INVESTIGATING THE EFFECTS OF TIME PRESSURE
ON NEW PRODUCT DEVELOPMENT TEAMS
INVESTIGATING THE EFFECTS OF TIME PRESSURE ON NEW PRODUCT DEVELOPMENT TEAMS

PROEFSCHRIFT

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Sir Winston Churchill once remarked that ‘writing a book is an adventure. To begin with it is a toy and an amusement. Then it becomes a mistress, then it becomes a master, then it becomes a tyrant. The last phase is that just as you are about to be reconciled to your servitude, you kill the monster and fling him to the public.’ In the process of writing, I have encountered an amuser, a mistress, a master, and the monster! Nonetheless, the writing has endured and is finished! I shall not reveal to you if I had reconciled, flung the monster out of my window, or found my first love again. This, I intend, to keep as a mystery.

I never have imagined myself writing a book – like a doctorate thesis. Writing is hardly my forte. Life brings us to do things that we least expect. Pursuing a doctorate degree had never crossed my mind until I was a final year undergraduate student. Embarking on a doctorate (Organizational Behavior) program that differed so much from my Bachelor’s degree (Electrical Engineering) is considered a road less traveled, and a road that I knew I would not revisit once I began my career. I believe it was the passion to dive deep to explore and understand team dynamics as well as human behaviors, coupled with the open doors that landed me in the four year program. The journey has been fascinating! Although the process was very challenging and at times a lonely one, I knew deep inside that I would not exchange the experience for anything else. My experience has spanned beyond learning the ropes of conducting rigorous scientific research, which my supervisors have done an exceedingly good job guiding me in. The joint program had offered me the opportunity to live and sink roots in a country that is in many ways unique from Singapore. Not only that I am enriched culturally, but I have also learned how to work with European management in the universities and in multinational companies, like Philips, NXP, ASML, and Oce. I am still very impressed with the openness and support that the industry in the Netherlands has towards academic research.

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Eerde is my supervisor from the Netherlands. She is patient and has coached me very well on topics pertaining to time pressure, team behaviors, and statistical techniques. Her supervisory style has allowed me to think independently and creatively while conducting the research. Not only is Wendelien a mentor, she is also a friend to me. Wendelien has so gracefully looked out for my welfare when I first arrived in Eindhoven; inviting me to a garden open house and bringing me for meals. I truly appreciate the times we spent together. Matter-of-fact, I have come to learn more about the Europeans as well as Singaporeans through her mind.

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Moving to a new place isn’t easily and needs a lot of adaptation. My international church in Eindhoven has helped me integrate smoothly into the new environment. Families from the church, such as the Lee’s and the Koole’s, and the TIFF group had brought joy to my stay in the Netherlands. I am grateful to Francis and Barbara Noordanus for faithfully providing spiritual food to the congregation and me. Through their diligence, I was able to remain strong on the inside to pursue my research. Living under the same roof with Bobby, Manju, and (baby) Benjamin Daniel was one of the best things that had happened to me in the Netherlands. It was a gift. Thank you so much for so graciously sharing your home and meals with me. It was simply fantastic to be able to have warm and tasty Kerala Indian food after a long day of work in the university.

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“The Lord is my Shepherd. I shall not be in want. He makes me lie down in green pastures, and he leads me beside quiet waters, he restores my souls.” (Psalms 23:1-3). These verses summarize my God’s faithfulness - how He has given me wisdom, strength, and open doors to finish authoring this book.

Darrel Chong
INVESTIGATING THE EFFECTS OF TIME PRESSURE ON NEW PRODUCT DEVELOPMENT TEAMS

Summary

The need for innovation has led high-technology organizations to use project teams as the method of choice to bring new products to market under demanding schedules. Adopting a team approach, however, is not always fruitful and often depends on whether team members can work effectively together. Several studies have identified stress to potentially enhance or threaten team effectiveness. Among the different kinds of stress, time pressure has emerged as a prominent and ubiquitous stress experienced by innovation teams. Although much research was conducted on time pressure, most of them had focused on individual processes. Therefore, we decided to study time pressure in a team environment, with a specific focus on new product development (NPD) teams.

This thesis consists of four empirical studies. The first study is exploratory. It examined the antecedents of and coping resources in relation to time pressure. The subsequent two studies investigated the effects of time pressure on team outcomes, with team communication being the key team process in the second study and a two-dimensional model (challenge-hindrance time pressure) developed in the third study to provide an added perspective on how time pressure influence critical team outcomes, such as coordination, quality, and timeliness. The fourth study, which evolved from the earlier investigations, tested the moderating effects of time pressure on the relationship between team proximity and team communication. All the studies were conducted using NPD teams from Western Europe (Belgium, France, Germany, The Netherlands, and United Kingdom), involving respondents from various hierarchies (developers, leaders, managers) of project teams in Philips, NXP, Oce, FEI, Medtronics, and Infineon, to name a few. The first two studies were qualitative, and adopted a multiple case study (interview) method, using a sample of 8 teams. The subsequent
studies were quantitative, and adopted an electronic survey method, using a sample of 81 teams (500 respondents).

In the first study, our investigation uncovered nine categories relating to antecedents of time pressure, and ten categories relating to contexts that increase teams’ coping resources. Among the antecedents, ‘management attention’, ‘multiple projects’, and ‘unrealistic schedule’ are seldom mentioned in the literature, whereas ‘shielding’, ‘team commitment’, and ‘customer involvement’ are considered new variables that increase teams’ coping resources. Importantly, out of the nine antecedents, only two are associated with factors external to the organization. This suggests that time pressure is largely perceived to originate from within organizations. In addition, our findings show that teams tend to perceive time pressure negatively if they encounter numerous internal antecedents of time pressure and a few coping events at the workplace. Therefore, we conclude that management should reduce the occurrences of internal antecedents of time pressure and increase coping events, respectively, if they want to help their teams experience time pressure as an enabling instead of an inhibiting stressor.

Subsequently, this thesis examined the effects of time pressure on team communication using real project teams because studies have found this team process to strongly determine project success. Our research indicates that team members tend to perceive time pressure as an obstacle to team communication. Although, our findings show time pressure to increase proactiveness in terms of soliciting information from colleagues directly, time pressure also threatens other communication dimensions, such as scope, depth, and timeliness. Results demonstrate that time pressure induces teams to focus more on information sharing between members of the same sub-team than with members of other sub-teams of the same project, to experience a tension in information exchanges between information providers and seekers as both parties develop different task focuses, and to become more self-focused and pay less attention to social cues.

A goal of this thesis is to reconcile some of the discrepancies related to the effects of time pressure on team performance. In general, levels of felt stress have been used to
understand the positive and negative effects of time pressure on performance. Scholars have used the inverted-U model, where low and high levels of time pressure are related to poor performance, to explain the relationship. However, teams do not necessarily perform worse when the levels of time pressure are high. The inverted-U model cannot satisfactorily explain the exceptional performance of some teams under intense time pressure. A probable explanation for such inconsistencies may be found while considering the nature of stress. In this study, we followed LePine and colleagues’ two-dimensional model for stress to conceptualize time pressure as challenge and hindrance time pressure. Confirmatory factor analysis provided statistical significant support for the two-factor structure. Our research shows challenge and hindrance time pressure to, respectively, have positive and negative effects on team coordination, solution quality, and development timeliness. This study offers to explain why some studies found positive, null, or negative relationships between time pressure and quality. We suggest that treating time pressure as a uni-dimensional construct, while it has two properties, might have caused the mixed outcomes. Equally important, we found team identification to mitigate the negative effects of hindrance time pressure on team coordination. We conclude that the nature of time pressure plays a central role in determining how time pressure affects team outcomes, and underscore that teams can remain viable even under intense time pressure if it is perceived as challenging. Therefore, cultivating a work environment to instill a challenging perception and to reduce the negative effects of time pressure is essential.

Finally, our research shows team proximity to improve team communication only when teams experience high levels of challenge time pressure, or low levels of hindrance time pressure. Past studies have generally assumed close physical proximity to improve team communication on the premise that reduced physical distance increases the probability of chance contact and information exchange. However, research also showed that the relationship between team proximity and team communication is not always straightforward. We conclude that the relationship depends on some contextual conditions, and time pressure is one factor to influence that relationship.
In sum, this thesis contributes to knowledge in relation to understanding the antecedents and coping resources of time pressure, the effects of time pressure on key team outcomes, and its role as a moderator, all in the context of NPD teams. The conceptualization of time pressure as challenge and hindrance time pressure is new and needs to be further validated in future research. The detailed implications with respect to theory and practice as well as limitations of our research are discussed in the main chapters of the thesis.
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Figure 5.2: Effects of Hindrance Time Pressure on Interaction between Team
Proximity and Team Communication
Chapter 1

Introduction

Time pressure is a common experience at work, especially for teams that develop new products for fast-paced industries. Although much has been said about the effects of time pressure, more fieldwork is needed to better understand its impact on teams. The thesis presents four studies in which we investigated the antecedents and coping resources of time pressure, and its influence on team processes and team performance. In the later studies, we took into account the nature of time pressure, its positive and negative characteristics, to shed light on inconsistent relationships between time pressure and performance found in extant literature. We will start this chapter with an example based on the development of the Hubble Space Telescope. Subsequently, we underline the primary objectives and flow of the thesis.

In April 1990, space shuttle Discovery lifted off with the Hubble Space Telescope (HST) from the Kennedy Space Center in Florida (Caper & Lipton, 1993). The instrument, which was first conceived in 1946 and designed to provide unprecedented deep and clear views of the Universe, was one of the most complicated telescope ever constructed for space exploration. The HST project was so complex and challenging that it required partnership of many organizations, such as NASA\(^1\), European Space Agency, and Perkin-Elmer Corporation, taking a multi-team approach to jointly develop the telescope. The space project, which was state-of-the-art, costly, under time pressure, and requiring intricate collaboration between experts from numerous fields, is a magnified reflection of organizations developing new products in automotive, medical, or consumer industries. The scale and complexity that often surround delivering an innovative product have induced contemporary organizations to

\(^1\) National Aeronautics and Space Administration
rely heavily on project teams to achieve their goals, as such an approach reduces the obstacles for sharing of knowledge and experience among individuals (Guzzo & Shea, 1992). In this research, we defined a project team as an interdependent collection of individuals whose basic function is to work on complex tasks to deliver a specific output which is measurable by some deadlines, after which, the project team is discontinued (cf. Janicik & Bartel, 2003).

