent link to the survey:

Survey link: https://www.soscisurvey.de/internationalproductdevelopment/
password: fomphd

It takes 15-20 minutes to complete the online questionnaire. The survey gathers no personal data and no sensitive business data.

The survey is online until end of June 2013, and I will provide participants with a report of the results by the end of September 2013.

Should you have any questions or remarks about this research project and survey, please do not hesitate to contact me. Please also feel free to forward this email to colleagues at [COMPANY]. Thank you very much for your support.

Kind regards,
Britta Müller

Britta Müller MBA
Research Fellow
Kompetenzcentrum für Unternehmensführung & Corporate Governance (KCU)
FOM Hochschule für Oekonomie & Management

Tel. +49 177 5159 013
Mailto: britta.mueller@fom.de
http://www.fom.de/kcu.html#!tab=research-fellows-3/

When the hyperlink was not followed, participants received up to three individual reminders following the subsequent example:

Dear [TITLE] (NAME]

I contacted you recently on behalf of my PhD study on **managing international product development projects** (see my email dated [DATE]). In a scientific online survey, I aim to identify and quantify **best practices and success factors for international product development.**

Until today, development project managers of more than [NUMBER] blue chip companies took part in the survey. The survey is online **until end of June only,** and I would appreciate **your participation.**

It takes on average **15 minutes** to complete the online survey. All participants receive the **results of the study** by **September 2013.** I am convinced that they will be of interest to [COMPANY].

Please follow the subsequent link to the online survey or forward this within your organization:
Survey link: https://www.soscisurvey.de/internationalproductdevelopment/
Password: fomphd

Participation is anonymous. The survey does not require sharing any personal data or sensitive company information.

I am available for questions any time. Thank you very much for your attention and support.

Kind regards,
Britta Müller

Britta Müller MBA
Research Fellow
Kompetenzcentrum für Unternehmensführung & Corporate Governance (KCU)
FOM Hochschule für Oekonomie & Management

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http://www.fom.de/kcu.html#!tab=research-fellows-3/

APPENDIX H: TREATMENT OF NON-NORMALLY DISTRIBUTED DATA

Indicator acronym	Indicator content	Function applied to achieve normal distribution of data
PDPF_04	Overall, our organization considers this project a success.	$x \rightarrow x^2$
KNIN_05	The project team could access knowledge from different countries when needed.	$x \rightarrow x^2$
MGAT_03	A steering committee regularly checked on the project's progress.	$x \rightarrow x^2$
STDP_01	The project adhered to our organization's global standard product development process.	$x \rightarrow x^2$
STDP_02	A formal (written) business plan clearly stated the project objectives, resources, budget and time frame.	$x \rightarrow x^2$
STDP_03	The project progress was frequently measured against pre-defined performance indicators (budget, time, quality).	$x \rightarrow x^2$
SOCN_01	Project members were exposed to long-term assignments abroad (greater than 6 months).	$x \rightarrow \log(x)$
TACT_01	The knowledge shared between the team members was complex.	$x \rightarrow x^2$
TACT_04	Project members could not be easily replaced during the project because they developed or acquired specific knowledge.	$x \rightarrow x^2$
TSIZ_01	Number of employees who regularly contributed to the project	$x \rightarrow \log(x)$
PMAT_01	I enjoy working in international teams.	$x \rightarrow x^4$