Although the launch of HST marked an important step towards extra-terrestrial astronomy observation, the data that was soon collected after the lift off raised a huge amount of questions on the quality of the images captured (Capers & Lipton, 1993). After weeks of interpreting the data, the scientists finally discovered that the mirrors, which were a critical component of HST to capture and focus light that had traveled billions of years, were in the wrong shape. Capers and Lipton (1993) later wrote that the wrongly shaped mirrors were due to a combination of mistakes that had remained undiscovered during the development process. The negligence was largely linked to the lack of time and financial resources needed to pull together such an enormous endeavor. This, unfortunately, had caused good people to do bad things (Stein & Kanter, 1993). While teams provide an important backbone for organizations to execute massive projects (Denison, Hart, & Kahn, 1996), the failure of HST's launch in 1990 provided a real example when teams failed to meet project expectations. This example and others (cf. Foushee, 1984) revealed that some conditions critically threaten the viability of teams to function collaboratively to achieve their goals. A condition that has been repeatedly cited in the literature is stress (e.g., Cannon-Bowers & Salas, 1998; Driskell, Salas, & Johnston, 1999; Ellis, 2006; Gladstein & Reilly, 1985). In fact, the HST project was characterized by a huge amount of stress due to budget cuts and difficult deadlines both at NASA and Perkin-Elmer (Capers & Lipton, 1993). The scientists at Perkin-Elmer were under tremendous pressure to meet deadlines. The overwhelming stress had caused their scientists to cease asking questions and to overlook some critical flaws, which ultimately contributed to a misshapen mirror. "There wasn't even time to ask the machine shop to custom-make spacers for the [mirror] bracket. The technicians grabbed three household washers and put them into the $1 million null corrector. ... [There was not] much discussion about it, just the pressure to
finish the job." (Capers & Lipton, 1993; 45). Numerous incidents, like the Hubble disaster have been reported, and researchers have linked the detrimental team performance to acute stress experienced by these teams (cf. Driskell, Salas, & Johnston, 1999). Even so, this research area has remained surprisingly understudied, and the process through which stress causes teams to malfunction has not been satisfactorily answered (Driskell, Salas, & Johnston, 1999).

In this thesis, we focused on time pressure among the different kinds of stress because time pressure has emerged as a prominent stressor experienced by project teams today (Barczak & Wilemon, 2003). Given that time pressure is induced primarily due to a lack of temporal resources to meet situational demands, time pressure is unique from other kinds of stress and thus, calls for focused attention. Barczak and Wilemon (2003) found teams developing innovative products to attribute time pressure as the most frequently felt stress at work. The scientists in Perkin-Elmer were seriously pressed by deadlines. Bud Rigby, the project manager of the Hubble mirror, had attempted to be realistic about the project schedule. But whenever he sent a schedule to management, it would be cut in half before reaching NASA (Caper & Lipton, 1993). The difficult schedule was identified to have led to several major incidents during polishing and testing of the telescope mirror. For instance, the null corrector, which had been used previously by Perkin-Elmer to accurately measure surface smoothness to a few millionths of an inch and to test the mirror shape, was unexpectedly erroneously built to test the Hubble mirror. "Under normal circumstances, design anomalies might have triggered an engineering inquiry; but the deadline was upon [the scientists]. There was no time for an inquiry." (Capers & Lipton, 1993; 45). Unfortunately, the problem with the shape of the mirror was not found until the telescope was set in the orbit around the earth, and could only be remedied three years later during the first service mission. The Hubble incident clearly demonstrated the negative side of time pressure on teams. However, studies have also shown intense time pressure to positively affect teams. For instance, outstanding performance of the Houston base crew despite extreme lack of time during the Apollo 13 accident suggests that intense time pressure does not necessarily deteriorate performance. The
existence of both exceptional and inferior team performance during intense time pressure raised questions on whether we know sufficiently about time pressure, and if and how teams can be better managed to function under intense time pressure situations.

In the thesis, time pressure is defined as a specific kind of stress that is triggered by an imbalance between individuals’ cognitive resources and the situational demands (McGrath, 1976), such that the former is insufficient to meet the external demands. In the later chapters, the imbalance was hypothesized to have positive or negative effects, depending on the environment in which time pressure was triggered. In addition, the term ‘stressor’, which has generally been used with a negative connotation (e.g., Jonge & Dormann, 2006), will be referred to as having positive or negative connotation in this thesis. This is because the development of the later chapters is largely based on Lazarus and Folkman’s (1984) nature of stressor, and LePine and colleagues’ (2004; 2005; 2007) challenge-hindrance stressor framework.

1.1 Objectives of the Thesis

The first objective of this thesis is to explore the antecedents and situational coping resources of time pressure in NPD team contexts. Escalating market competition has made time pressure a common experience at work, especially for teams operating in fast paced environments, where project development cycles are three years or less (Datar, Jordan, Kekre, Rajiv, & Srinivasan, 1997). Although this trend appears to continue, no empirical study has been conducted to identify the antecedents and situational coping resources of time pressure in new product development (NPD) teams. In this study, situational coping resources is defined as resources triggered by one’s environment to help them to avoid, reduce, or control distress (Hobfoll, 2002). Here, we recognize that there are a number of studies that have examined the antecedents and coping resources of stress. However, they have either concentrated on stress in the generic sense (e.g., Cooper & Payne, 1994; Parasuraman & Alutto, 1984; Newton, 1995; Thoits, 1995) or focused on a type of stress, such as role stress (e.g., Schaubroeck, Cotton, & Jennings, 1989) or emotional labor (e.g., Schaubroeck & Jones,
Time pressure is a specific kind of stress that is fundamentally triggered by a lack of temporal resources (McGrath, 1976). Therefore, what leads to or what contributes as a situational coping resource for generic stress and time pressure could be quite different. Furthermore, the antecedents and situational coping resources may be context specific. For example, the sources of stress in hospitals could be well related with death and illness of patients (Hipwell, Tyler, & Wilson, 1989), which is an unlikely cause of stress in other industries, such as service or education sectors. This explains that though some work had been done to investigate the antecedents and situational coping resources relating to stress, investigating the topic on time pressure in NPD context serves to extend the stress literature. At the same time, the outcomes are valuable to practitioners in terms of managing innovation teams that are under intense time pressure.

Equally important, the second objective of this thesis is to further understanding on the relationship between time pressure and team processes, and team performance. In this aspect, we focused first on the impact of time pressure on team communication. Since this team process has been identified as a strong determinant for project success (e.g., Ancona & Caldwell, Keller, 2001), it deserved focused attention in this thesis. Previous works have typically examined how time pressure affects communication frequency (e.g., Entin & Serfaty, 1999; Karau & Kelly, 1992; Parks & Cowlin, 1995), which unfortunately is not necessarily a strong predictor of team outcomes when considered on its own (Patrashkova-Volzdoska, McComb, Green, & Compton, 2003). Thus, we specifically examined the influences of time pressure on other facets of team communication, such as formality (formal and informal communication), openness (capacity and willingness to communicate), and timeliness (responsiveness in providing information and proactiveness in acquiring information). Next, we aimed to reconcile some of the discrepancies related to the effects of time pressure on performance. Time pressure has been shown to have positive and negative effects on performance (Andrews & Farris, 1972; Amabile, Hadley, & Kramer, 2002). In general, levels of felt stress have been used to understand the dual effects of time pressure. So far, scholars have used the inverted-U model, where low and high levels of time pressure are
related to poor performance, to explain the relationship between time pressure and team performance (Isenberg, 1981). However, recent studies have shown that teams do not necessarily perform worse under higher levels of time pressure (Amabile, Hadley, & Kramer, 2002; Baer & Oldham, 2006; Lovell & Kluger, 1993). The inverted-U model cannot satisfactorily explain the exceptional performance of some teams under intense time pressure. A probable explanation for such inconsistencies may be found while considering the nature of stress. Selye (1982) suggested the importance of the nature of stress in influencing performance more than two decades ago, but it was only recently that scholars began to explore the effects of stress by taking into account if it is perceived positively or negatively (e.g., Cavanaugh, Boswell, Roehling, & Boudreau, 2000; Boswell, Olson-Buchanan, & LePine, 2004; LePine, Podsakoff, & LePine, 2005). In this study, we attempt to reconcile the discrepancies on the impact of time pressure on team performance by using the challenge-hindrance stressor framework to conceptualize time pressure, and investigating its effects on selected team processes and team performance indicators. All studies in this thesis were conducted with real NPD teams. Here, we chose to focus on innovation (NPD) project teams for two reasons. First, such teams and especially those that function in short-cycled industries tend to experience more intense time pressure throughout the project (Barczak & Wilemon, 2003) than teams in research or longer-cycle industries (e.g., paper or marine). Second, innovation teams work on complex tasks, which require highly interdependent effort between their members. This coupled with high emphasis on creativity, quality, timeliness, and cost made exploring the effects of time pressure on such teams extremely valuable.

The third objective of this thesis, which evolved from the early studies of this thesis, is to explore the role of time pressure while understanding the impact of team proximity on team communication. So far, numerous studies proposed close team proximity to improve communication between members. This is largely based on the assumption that the shorter the physical distance between members, the higher the chance their paths cross and hence the more effective the extent of team communication (Allen, 1977). However, this assumption may not always hold given that time pressure, which has become a common work experience
and is found to constrain attentional resources, is likely to cause even members colocated in a room to cease sharing information efficiently.

1.2 Developments and Outline of the Thesis

This section provides an overview of the four empirical studies (chapters) that were conducted to achieve the objectives presented in the previous section. Although the later chapters were partially motivated by earlier findings, the chapters are, to a large extent, standalone and can be read independently.

The next four chapters of this thesis describe four studies: two qualitative studies and two quantitative studies. The first two studies involved preliminary interviews with 8 persons working in NPD environment in the Netherlands and an in-depth multiple case study with 8 NPD teams (49 informants) from Western Europe. The next two studies were quantitative in nature, in which their hypotheses were tested by means of online survey using 81 NPD teams (500 respondents) from Western Europe: Belgium, England, France, Germany, and the Netherlands.

Chapter 2 describes a multiple case study that explores the antecedents of time pressure and coping resources that help teams to cope with time pressure. The multiple case study led to 9 antecedent and 10 coping resource categories, which can also be classified as external, management, or team related. Finally, we introduced an overarching model to present the categories and their relationships with time pressure.

Chapter 3 examines the impact of time pressure on communication in teams using the same sample as in Chapter 2. The study contributes to research by demonstrating how time pressure affects other facets of team communication in the NPD context. Results showed that negative (“hindrance”) time pressure increases proactiveness, in terms of soliciting information from colleagues directly, but threatens other communication dimensions, such as scope, depth, and timeliness. Our findings also revealed that hindrance time pressure induces information providers and information seekers to experience a tension in their
communication. Furthermore, the findings suggest that time pressure does not simply affect information exchange, but essentially the coordination of members in teams.

Chapter 4 presents a research framework examining one antecedent, moderators, and outcomes of time pressure on team processes and team performance. The study introduces the concept of challenge and hindrance time pressure, which is based on the challenge-hindrance stressor framework of LePine and his colleagues and inspired by our earlier findings in chapter 2 and 3. The examples collected from interviews in chapter 2 enabled us to develop new scales to measure challenge and hindrance time pressure. The outcomes of previous chapters also shaped our research framework. For instance, the choices of management support as the antecedent and team coordination as the team process were motivated by findings in chapter 2 and 3, respectively. The results in Chapter 4 showed challenge time pressure to improve team performance, and hindrance time pressure to deteriorate team performance, except for team innovativeness. We also found team coordination to partially mediate these time pressure-team performance relationships, and management support to increase challenge time pressure and to reduce hindrance time pressure. Team identification have also been found to sustain team coordination, especially for teams facing hindrance time pressure. Additionally, this chapter advances theory related to time pressure by addressing the inverted-U model, and solidifying the challenge-hindrance stressor framework.

Chapter 5 is a relatively short investigation, and a response to findings in Chapter 3. This study questioned the assumption that team proximity improves communication in teams because of the increased opportunities for face-to-face contacts. This study investigates the proximity-communication relationship by considering challenge and hindrance time pressure as moderators. The results showed that team proximity improves team communication only when teams experienced high levels of challenge time pressure or low levels of hindrance time pressure.

As a conclusion, Chapter 6 integrates the four studies and highlights the main theoretical contributions, strength and limitations of this thesis. Finally, we conclude with suggestions for future research and some recommendations for practice.
Chapter 2

Antecedents and Coping Resources of Time Pressure in New Product Development Teams: A Multiple Case Study

New product development teams typically operate under tight schedules to meet demanding product requirements. Consequently, time pressure has become increasingly prominent for such teams, especially those in the fast-paced industries. Despite this phenomenon, there is no research that specifically identifies the antecedents of time pressure, and the situational factors that enable development teams to cope with time pressure. Thus, this study is conducted to address the research gaps. We interviewed 8 respondents in a preliminary investigation, and subsequently took a multiple case study approach and interviewed 49 respondents, belonging to 8 new product development teams in Western Europe. Data analysis revealed 9 categories related to antecedents of time pressure, and 10 categories related to work contexts that increase teams’ coping resources. Among the antecedents, ‘management attention’, ‘multiple projects’, and ‘unrealistic schedule’ are categories that are seldom mentioned in literature, whereas ‘shielding’, ‘team commitment’, and ‘customer involvement’ are considered new variables that increase teams’ coping resources. In general, we found respondents to associate antecedents of time pressure with factors internal to their organizations. Other implications with respect to theory and practice are discussed.

Innovation speed has become an important determinant for product success (Kessler & Chakrabarti, 1996). The advantages of first-movers and fast-followers in sustaining profitability and market position have induced companies to place a large emphasis on time-to-market (Makadok, 1998). Although emphasis on time-to-market potentially improves

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efficiency (Langerak & Hultink, 2005) and unites team members toward common goals (Lovell & Kluger, 1994), accelerating the development cycles, at a certain point, inevitably causes a shortage in team members' cognitive resources to meet escalating project demands. Such an imbalance often leads to feelings of time pressure (McGrath, 1976), which some studies have identified to be a prominent stress for innovation teams (Barczak & Wilemon, 2003; Saleh & Desai, 1986). While time pressure has been frequently reported to threaten team performance (e.g., Capers & Lipton, 1993; Hoopes & Postrel, 1999; Perlow, Okhuysen, & Repenning, 2002), some studies have found time pressure to influence teams positively under certain conditions (Eisenhardt, 1989a; Gersick, 1988; Lovell & Kluger, 1994). Thus, this study aims to uncover the antecedents of time pressure, and the situational factors that help innovation teams to cope with time pressure. Such investigation is important as it deepens understanding on how teams can remain viable while functioning in fast-paced environments.

This study contributes to research in several ways. First, our study focuses on a specific kind of stress - time pressure. Although several studies have examined the antecedents and the coping resources for generic stress (e.g., Broadbridge, 2002; Parasuraman & Alutto, 1984), the findings may lack extensibility to time pressure because it differs from other kinds of stress. This is because time pressure is induced fundamentally due to a lack of temporal resources to meet situational demands. Furthermore, time pressure being ubiquitous to many organizations, especially those involved in New Product Development (NPD), calls for focused attention. This is similar to studies that addressed purely role stress (Peterson & Smith, 1997; Stamper & Johlke, 2003) or work-family conflict (Aryee, 1992; Frone, 2000), instead of treating them as generic stress. Second, this study adds to the NPD literature by examining the topic in a setting where time pressure or stress, in general, is considered understudied (Barczak & Wilemon, 2003). Numerous studies have examined the antecedents of stress in various work settings (e.g., Broadbridge, 2002; Kaufmann & Beehr, 1989; Knights & McCabe, 1998; Parasuraman & Alutto, 1984; Schaubroeck, Cotton, & Jennings, 1989; Worrall & Cooper, 1995). However, to our knowledge, only few studies investigated
the topic in the NPD setting despite the high expectations on such teams to deliver on time, on quality, on budget, and be innovative under stressful conditions. This study, therefore, uncovers antecedents and coping resources relating to time pressure in the NPD sector. Third, this study differs from most research on coping, in that we focused on situational coping resources rather than personal coping resources. The former are triggered by people's environments to help them avoid, reduce, or control distress (Hobfoll, 2002), while the latter are related to people’s personalities, such as perceived control, self-esteem, or time management abilities (Terry, 1991; Claessens, Van Eerde, Rutte, & Roe, 2007). The benefits of paying attention to situational coping resources lie in identifying events that can be triggered by significant others at the workplace (supervisors and coworkers) to increase a team's coping resources (cf. O'Driscoll & Cooper, 1996). Although studies have provided a wealth of insight into personal coping resources (cf. Lazarus & Folkman, 1984), their focus on individuals and their coping strategies imply that organizations are largely dependent on their employees when it comes to time pressure management. If organizations are to be proactive in this area, management should know how to foster an environment that increases its teams' coping resources.

2.1 Theoretical Background: Time pressure at the workplace

Time plays an important role in people’s lives at work. A considerable portion of people’s cognition at the workplace relates to time, for instance reflecting on previous tasks, meeting imminent deadlines, and planning future projects. Not surprisingly, stress associated with a lack of time has been increasingly felt at today’s workplace due to changing global demographics, advancing technologies, and rising market competition. Actors experience time pressure when they encounter a gap in temporal resources to meet external demands (McGrath, 1976). Besides the gap between resource and demand, situational factors, such as negotiability of a project deadline, also determine how time pressure is experienced. A non-negotiable deadline implies that someone has to achieve the expected work specifications and quality within a prescribed timeframe without any possible shift in end date. This induces the
person to perceive more time pressure than colleagues who enjoy extensible deadlines. The industry people work in also determines how time pressure is experienced. Lee and Liebenau (1999) explained that groups operate under different time streams at work. For example, the time horizon for developers in short-cycle industries is measured in hours, days, and weeks, whereas people in long-cycle industries, like offshore marine or paper, may be concerned with months. Their definitions of time-to-market vary (Schein, 1992), and the consequences of not delivering the products on time are dissimilar. Hence, the experience of time pressure differs widely between teams in the two types of industry. Here, we focus on NPD teams in the short-cycle industries, where the time to develop a product is generally three years or less (Datar, Jordan, Kekre, Rajiv, & Srinivasan, 1997).

Studies have shown time pressure to improve performance under certain conditions. However, performance tends to worsen when time pressure increases beyond a certain threshold (Andrew & Farris, 1972). On the one hand, time pressure enhances motivation (Amabile, Hadley & Kramer, 2002), challenges people towards difficult goals (Peters, O’Connor, Pooyan, & Quick, 1984), leads people to focus on important information (Kelly & Karau, 1999), and stimulates team members to consider more alternatives (Eisenhardt, 1989a). On the other hand, time pressure causes people to isolate themselves, share little information (Ford & Sterman, 2003; Kelly & Loving, 2004), become less creative (Amabile, Mueller, Simpson, Hadley, Kramer, & Fleming, 2002), and feel emotionally exhausted (Teuchmann, Totterdell, & Parker, 1999). These findings have demonstrated that time pressure could have positive as well as negative impacts on performance. Hence, we suggest that the experience of time pressure could be managed or coped with to bring about better performance.

Stress coping has gained increasing importance as a result of escalating stress at the workplace (e.g., Hobfoll, 2002; Jonge & Dormann, 2006; Thoits, 1995). Lazarus and Folkman (1985) and several other scholars (e.g., Billings & Moos, 1981; Pearlin & Schooler, 1978) explained that people minimize the impacts of stress by adopting problem-solving and/or emotion-focused approaches. The former approach focuses on removing or reducing
the occurrences or intensity of stressors, while the latter attempts to change the way people respond to displeasing thoughts and emotions aroused by stressors. In this study, coping resources do not refer to what people do, but what is externally available to help them cope with time pressure. Pearlin and Schooler (1978) proposed that coping resources can be separated into two kinds: personal and situational coping resources. Personal coping resources are linked to personality traits, which do not alter within a short span of time. On the other hand, situational coping resources are induced by external parties or circumstances, and are more arbitrary. Thus, this study focused on situational coping resources given the relative ease of inducing them. So far, social support is the most widely examined situational coping resource (e.g., Heaney, Price, & Rafferty, 1995; Jonge & Dormann, 2006; Van Yperen & Hagedoorn, 2003), and has been identified as emotional, appraisal, instrumental, and informational aid gained through social interactions (House, 1981). At the same time, only some studies have examined what supervisors can do to increase coping resources. One example is the work of Heaney, Price, and Rafferty (1995), where the authors found soliciting participation in decision-making to increase employees’ coping resources. As certain stress cannot be easily reduced in some work environments, for instance the emotional stress of nursing critically ill patients, it is benefiting then to focus on how to increase situational coping resources in these contexts so that employees can combat prevailing stress at the workplace. Along this line of thought, exploring situations that help NPD team members to cope with time pressure is important, given that it is a prominent stress for organizations in short cycled industries.

2.2 Methods

This study was conducted by means of a case study approach because this approach is well suited for exploring research topics that are understudied (Eisenhardt & Graebner, 2007). The multiple case study design was chosen because it enables a replication logic in which cases are treated as a series of experiments, each serving to confirm or disconfirm inferences drawn from the other cases (Yin, 1994). The research also uses an embedded design that includes
informants from various hierarchies of a project team: manager, leaders, and designers. The benefit of a multiple-case and embedded design is that it facilitates the induction of a richer model than those of single-case studies (Yin, 1994).

2.2.1 Case Selection

Data were collected from eight NPD teams in Western Europe: in Belgium, Germany, and The Netherlands. The unit of analysis is a team. Cases were selected based on the characteristics of the NPD teams and the industries for which these teams were developing the products. All participating teams developed new products that were innovative either to the organization or market of the short-cycled industries. The team also had a strong emphasis on speed, quality, and cost. These characteristics made time pressure a common experience in these teams, and thus made the teams suitable for this study. Accordingly, we contacted vice presidents and project managers of high-tech companies about this study. Interested contacts then directed us to appropriate projects. Three (MicroFine, Semicaps, Accelov) of our initial four teams were in the semiconductor industry (see Table 2.1). We extended our investigation to other industries that fitted our selection criteria, like the consumer and medical industries, to examine if our findings could be replicated in other industries and to control for environmental variation (e.g., Pettigrew, 1988). This step permitted us to develop a more elaborated theory (Eisenhardt, 1989b). Additionally, participating teams were either in progress or had ended not more than twelve months from the time of interview. This allowed us to gather recent events retrospectively and on a real-time basis (Eisenhardt & Graebner, 2007).

Eisenhardt and Graebner (2007) suggested soliciting numerous and highly knowledgeable informants who viewed the focal phenomenon from various perspectives, because these approaches mitigate the biases that may arise from using interviews as the data collection method. Therefore, we invited informants from different hierarchical levels within a case for the interviews, one at a time. In this study, we focused on collecting rich data from leaders and developers, as they are usually immediately influenced by time pressure and thus
are vastly acquainted with the topic of investigation. Table 2.1 summarizes the profile of the cases.

### 2.2.2 Data Collection

In total, 56 interviews were conducted. Preliminary interviews were conducted with seven NPD managers or developers in the Netherlands to refine the interview questions. Subsequently, 49 interviews were conducted with members from the eight cases. The interviewees, consisting of 10 managers, 17 leaders, and 22 developers, were visited at their places of business. All interviews were semi-structured, and embedded with Critical Incident Technique (CIT) (Flanagan, 1954), which consists of a set of specifically defined procedures for collecting observations of human behavior. CIT was used in the interviews to help informants recall events related to time pressure. These accounts provided rich details because the informants were asked about specific events rather than generalities, interpretation, or conclusions. Flanagan (1954) defined a critical event as "an observable human activity that is sufficiently complete in itself to permit inferences and predictions to be made about the person (or others) performing the acts" (pg. 327). In this study, a cited event was considered a critical event if it met Flanagan's definition, was related to time pressure, based on the project specified, and complete in itself to permit inferences and predictions. The interviews took

<table>
<thead>
<tr>
<th>Case</th>
<th>Location</th>
<th>Industry</th>
<th>Degree of Innovation(d)</th>
<th>Project Length (Month)</th>
<th>Team Proximity(d)</th>
<th>Team Size (Core)</th>
<th>Interviews(e) (Hierarchical)</th>
<th>Project Status (during interview)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microfine(a)</td>
<td>Germany</td>
<td>Semiconductor</td>
<td>High</td>
<td>36</td>
<td>1R</td>
<td>4</td>
<td>1 0 3 4</td>
<td>Real Time(f)</td>
</tr>
<tr>
<td>Semicaps</td>
<td>Germany</td>
<td>Semiconductor</td>
<td>Medium</td>
<td>18</td>
<td>2R (2)</td>
<td>8</td>
<td>1 2 5 8</td>
<td>Retrospective</td>
</tr>
<tr>
<td>Accelov(b)</td>
<td>Germany</td>
<td>Semiconductor</td>
<td>High</td>
<td>24</td>
<td>MR (2)</td>
<td>45</td>
<td>2 5 1 8</td>
<td>Real Time(f)</td>
</tr>
<tr>
<td>Orbiotech</td>
<td>Netherlands</td>
<td>Medical</td>
<td>High</td>
<td>36</td>
<td>1R/2B</td>
<td>16</td>
<td>1 2 2 5</td>
<td>Real Time(f)</td>
</tr>
<tr>
<td>Phoenix I(i)</td>
<td>Belgium</td>
<td>Consumer</td>
<td>High</td>
<td>12</td>
<td>1H</td>
<td>40-50</td>
<td>2 3 4 9</td>
<td>Retrospective</td>
</tr>
<tr>
<td>Lapson</td>
<td>Netherlands</td>
<td>Consumer</td>
<td>Low</td>
<td>9</td>
<td>MR (1)</td>
<td>10</td>
<td>1 1 3 5</td>
<td>Retrospective</td>
</tr>
<tr>
<td>Phoenix II(j)</td>
<td>Belgium</td>
<td>Consumer</td>
<td>High</td>
<td>12</td>
<td>1H</td>
<td>12</td>
<td>1 3 2 6</td>
<td>Retrospective</td>
</tr>
<tr>
<td>Playton</td>
<td>Netherlands</td>
<td>Medical</td>
<td>Medium</td>
<td>36</td>
<td>1R</td>
<td>25</td>
<td>1 1 2 4</td>
<td>Real Time(g)</td>
</tr>
</tbody>
</table>

Note:
- The team was part of a multi-site project; \(i\) The team was part of a larger project
- "High" radical (new to organization/market), "Medium" radical (new to team), "Low" incremental innovation
- \(d\) "xR", "xH", or "xB" indicates the number of rooms, halls, buildings the team members were located in, where M: multiple. (n) represents the estimated time, in minutes, to walk from one room or building to another.
- \(e\) "M" manager (3rd hierarchy), "L" direct leader (2nd hierarchy), "D" developer (1st hierarchy), "T" number of interviews per case
- \(i\) The team was at the design phase (before mid-point); \(j\) The team was at the testing phase (after mid-point)
about 30 – 45 minutes each, and were conducted in English. All interviews were taped and fully transcribed.

An entry interview was conducted with the project manager of each team. The interview began with general questions about age, work experience, and project responsibilities. Next, we asked them to describe the team structure, project schedule, market competition, and product characteristics. Each project manager was also asked to explain how the project schedule had been determined and if milestones had shifted since project launch. Although innovative projects in general encounter intense time pressure, we did not assume that in our interviews. Instead, we asked if the managers had experienced time pressure in the project. If the answer was affirmative, we proceeded to the subsequent questions, ‘Can you recall an occasion in this project when you (or the team) experienced high time pressure?’ and ‘Can you recall an occasion in this project that helped you (or the team) cope with time pressure?’ to elicit critical incidents from the managers. We also followed up each discussion with questions like, ‘Can you elaborate on what happened and when?’, and ‘How did the occasion affect you and your work?’ At the end of the entry interview, we asked project managers of large projects, typically those with more than eight members, to identify members who were thought to have experienced a considerable amount of time pressure for follow-up interviews. The interviews with the project leader and team members followed the same procedures as the entry interview, except that we did not ask them specifically about the project, market, and product information. The combination of multiple informants and tandem interviewing addressed some previous criticisms of research relying on informants’ recollections (Schwenk, 1985). Moreover, previous research (Huber, 1985) indicated high temporal stability in informants’ recollection of important events. Occasions related to time pressure are such events that could be easily recollected.

2.2.3 Data Analysis

The interviews were fully transcribed and analyzed. The scripts were read through once, before the time pressure events were extracted. Follow-up conversations surrounding an event
were examined before it was accepted, to ensure that the event fitted the criteria of a critical event.

Next, the first author conducted within-case analysis by investigating how critical events were related to one another in each case (Eisenhardt, 1989b). The analysis was conducted separately for events on the antecedents and the coping resources of time pressure, one case at a time. The author content analyzed the events by identifying key words and phrases in each event. This allowed him to systematically group events of similar meanings into common initial categories (Wengraf, 2001). This process involved the use of the existing theory on stress and coping, and data presented by the informants. In general, there was moderate agreement among team members on the antecedents and the coping resources within a case, even though agreement was more obvious in the former than in the latter. At the same time, the author also identified standalone events, which were different from events provided by other informants from the same team. Such events were retained to potentially help us gain a broader picture of each case during later analysis. All in all, the multiple informants approach allowed us to triangulate our results, reinforce our understanding of each case, and compare informants’ data to look for agreements and discrepancies (Jick, 1979).

Subsequently, the first author used the cross-case analysis approach to look for an emergence of similar patterns across multiple cases (Eisenhardt, 1989b). He used tables and cell designs to facilitate the process and to compare several categories at once (Miles & Huberman, 1994). From the emerging patterns, he then refined the initial categories developed during the earlier analysis. For instance, the author found numerous events in the eight cases to illustrate management and team support. He then used House's (1981) social support classification to explore if the support category could be better represented by smaller sub-categories. Theory and cross-case analysis later showed that the support category should be refined to four sub-categories as they provide more meaningful insight for readers. In sum, the antecedent and coping resources categories were refined through frequently revisiting the data to systematically compare and verify the occurrence of specific themes within each case.
Next, the author examined the events to see if they represented team-level or individual-level experiences since we had collected data from individuals about teams. Although the process revealed that the events were generally related to team-level experiences, there were some events associated with categories, like ‘*multiple projects*’ and ‘*interruptions*’ that appeared to be strongly related to individual-level experiences. This suggested that some of our categories might be more applicable at the individual level instead of the team level. To evaluate if these categories could be considered at the team level, we examined the events within each case. For instance, based on the ‘*multiple projects*’ category, Semicaps and Lapson were the only two teams to work on more than one project at any one time. And we found more than half of the informants from each of the two teams to spontaneously cite multiple projects as a source of time pressure (see Table 2.2). Although they used individual-level experiences to describe the phenomenon, this observation did not demonstrate that ‘*multiple projects*’ is an individual-level category. Rather, we suggest that the informants did so because the category can be better illustrated based on personal encounters than on what their teams did. Therefore, we suggest that categories like ‘*multiple projects*’ and ‘*interruptions*’ can be treated at the team level.

In order to provide statistical evidence to the reliability of the developed categories, the second author grouped all the events according to the developed categories. Events that were interpreted differently were discussed to reach an agreement. After that, we used the Cohen Kappa index to compute the inter-rater reliability between the two authors because it is chance adjusted and thus provides a reliable measure. Since our computed indices for the antecedent and coping resources categories were 0.84 and 0.88, respectively, and were both above the acceptable level of 0.70, the developed categories were considered satisfactory.
2.3 Results and Discussion

Data analysis led to 9 and 13 categories related to the antecedents and coping resources of time pressure, respectively. Table 2.2 shows the frequency counts of the events organized according to categories and cases.

### 2.3.1 Antecedents of Time Pressure

In this section, we discuss the factors that were identified to cause time pressure in innovation teams. The time-pressure stressor categories were then broadly classified as external or internal (management and team related) to the organization (see Table 2.2). The former class (two categories) consists of events that are inherent to the short-cycle industries and outside management's control, whereas the latter class (seven categories) are events that originated from the project team. In general, data analysis showed that some antecedents were prominent for some teams but not for the rest. For instance, ‘management attention’ appeared to affect Accelov and Phoenix but not Lapson and Microfine. This highlights that teams are likely to
experience time pressure due to diverse factors, and the more prominent the antecedents, the higher the likelihood that team members demonstrate agreement surrounding certain antecedents, and thus a stronger collective perception of time pressure.

**Market Forces:** A tight schedule and hard deadlines coupled with resource constraints and a need for quality and competitive product functionalities sum up the way of working in short-cycle industries (Smith & Reinertsen, 1998). These characteristics are the primary reasons for time pressure. Members generally accept and are willing to work under time pressure when it is due to the circumstances that are inherent to the industry. We collected several events illustrating market competition and customer expectations as the two basic market forces that cause time pressure. A member of Phoenix I shared:

“...The product for the U.S. is difficult because you have to be there on time. That is the biggest problem. If you are not there on time, you don't have your place on the (store) rack! (But), you don't have that here in Europe. If you are two weeks late (here)... they will (still) have space. In the U.S. if you are late, you are (just) too late.”

**Technical Complexity & Lack of Experience:** NPD teams operate in a complex and fast changing environment, which requires actors to readily acquire leading-edge knowledge, master new skills, and apply them in current development processes for a product to stay relevant to the market. Inadvertently, there is a gap between what a person knows and what is required to develop an innovative product. Such disparity presents a steep learning curve and heightens the pressure to attain knowledge in a limited time period. A mismatch between a member's skill set and the tasks means that the person needs more time, which is already a scarce resource, to accomplish the job. A leader of Phoenix I shared:

“...This (product) is the first of its kind. You can't really predict what will be the problems and (the) solutions. You don't even have a clue ... You also have the learning curve, which you have to (overcome) to realize the project.”
In addition, complexity posed further difficulties to a team when an experienced person leaves the organization taking with them years of implicit knowledge. A new person who takes over the role, expectedly, requires more time than what was usually needed for a veteran to finish the same task. This induces time pressure for the team, considering the interdependencies that are usually involved in a complex project. Data also show that during the planning stage the management should take into account that a new member needs more time to complete the same tasks as a veteran in order to reach a realistic schedule. A leader of Lapson said:

“We have a new guy for the mechanical part, so that makes it a little bit difficult (when there's) time pressure. As a project leader, you like somebody who has a lot of experience, who can do (things) very quickly, and is familiar with all the problems from the past. If it's a new guy, then (the project) takes more time.”

Members who are new are likely to perceive more time pressure, since they are less familiar with the technologies relating to the product and the work conditions than their colleagues. This category highlights the need for organizations to engage in strategies to retain their employees especially those working on innovative projects.

Management Attention: This study collected numerous events where management's course of decision and action led teams to perceive time pressure as bothering, disturbing, and discouraging. Actions such as frequent reporting and the abrupt involvement of upper management are some examples of negative management attention. Such attention disrupts members' focus, and converses a feeling of nervousness to the team. Mood contagion theory suggests that leaders are prominent mood 'conductors' and can easily transfer negative moods to their members (Sy, Coté, & Saavedra, 2005). This suggests that too much management attention confirms a feeling of insecurity within the top leaders, and this induces members to perceive the overall time pressure environment as negative. We identified three management actions that are not benefitting to teams. First is the increased reporting of project status to
senior management, which takes the person concerned away from where the real action is. The project manager of Accelov recalled:

“As soon as we got to the critical schedule, we were asked to report weekly instead of bi-monthly. (Senior management) wants to have a closer tracking. But, it is more work for me because I have to report weekly ... The later we are, the more reporting I have to prepare!”

Second is close watching, where a manager stays physically near or regularly follows up on a task status, to pressure a member to finish his or her assignment as soon as possible. This, however, often has a reversed effect, for it conveys a lack of trust on the members causing them to be reluctant to put more effort in such moments. A member of Phoenix I grumbled:

“When a problem appears, people come to you and say, 'this is the problem and it has to be solved as quickly as possible'. And they will be standing beside you while you are solving the problem. This annoys me! I'm trying my best but if you are standing here .... Stop bugging me. Go and do other work!”

Third is the abrupt involvement of managers who usually do not directly participate in the development process during a crisis. This may be a kind of impression management where people get involved to show, in this case to senior management or even to the developers, that they too are contributing to the solutions (Bolino, 1999). The sudden involvement of these managers often renders their motives questionable, which distracts teams from the real task at hand, and also increases the overall sense of urgency, which is not benefiting to teams under pressure. The project manager of Phoenix II aptly shared:

“When there's high time pressure to get things done, you see that other people also try to give a little more pressure to show that they care. But sometimes that doesn't help. ... In those periods, function management is getting involved in the sense that (they probed), 'what are you going to do next for this activity?' It's like you see them only in those periods, just to show that they are also involved in the project progress, which you don't see outside these time pressure periods. As a team, you expect them to support and ... not to mingle and have second opinions about things. ... People are made more aware of the time pressure. I don't believe it is necessary. I feel that it is seen more as a burden, at that moment, than as support.”
These events illustrate the negative influences of management pressure on time-pressured teams. Nonetheless, management attention does add value to team progress if it eases resource accessibility and is seen as support. Otherwise, management attention is unnecessary and disruptive.

**Multiple Projects:** Organizations developing innovative products are increasingly reliant on cross-functional teams (Parker, 1994), where its members are generally accountable to a functional group and work in multiple projects. A matrix organization offers the advantages of flexibility in the use of human resources (Larson & Gobeli, 1987), increased external communication (Keller, 2001), and technical excellence (Kolodny, 1981). However, it also leads to disadvantages that require attention (Ford & Randolph, 1992). Individuals pay a price for working in multiple projects, for they often need to deal with role ambiguity, conflict, and stress (Denis, 1986). This study supports the finding and elaborates on how working on multiple projects relates to felt time pressure. The expectations and timing of projects in a department are generally dissimilar, meaning that a member working on more than one project has to frequently switch cognitively between projects or tasks to promptly meet the expectations of each project. Such a person rarely has a period in which he or she can examine a task in detail without needing to switch to another task. Therefore, working on multiple projects threatens a member’s ability to concentrate. Cognitive switching is taxing and time consuming, especially if a task can best be solved when one is giving it one's full attention. In such situations, the person concerned generally takes more time to complete a task. The project leader of Semicaps shared:

“I had a topic that could be solved in one week but it took two or three weeks because I could not concentrate. For example, most of the time I am not at my desk for more than an hour. There are a lot of meetings the whole day. So when do I do the planning, when do I do all the coordination? You have to take time to concentrate on these topics otherwise you have to start from scratch again.”
Time pressure is also felt when one is unable to make a good estimation of the time needed for handling and making personal schedules for more than one project. A member of Semicaps added:

“The last three months there has been really high time pressure, working in two projects in parallel, due to not having complete focus on just one project. Having more than one project for the first time was (a) new experience. So, (personal) scheduling is not that effective.”

Role ambiguity and conflicts escalate when the priority of the projects is unclear. This becomes a problem when the leaders of these projects insist that a member completes their tasks first. A member of Phoenix I described the dilemma:

“I'm not working on one project but on several projects. And every project has its own project leader. If there are problems in the factory, they will come to us. So far, (all) of those project leaders (think) that their project is the most important one. They want you to look at their problems.”

In such occasions, members who are the critical resource for various projects are torn between meeting all the essential needs. This inadvertently induces emotional strain, guilt, and gives a feeling that time is never sufficient.

**Unrealistic Schedule:** An unrealistic planning fundamentally stems from poor estimations in terms of time, budget, and effort towards realizing a set of product specifications. Members perceive time pressure that originated from such a schedule as negative, especially when it is derived through backward planning and imposed upon the team. This study found three factors that lead to unrealistic schedules. First, data shows that management tends to introduce ambitious plans even when a project is first of its kind, either in its technical complexity or scale for the organization. This aggravates a team's uncertainty about delivering the product in time, which further heightens the perceived time pressure. Accelov experienced a very unrealistic schedule. A member shared:

“My opinion is (management) wasn’t realistic. This is a very huge project. They never have done this kind of project in this location. For that reason, they should have planned buffers. Just
everything is optimistic, the management said, ‘when everything runs perfect, we have a certain chance to reach or to get to that business case’.”

Second, with regard to time resources, not having time slack in a project schedule causes teams to perceive time pressure negatively, as they fear to encounter problems that may deter them from completing the project on time. The higher management of Accelov insisted on a hard deadline, leading to a schedule that had no time buffer. In many occasions, the team had to ‘fight’ for more time. A leader said,

“At the moment we don’t have any slack in this project. If I have a one-day delay, I cannot see any compensation action. The designers are not able to think calmly when a problem appears.”

Third, we found that schedules lacked good time estimation partly because they did not take into account time required for activities not immediately related to technical tasks: time for members to accumulate appropriate knowledge, time to coordinate with external parties, and time to respond to unexpected requests from the field were commonly overlooked. When unrealistic planning persists in a department, it gives a feeling that the time pressure is intentionally induced. In time, people gradually cease to take schedules for real, thinking that management is only interested in reaching its business targets with little concern about the sacrifices of the employees. Leaders of Accelov and Microfine shared:

“People said, ‘I don't trust management. I don't take the goals for real.’ ... Then, it is hard for project leaders to convince the people that the schedule is still reachable. ... This is not the first time that the management set unrealistic goals. Here ... some projects were scheduled for one year. The management said that if the project wouldn't finish in one year, it would die. (But, one of the) projects took 3 years and the company still made a lot of money.”

“(Management) puts financial pressure on you for less money which is the same thing as doing it quickly ... I think I'm not the only one, sort of suspicious now (when) time pressure keeps coming. Ok, you can argue that ... you have so many competitors. (But) if management is good, they should be able to find a project where it is important enough that.... even if you miss (the deadline) by a month, you still have customers. ... I think time pressure now is more and more bad out of the management.”
In some cases, we find management's procrastinating response to feedback and resource requests when schedules were already difficult to realize to heighten time pressure in a team. A member of Playton contributed:

“Management was not listening well enough to the signals that the (team) was giving. We indicated problems, but the management didn't include the information in the planning. ... Although they thought it was possible to finish the project by the end of 2005, people were reacting and thinking that it was complete nonsense. The amount of work was much more than what we had done in the past, and we were getting less time! This is an example of not being listened to. That is what you get when management has completely unrealistic targets!”

Eventually, the project duration was extended from two to three years! These examples also elaborate the effects of unrealistic scheduling on members' trust in higher management. The level of trust, then, determines if a member channels more energy to perform the tasks effectively under time pressure, or to achieve alternate objectives (Dirks, 1999) - for example monitoring management's actions to ensure fairness for the team or oneself. This section emphasized the negative effects of unrealistic schedules, which spans beyond simply the feelings of time scarcity. The unrealistic schedules also compete for members' already limited attentional resources as some are channeled to cope with the anxious, uncertain, and insecure work environment.

**Interruption:** Interruption refers to an event that breaks the continuity of a member's work, and is unexpected and not directly related to the work that the person is concentrating on. This definition is consistent with Jett and George's (2003) interpretation of intrusion. In this section, we focus on interruptive events that originate from within the team. In some occasions, a member can be so overwhelmed with questions or requests that are not directly related to his or her immediate tasks that the only time to do any *real* work is at the end of the day. A leader of Phoenix I commented:
“After you have handled all your mails, after all the interruptions from the integrators, and from the project managers ... asking for status, there is hardly enough time to do your own job. So ... you have to spend a lot more time, or sometimes work at home.”

We also collected examples suggesting that the hectic environment triggers some intrusions, causing people to ask trivial questions. A member of Oribiotech recalled:

“When I (don't) have time and someone is always asking me questions, it is very annoying. I can't go on with my work. When (I am) working on this table, one meter away ... there is something that has a little pressure. ... (I tell my colleague to come back later with his questions), then it is out of the building. They never come back. So (the questions) were not that urgent, but (posed just) because you are in the neighborhood.”

These examples support that interruptions cause people to sense a lack of time to perform time sensitive tasks. Furthermore, interruptions disturb someone's concentration and hinder that person from reaching a state of total involvement in the task being performed (Jett & George, 2003). Although offering advice and support to team members signifies strong teamwork (Hoegl & Gemuenden, 2001), help seeking may produce negative outcomes when it becomes too frequent and random. We also found some examples suggesting that team members prefer to approach colleagues directly for information rather than to use the information database to answer their queries. Therefore, coaching members to consider mindfully about when interruptions can and should occur, and be dealt with, is essential. Additionally, synchronizing quiet time (Perlow, 1999), when members work independently, and interaction time in a team to ensure that interactive activities do not unnecessarily disrupt members’ individual activities can reduce the negative consequences of interruptions.

**Project Overrun:** In this study, project overruns occur when phases of two or more projects deviate from their schedules and unexpectedly coincide. A difference between the events in this category from those in *multiple projects* is that the projects in the latter are intended to overlap, while those in the former are not planned. The coinciding of a project's ending phase with the start of a new project is an example of project overrun. Members in such situations
mostly focus on the closing projects as these are considered urgent and important for sales, even though new project success depends critically on the rigor and quality of up-front activities, such as knowledge transfer and problem solving (Thomke & Fujimoto, 2000). A delay in these activities inadvertently shifts the identification and solving of problems downstream, and increases the uncertainty of reaching the new project schedule. A member of Phoenix I said:

“Last year, the first spin project slipped. (Management) then took resources from the second spin to the first spin, which automatically meant that the second spin was not moving forward. The most urgent project always wins. This definitely made the second spin lost time in the beginning of the project.”

Though project overrun is difficult to control, the chances of such occurrences can be reduced if planning accuracy is improved, and if there is a reasonable amount of time for members, especially critical resources, to transit from closing to starting projects. A team's primary concern when projects overlap is the relative priorities of the projects. This emphasized the need for management to prioritize projects clearly when unanticipated overlap occurs. A leader of Accelov recalled:

“I felt time pressure already in the beginning because when this project started, my old project had not finished. This was really crazy. ... When we asked (management) for a priority list, they said, 'both projects have the same priority!'”

This example also shows that project overrun creates a resource bottle-neck where members cannot be readily available for a new project if they are still firefighting in an ending project. This leads us to the next category.

**Change Request:** Smith and Reinertsen (1998) defined specifications as the written descriptions of products that are generated in advance to guide the NPD process, which ultimate goal is to develop a product that meets customer needs. Detailed and understandable specifications therefore provide a roadmap for teams to follow and focus their resources on. However, specifications are often subjected to change, especially in product development.
Although changing requirements may be an inherent part of NPD processes as organizations react swiftly to competition, shifting specifications are unfortunately, in many occasions, induced by a lack of specification clarity during project start. This increased the need for corrections as the project continues. A member of Phoenix I echoed:

“I think in the end you have a better product, (if) you have more slack for the requirements. We are having some problems with the tuner. The requirements were defined and approved. But, if you look at them afterwards, they were not detailed. There were (grave) mistakes. There should be more time to do the requirement part.”

These examples show that a lack of time for up-front activities caused the poorly defined specifications. This emphasizes and echoes the importance for high performance teams to have slack resources (Greenley & Oktemgil, 1998) at the early stages of a project. The consequences of unstable specifications are more change requests, less time for planned activities, and a heightened sense of uncertainty. Examples showed change requests to be a source of time pressure, and many of them were unexpected. A manager of Phoenix II shared his experiences of a major change request due to a late decision:

“We got a no-go from our plant manager to use a display supplier. So we again had to swap displays. We only have two and a half months to implement the (hardware). ... To integrate the (new display) in principle we need 4 months. ... So we are really in time pressure to finish.”

Change requests due to external events are generally uncontrollable, and are those that teams need to manage as they function in a competitive environment. However, rework due to internal faults at the early stages can be and should be avoided, for these not only increase the amount of work but also discourage people.

**Long Periods of Time Pressure:** The duration of time pressure influences the extent to which people perceive time pressure as negative because an extended stress period gradually reduces individuals' ability to sustain task concentration. Our findings suggest that people work most effectively under time pressure only when its duration is short and within a clearly stated timeframe. Members of Accelov and Semicaps explained:
“I think I can handle (time) pressure, but it has to be for a fixed period and (that) I know this period. At the moment, I don't know when the period ends. ... I cannot (cope with) the pressure, so motivation is going down.”

“People got frustrated because they did not see the end coming even after they put in more time than they should. They forgot about other things. They were just working, working, and working. But the goal was not approaching!”

Furthermore, consistently putting more hours and energy into work and not knowing when time pressure ends reduces motivation. People need to see the end of the tunnel. For example, Oribiotech was stimulated by a two-week non-negotiable deadline, while Accelov, also speeding for a non-negotiable deadline, was discouraged when it was nine months into the project. Here, we suggest that projects consist of short and finite durations of time pressure so that members can recover from demanding periods. Studies have consistently demonstrated the benefits of work recovery. For instance, it prevents deterioration in performance in the long run (Meijman & Mulder, 1998), and increases work engagement and proactive behaviors (Sonnentag, 2003). Structuring periods for recovery in project development means that management has to emphasize non-shifting milestones, so that the experience of time pressure comes in distinct periods of peaks and troughs where members know when to work vigorously, and when to work at a less demanding pace.

### 2.3.2 Circumstances that Increase Situational Coping Resources

The findings showed that the team environment plays an important role in enabling members to function effectively under time pressure. In addition, management interventions, such as setting clear task priorities, sheltering members from unnecessary disturbances, and clear articulation of goal importance, are also found to ease members' workload and help members channel their attention to the critical tasks. Support from the workplace was frequently mentioned as a critical coping factor for stress. The categories could be broadly classified as related to management, team, or external entities (see Table 2.2).
**Prioritization:** Studies conducted at the individual level of analysis have indicated that individuals allocate limited resources on the basis of a task's importance or priority (Matthews & Margetts, 1991; Smith, 1982). Prioritization is imperative, especially when the tasks are complicated and require concentration. However, project complexity and interdependencies across its interfaces often disallow team members to independently determine the relative task importance and the sequence in which the tasks should be done. Having to work on multiple tasks of equal priority naturally threatens one's ability to focus, and heightens one's perception of time pressure. In a team, the charge of prioritization lies critically on management for it has the project overview. This study also shows that prioritization is, at times, best done on a daily basis. A member of Phoenix I aptly shared:

“... That's a good thing here with (this company). The more time pressure you have, the faster (the management) goes into prioritization mode. ... I never have had the feeling that I had to do a 100 things and had no clue what was the most important.”

Furthermore, a person experiences emotional conflict when torn between not knowing which tasks to work on first, and having to deal with the stress of possibly disappointed colleagues who are depending on his work. Thus, setting clear priorities on multiple tasks directs people to the critical issues and frees them of any possible emotional onus. At times, prioritization simply means that management needs to make the decisions of removing some difficult-to-realize functionalities and focuses on the need-to-haves.

**Shielding:** A pragmatic way of ensuring that team members are able to concentrate on their tasks is to shield them from disturbances and demands arising from outside and within the project. This study found that direct supervisors form the insulating layer that filters untimely and onerous requests that may cause their teams to feel more pressed for time. Some companies make shielding their employees from external disturbances a policy, while in other cases, effective shielding plainly requires initiative and care from the project managers and leaders. An example from Phoenix I illustrates:
“At some point, I find that our team leader is not really taking time pressure off our people. With other teams, the team leaders protect their people. If management says, 'This has to be done', the team leader would say, 'You can tell me, and I will see if my people can do this'. My team leader is more like (if management says), 'this has to be solved'. He will say (to us), 'ya ... why is this there?. Why has this not been solved yet?'. This is something we see different with our team leader.”

The example demonstrates that shielding does not imply that supervisors should block requests indiscriminately. Rather, supervisors should act as a filter to either block or delay, for example, a request, until it is found to be relevant before letting it reach their members. Otherwise, the event would just be another non-purposeful interference.

**Task Importance:** Team goals are strong determinants of successful projects (O'Leary-Kelly, Martocchio, & Frink, 1994). Nevertheless, having goals alone is insufficient. This study illustrates the need for well-articulated and meaningful team goals. Members need to be convinced that the goals are not due to self-serving and overly ambitious intentions, but are genuine and worth pursuing. Such goals motivate and enable people to endure time pressure periods. A member of Microfine shared:

“If I feel pressure, I don't do anything until I see there are some reasons for it. Then I feel better because I feel like it's a good thing that I'm doing.”

In addition, the importance of reaching personal goals amplifies when members realize the degree of task interdependency in the project. Not only knowing how one's work fits in the bigger picture helps, recognizing that the team needs all its members to function well for the team to deliver the product propels people to thrive even when pressure is rising.

**Autonomy:** Supporting autonomy at the workplace requires trust, and allowing members to make certain choices about their work, such as being involved in project scheduling (timing control) or deciding on the problem solving techniques (method control). Karasek's demand-control model proposed that autonomy is particularly important for members' motivation when they function in stressful environments (Karasek, 1979). Events in this study clearly
showed that autonomy, be it team members participating in project scheduling or having flexible work hours, gives people a sense of involvement and control. An example from Microfine illustrates the importance of having job autonomy in a time-pressured environment: “(My boss) gives me the time. He lets me work independently and comes back to me and checks my mistakes, and so on. He is not consistently keeping me under pressure.”

**Schedule Clarity:** A schedule that is agreed upon and clear enables members to structure and pace project activities in their minds. Furthermore, people are likely to work more effectively under time pressure when the next course of actions is unambiguous, such that they know exactly what to focus on next (Pfeffer, 1981). Clear planning also ensures that critical resources for certain phases of the project are available when the time comes. A member of Playton explained:

> “The week when we made a very detailed planning for the system testing helps because we know exactly what test to do in time. The availability of the test system is also included in the planning. The precondition (such as availability and right configuration) for system testing has improved a lot and that saves a lot of time. In the past, I had to get the preconditions fulfilled. (Now), I can focus much more on the test and don’t have to worry about those issues.”

This finding is also consistent with the results of Claessens, van Eerde, Rutte, and Roe (2004) that planning behaviors and perceived control of time reduce the amount of stress.

**Social Support:** In this study, social support refers to providing resources, such as tangible aid, advice, and empathy, to team members in need. Support comes in different forms: instrumental, emotional, informational, and appraisal (House, 1981). Importantly, this study shows that social support stems not only from members of the team, but also from its higher management.
a. **Instrumental support:** refers to the extent to which tangible aid or a service that directly assists a team member in need is provided. Events that reduce the situational demand consequently diminish the level of felt time pressure. A designer of Semicaps recalled:

“A colleague was ready with his project, and he took over some work from me so I did not need to worry about (too many things). It was just time for me (to) breath!”

More importantly, some events collected showed that management has the overview of who were near task completion and who were still bottlenecked, and they played an important role in ensuring that distributable team tasks were spread out well between team members. Such direction from management not only helps to keep a balanced task distribution in a team, but also implicitly cultivates a cooperative environment so that not one person is experiencing too much time pressure.

b. **Emotional support:** refers to the extent to which empathy, love, trust, and care are provided to one another in the team. An advantage of working in teams is the social relationship between members. This study showed that emotional support originating from the top is seen to be very valuable, for it makes members feel that management does not simply throw problems at them but are willing to listen and be available to make things easier. A member of Accelov shared:

“Now we have to work on Saturdays. So one nice thing was that our management also comes on Saturdays to their offices. They came around and giving everybody (snacks) during lunch time. This is one little thing that helps us to deal with time pressure ... Just to see that they care about us and understand that we are doing a tough job.”

Accepting that members can make mistakes and not reprimand them help members to remain calm under time pressure. A member of Microfine recounted:

“I (did) something wrong because of time pressure. I felt like I was not able to cope with it. Then (my project manager) said, 'oh, this can also happen because of time pressure. That's the way we learn'. So he is relaxing me.”
c. **Informational support:** refers to the extent to which advice, suggestions, and information that a team member can use to address problems are provided. Time pressure generally leads people to isolate themselves to focus on their personal tasks. This occurred to Microfine and caused its members to feel uncoordinated, as if they were running their own races. The team eventually decided to resume its weekly technical meeting. A Microfine member shared:

“(The technical meeting) is a moment when we sit and talk. At the meeting everybody hears (your problems). You only have to say once, and people say, 'well, this is not worth trying because somebody tried it.’ (People give you advice) and you also learn from them.”

Regular technical meetings provide opportunities for team members to share information, which aligns the team and minimizes ambiguity. A member of Accelov acknowledged the importance of informational support in coping with time pressure. He said:

“The LAC module was magic. You faced problems that you could not explain. You did not know what was going on. Fortunately, the video and audio teams came together, and that was a good thing. To (see the bigger picture), and know what you have to do.”

We noticed that project managers increase the frequency of meetings when approaching hard deadlines. Although this facilitates knowledge sharing, the timing, nature, and proper handling of such meetings eventually determine whether these meetings provide informational support to members, or steal time away from them.

d. **Appraisal support:** refers to the extent to which information that is useful for a team member’s self-evaluation purposes (e.g. constructive feedback, affirmation, and social comparison) is provided. Team members generally work extra hours when pressed for time. People want to be appreciated and rightly recognized for the results delivered, especially after working overtime. Showing sincere appreciation affirms the members that the extra hours and effort that they have put in are valued and noticed. This enables members to function more effectively despite the time pressure. A member of Microfine said:
“The management sort of gave us positive congratulations ... somehow it helps. You feel like (the whole project) is for a good cause. If you succeed, those people will be happy and you want them to be happy.”

Appreciation works both ways. Project leaders also need assurances from their members. The project leader of Accelov shared:

“It is very important that you get recognition for doing a good job, especially from team members, (to know that) I am not fighting for nothing. ... a team member came to me and said, ‘Hey, it was a good meeting with some constructive actions.’ When it comes from the team members, it is really honest.”

**Team Commitment**: Team commitment refers to the acceptance of and the strong belief in the goals and values of the project, the willingness to engage in the project, and the desire to maintain membership in the project (Bishop, Scott, & Burroughs, 2000). In this study, we collected various events where informants used words like *team spirit, togetherness, not alone*, and *solidarity* to describe what helped them to maintain their effort during time pressure periods. These events were grouped together for they are consistent with the theme of commitment. Members of a committed team tend to feel like they are on a mission, and therefore experience timelessness and 'flow' in their work (Csikszentmihalyi, 1990). This leads people to perceive time pressure as a positive impetus. The project manager of Microfine shared:

“Certainly my co-workers are working harder to help me. (But) what is important is also the solidarity. If you are working late and you are alone, you really feel bad. If there are people who are working hard too and making sacrifices, you feel like it is an adventure.”

A member of Oribiotech contributed along the same line:

“In fact in the period (hard deadline), it did not feel like time pressure because I saw that everyone was working hard ... everyone was willing to work longer. When I was working in the LAS group, the projects were small and I worked on my own. When I finished (my work) in the laboratory at 8pm, no one saw me. That is different from working in this team, where you know everyone is working. If they are not in (the same room), they are in other rooms.”
Our result is consistent with the studies of Bartunek, Foster-Fishman, & Keys (1996) and Souder (1981) that whenever two or more persons, or organizational entities, interact for the purpose of superordinate goals, it is important that they demonstrate a commitment to the overall goals. In this case, the pursuit of common goals and values to make the project successful turns out to keep innovation teams focused on the deadlines.

**Team Potency**: In this study, we found team potency to be a coping resource for innovation teams. Similar to findings in previous studies (e.g. Lester, Meglino, & Korsgaard, 2002), we found past success and small wins to contribute to team potency. This study showed that small wins enhance confidence and reduce the uncertainty of reaching deadlines. Interestingly, we found the experiences of team members, and in particular, that of the project leader, to heighten team confidence and help teams to remain viable under intense time pressure. A member of Accelov held such a view. He commented:

“We have some really experienced people in our team. You know you can rely on them because even though we all have time pressure, you can always ask and you will get an answer. And he thought of situations that I did not think of. Just talking (to him) gives me a higher confidence (in) how I implement this stuff.”

The study suggests that project managers who are technically strong in fields relating to the project are most suitable to lead highly time-pressured projects. Managers with a strong technical background appear to be able to navigate teams through rough technical terrains, and to provide the assurance to team members that they have someone whom they can depend on if they run into impasses during the project. This makes a team feels confident of succeeding despite the tight deadlines and uncertainties. A member from Microfine shared:

“(Our project manager) always knows the answer and so you feel good even if you are under pressure. You know that there are good people in the group who will come up with the answers but it just takes some time. You do not look at the pressure as a bad thing as much, as you have no idea what the answer is. But if people are not as experienced, then (time pressure) can become bad. It is a question of confidence. The more you have, the less time pressure affects you.”
As a result, we recommend organizations and scholars to re-consider the pros and cons of appointing project managers or leaders of other backgrounds to lead innovative and time driven projects given the fact that the extent of technical experience of managers appears to affect team potency, which has also been empirically supported to improve team performance (Gully, Incalcaterra, Joshi, & Beaubien, 2002).

**Customer Involvement:** An NPD team in general develops an innovative product for which its business line management, a division of its company, or an external company is the immediate customer. This study suggests the importance of customer involvement in all these scenarios. The key benefit of a close working relationship between a development team and its customer is open communication. This provides the foundation for a team to discuss promptly and openly with its customer about specifications, risks, and possible schedule slips. Although the advantages of customer involvement have been highlighted in numerous studies (e.g., Ciccantelli & Magidson, 1993), they were not linked to how team members experience time pressure. Here, we collected examples illustrating that customer involvement helps teams to cope with time pressure. First, it gives members a sense that their customers are not simply throwing problems over the fence but are willing to stay involved to see the team succeed. Second, such a relationship sustains the team when the deadline presses because they then know for whom the long hours are for. Microfine and Accelov have a close connection with their customers. The team members shared:

“You have a face and a voice which you can think about ... there's more human connection to it. Not just computers and machines.”

“We have a very good understanding with the customers on a monthly basis. They visit us or we visit them. ... They are very friendly. Everything is discussed. It's not that they throw the problem over the wall and (we must) solve them (by) this and this time. They are very well involved in our problem and that helps us to cope with time pressure. If we have a problem, we can discuss it very openly with the customers.”
The examples suggest that a project may benefit if its members, and not only the managers, meet and hear from the customers directly about their expectations and feedback at some project intervals.

**Family Support:** This study did not only focus on coping events from the workplace. It offered us the opportunity to uncover that family support is an important source of coping resources for our respondents at work. A member from Semicaps said:

“It's important that your family agrees on what you are doing; accepting that you are coming home late.”

Deadlines often require project members to work overtime to cope with the demands. However, a period of working extra hours inevitably induces strains on an individual's family life, especially so if work is the lead cause of them not able to fulfill their roles at home. This results in family tension (Ganster & Bates, 2003), and may spiral to aggravate the amount of stress at work (Netemeyer, Maxham III, & Pullig, 2005). Thus, organizations should invest effort in communicating the importance of their development to employees' families, and at the same time, be aware of the possibility of work family conflicts if team members are consistently under time pressure.

### 2.3.3 Summary

In all, we observed that teams tend to perceive time pressure negatively when they encounter numerous negative antecedents but few coping events at the workplace. For example, content analysis showed that Microfine went through an extremely time pressured project. However, we collected fewer time pressure antecedent events, on average, from Microfine than from the other teams. At the same time, Microfine provided more coping events, and appeared to be more satisfied about their project than the other teams (see Table 2.2). On the contrary, Accelov encountered many internally induced antecedents and comparatively few coping events. This combination appeared to have caused them to perceive time pressure negatively.
2.4 Implications

This study serves to investigate the antecedents of time pressure and the situational factors that help teams to cope with the stress in NPD contexts. This study adds to the literature by focusing on a specific kind of stress - time pressure, and studying it with ongoing and real project teams. Table 2.3 and 2.4 summarize the categories that we have identified in the previous sections. The implications of the findings are discussed in this section.

2.4.1 Implications for Theory

This study identified a number of antecedents of time pressure. Based on the results presented in table 2.2, two out of nine antecedents are associated with external factors. These represented only 26.1% of the total number of events collected (see Table 2.2). This suggests that time pressure is largely perceived to originate from within their organizations. This gave hints that the experience of time pressure can be managed if management pays attention to certain internal factors. Content analysis also suggests that team members tend to appraise the external factors: ‘market forces’ and ‘technology complexity & lack of experience’ somewhat positively. This is because team members understand that their work involves market uncertainties and technology leaps. The internally related antecedents, however, tend to be appraised negatively. Among the internally induced antecedents, some, such as ‘multiple projects’, ‘change request’, and ‘interruption’ appear to be inherent to NPD jobs, whereas the rest (‘management attention’, ‘unrealistic schedule’, ‘project overrun’, and ‘length of time pressure’) can be systematically reduced with effective project management. To add, some of these internal antecedents may induce negative perception only when they become too intensive. For instance, ‘multiple projects’ starts to induce negative perception when team members were assigned to too many projects, which unfortunately required them to switch (cognitively) frequently between tasks and projects. Besides identifying the antecedents, the findings also suggest that time pressure may be perceived as a positive or negative stress, depending on its antecedents. So far, time pressure has been conceived as a uni-dimensional construct (Amabile, Mueller, Simpson, Hadley, Kramer and Fleming, 2002; Kelly &
McGrath, 1985; Parks & Cowlin, 1995) and its impact on performance generally depicted by the inverted-U model (e.g., Baer & Oldham, 2006). Although this approach has generally being used to explore the relationship between time pressure and performance, some inconsistencies seem to surface (e.g., Baer & Oldham, 2006). Since our work showed that teams are likely to perceive time pressure as positive or negative depending on the work situations, we recommend future research to explore the time pressure-performance relationship by conceiving time pressure as a two-dimensional structure.

In this study, we focused on situational coping resources by examining how supervisors and coworkers may intervene to increase coping resources of team members. We found some top-down interventions (e.g., shielding), and team characteristics (e.g., team commitment) as well as extra-organizational factors (e.g., customer involvement), which are rarely emphasized in earlier research, to increase team members' coping resources. This alone provides opportunities for future investigation. According to Thoits's (1995) review on stress coping, situational coping resources benefit actors by increasing their personal coping resources and/or by inducing them to engage in result-oriented coping strategies, like problem-solving tactics. This study did not examine the underlying mechanisms through which increased situational coping resources influence personal coping resources and individual coping strategies. Nonetheless, we revealed a number of situational factors that future coping research can use to quantitatively investigate the underlying coping mechanisms.

2.4.2 Limitations

This study has a number of limitations and it is important to mention them. The first limitation is the extent to which our findings are applicable at the team level. Time pressure (stress) has mainly been investigated at the individual level, given that people generally perceive similar stressful situations differently because of varying personality traits (e.g., Lazarus & Folkman, 1984; Waller, Conte, Gibson, & Carpenter, 2001). Although, we agree
### TABLE 2.3: Antecedents of Time Pressure

<table>
<thead>
<tr>
<th>Theme and Category</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Externally Related</strong></td>
<td></td>
</tr>
<tr>
<td>1. Market Forces</td>
<td>“The pressure comes from the market. Our management must follow the market, and that is why we are too late from the beginning.”</td>
</tr>
<tr>
<td>2. Technology Complexity &amp; Lack of Experience</td>
<td>“If the product is first of its kind, you can’t really predict what will be the problem and what will be the solutions for these problems. You don’t even have a clue.”</td>
</tr>
<tr>
<td></td>
<td>People are going away. New people need more time to know the organization and the system. A new guy just replaced an experienced guy. That means more time needed to do the test.”</td>
</tr>
<tr>
<td><strong>Internally (Management / Team) Induced</strong></td>
<td></td>
</tr>
<tr>
<td>3. Management Attention</td>
<td>“There was a lot of pressure from top-level management. ‘We have to make it, we have to have it.’ So there is not really discussion on what is the reality.”</td>
</tr>
<tr>
<td>4. Unrealistic Schedule</td>
<td>“Bad planning. You plan tasks to be done in one month, but they get done in one month and one week. If you add 10 of these activities in a row, 10 weeks is a lot to slip in 10 months!”</td>
</tr>
<tr>
<td>5. Multiple Projects</td>
<td>“The application engineer was overbooked. He has 4 or 5 projects, or more. He was not able to manage, and provide the specifications in time.”</td>
</tr>
<tr>
<td>6. Project Overrun</td>
<td>“Resources were taken from the second to the first spin (when its deadline slipped). The most urgent project always wins. This made the second spin lose time in the beginning of the project.”</td>
</tr>
<tr>
<td>7. Change Request</td>
<td>“The definitions have changed during the project, which of course caused delay. You planned, but the boundary conditions changed during the development.”</td>
</tr>
<tr>
<td>8. Interruption</td>
<td>“Sometimes, I have 4 or 5 people in my room. And they are fighting … saying, ‘I’m more important’ when I’m busy calculating for my boss.”</td>
</tr>
<tr>
<td>9. Length of Time Pressure</td>
<td>“People get frustrated because they don’t see the end coming even when they put in more time than they should. The goal is not approaching.”</td>
</tr>
</tbody>
</table>
### TABLE 2.4: Situational Coping Resources for Time Pressure

<table>
<thead>
<tr>
<th>Theme and Category</th>
<th>Examples</th>
<th>Research Supported / Contribution to Stress literature</th>
<th>Category identified to be critical to team outcomes</th>
<th>Type of Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Management Related</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Prioritization</td>
<td>“I realized that my member was working for another project leader. So I talked with my colleague to set priorities. The member became happy. Not all things are as important at that moment of the project.”</td>
<td><strong>Support</strong>: Kelly &amp; Karau (1992) where individuals' attention resources are narrowed due to time pressure, and prioritization enables people to use the restricted resources for the most important task.</td>
<td>Li &amp; Calantone (1998) ⁴</td>
<td>PF</td>
</tr>
<tr>
<td>2. Shielding</td>
<td>“Our project leader is like an umbrella for us. He catches all the negative things from the management and don't give them to the team.”</td>
<td><strong>Contribution</strong>: This category highlights that protecting members from disturbances help them to better cope with the time pressure.</td>
<td>-</td>
<td>PF</td>
</tr>
<tr>
<td>3. Task Importance</td>
<td>“If I feel pressure, I don't do anything until I see there are some reasons for it, so that I feel like its a good thing that I'm doing.”</td>
<td><strong>Support</strong>: Important goals challenge individuals, and make them feel as if they are on a mission. (e.g. Amabile, Hadley, &amp; Kramer, 2002; Gallstedt, 2003)</td>
<td>McDonough (2000); Pinto, Pinto, &amp; Prescott (1993)</td>
<td>EF</td>
</tr>
<tr>
<td>4. Autonomy</td>
<td>“I think it helps a lot. You have to give your (schedule) estimates, and not your boss who says that you have to finish by this time. It's an exchange.”</td>
<td><strong>Support</strong>: Stress literature has long identified job control to balance job demand (e.g. Karasek, 1979).</td>
<td>Gerwin &amp; Moffat (1997); Tatikonda &amp; Rosenthal (2000)</td>
<td>EF</td>
</tr>
<tr>
<td>5. Schedule Clarity</td>
<td>“First of all, you need clear agreement (with the members) on the activities. You make clear on what you want, what the activities are for, and how they are going to be working in the next few weeks.”</td>
<td><strong>Support</strong>: This category supports the time management literature, which showed that clear daily schedule help people to better cope with stress (e.g. Claessens, van Eerde, Rutte, &amp; Roe, 2004).</td>
<td>Lynn, Abel, Valentine, &amp; Wright (1999)</td>
<td>PF</td>
</tr>
<tr>
<td><strong>Team related</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Team Commitment</td>
<td>“There are like-minded people. People who believe to make it happen. There are quite a few people you can rely upon, who share the same goals.”</td>
<td><strong>Contribution</strong>: Category 6 suggests that teams that are committed to the project goals are willing to exert extra effort to reach impending deadlines.</td>
<td>Hoegl, Weinkauf, &amp; Gemuenden (2004); McDonough (2000)</td>
<td>EF</td>
</tr>
</tbody>
</table>

1 PF: Problem-Solving intervention; EF: Emotion-Focused intervention

4 NPD Studies have generally focused on project or process prioritization, and not on prioritizing intra-team or individual tasks, which are the findings of our work.
7. Team Potency

“Having a success helps the next time in a similar situation. You know that you can handle it. You learn from situations like crash actions - learning how to manage, and how to do it better the next time.”

Support: For example, Gevers, van Eerde, & Rutte (2001) confirm that team potency reduces the negative effects of time pressure on teams performance

Contribution: We propose that the experience of team members, and members’ trust in their leader's competencies to influence team potency.

Support: Categories 8 – 11 confirm previous findings indicating that social support increases teams' ability to function under stress (e.g. Beehr, 1995; Van Yperen & Hagedoorn, 2003).

Contribution: Our work clearly highlighted that social support within a NPD team can be segregated into four distinct sub-categories. These facets of support should be nurtured in the NPD teams.

8a. Instrumental Support

“There was a time when I complained that I had not enough resources for my tasks. Then the management came to me and said, 'You can also use this guy'. This was very positive.”

Support: Categories 8 – 11 confirm previous findings indicating that social support increases teams' ability to function under stress (e.g. Beehr, 1995; Van Yperen & Hagedoorn, 2003).


8b. Emotional Support

“One example is now we have to work on Saturdays. One nice thing is that the management also comes on Saturday to their offices. ... Just to see that they care about us, and that they understand we are doing a tough job.”

“Support: Our work clearly highlighted that social support within a NPD team can be segregated into four distinct sub-categories. These facets of support should be nurtured in the NPD teams.”

Contribution: Our work clearly highlighted that social support within a NPD team can be segregated into four distinct sub-categories. These facets of support should be nurtured in the NPD teams.

Support: Categories 8 – 11 confirm previous findings indicating that social support increases teams' ability to function under stress (e.g. Beehr, 1995; Van Yperen & Hagedoorn, 2003).


8c. Informational Support

“I feel very comfortable working with a particular guy because he thinks of situations that I didn't think of. I talk a lot with him. Just talking what we do right now, always gives me a higher confidence on how I implement this stuff.”

Support: Categories 8 – 11 confirm previous findings indicating that social support increases teams' ability to function under stress (e.g. Beehr, 1995; Van Yperen & Hagedoorn, 2003).


8d. Appraisal Support

“When you got recognition that you are doing a good job. That's very important.”

Support: Categories 8 – 11 confirm previous findings indicating that social support increases teams' ability to function under stress (e.g. Beehr, 1995; Van Yperen & Hagedoorn, 2003).


External Related

9. Customer Involvement

“We have very good communication with the customer on the planning and milestones. They were very aware of the difficulties that we face. They know that they are the cause of the difficulties and so they accept delays.”

Support: Seers, McGee, Serey, & Graen (1983) found that employees' significant others (family/ friends) provide strong support to their work.

Contribution: This category proposes that teams experience a heightened sense of support when their direct customers are closely involved in the development process.

10. Family Support

“My wife taking care of my parents when I was working helps. Else, I will have to be there for my parents and can't be here for work.”

Support: Seers, McGee, Serey, & Graen (1983) found that employees' significant others (family/ friends) provide strong support to their work.

Contribution: This category proposes that teams experience a heightened sense of support when their direct customers are closely involved in the development process.


We found many empirical evidence supporting the importance of management support for NPD performance. However, research on team support appears to be lacking.
with this line of argument, we suggest that individuals working interdependently in a team are likely to differ marginally in their responses to similar antecedents. This is because people tend to ‘catch’ one another’s emotions after working closely together for a period of time (Barsade, 2002; Pugh, 2001). Emotional contagion theory showed that people ‘catch’ one another's emotions by unintentionally mimicking their colleagues' emotional expressions (Hatfield, Cacioppo, & Rapson, 1992). Such a transfer of emotions between team members serves to narrow the differences in perception of antecedents, and may consequently lead team members to respond fairly consistently to stress (Brief & George, 1993). The usefulness of our findings at the team level also increases when we consider the task nature of a typical NPD team. Research has shown team interdependence to be a critical determinant of developing a successful product (e.g., Adler, 1995; Ancona & Caldwell, 1992; Sethi, 2000b). This implies that tasks in an NPD team tend to be considered as conjunctive tasks, where performance depends on the weakest team member (Steiner, 1972). Hence, the team member who is most susceptible to time pressure may also be a critical person for a project, making him the weakest yet most crucial link in the team. Therefore, actions that remove a disturbing antecedent or realize a coping resource for any individual, especially the perplexed team members, ultimately enhance the team's potential to succeed under intense time pressure. A second limitation in this study is the generalizability of our results to innovation teams in the East. This is because team members from the East are more collectivistic than those from the West (Earley, 1993). Teams from a collectivistic culture may perceive time pressure and cope with it differently due to their values and background. Therefore, we encourage scholars to extend this investigation to teams from a collectivistic culture.

2.4.3 Implications for Practice

This study suggests that teams tend to perceive time pressure negatively when they encounter numerous negative antecedents but few coping events at the workplace. This offers to explain why some teams strive while the rest fail to perform under intense time pressure (Eisenhardt, 1989a; 2004; Perlow, Okhuysen, & Repenning, 2002). As discussed, teams that appeared to perceived time pressure negatively tend to encounter many internally induced antecedents and relatively few coping events. In
fact, a team may not perceive time pressure to be problematic if it is mainly caused by external factors. This highlights to management that what induces time pressure matters. And management should minimize the occurrences of internal antecedents, and increase the amount of coping events, if teams are to experience time pressure as enabling.

Following the Lazarus and Folkman’s (1984) framework on individual coping strategies, we grouped our coping categories into problem-focused and emotion-focused interventions (see Table 2.4). For instance, prioritization is a problem-solving intervention that helps members who have too much work to do at any one time to focus on a specific task, whereas appraisal support is considered an emotion-focused intervention because actors may interpret time pressure as ‘worth-enduring’ if efforts are duly recognized. Since our coping categories can be classified into problem-solving and emotion-focused interventions, we suggest that management can and should intervene wisely and appropriately to help their teams cope with time pressure (Cohen & Wills, 1985).

Finally, this study also demonstrates the importance of team functioning and a supportive, committed, and confident team climate for teams to strive under time pressure. Management should consider nurturing teams to possess these characteristics to position them strategically in projects where time pressure is intense and when the stakes are high. This means retaining team membership so that teams are able to grow in coordination and collectiveness over time through working on numerous projects. Such recommendation may contradict the matrix organization design where employees are allocated to projects primarily according to skill sets. In many occasions, members of even high performance teams are seldom retained to work together in another project. Nonetheless, it may be time to rethink the matrix organization design given that it was a strategy conceived more than four decades ago (Kolodny, 1979; Mee, 1964) when market competition was not yet as intense and time pressure not as pressing as today.
As organizations continue to invest effort in shortening new product development (NPD) cycles, we studied time pressure as a central construct in the communication of NPD teams. This study examines how speeding up the development process affects communication, by focusing on the influence of time pressure on teams. We conducted a multiple-case study with 8 new product development teams (49 respondents) in Western Europe. Results showed that negative (“hindrance”) time pressure increases proactiveness, in terms of soliciting information from colleagues directly, but threaten other communication dimensions, such as scope, depth, and timeliness. Our findings also revealed that hindrance time pressure induces information providers and information seekers to experience tension in their communication exchange. The implications for theory and practice are discussed.

Time-to-market is commonly viewed as a competitive advantage, especially in fast-cycled industries (Datar, Jordan, Kekre, Rajiv, & Srinivasan, 1997) where product life cycles are often three years or less. Shortening development cycle time implies that employees have to complete more tasks in less time if they are to achieve superior outcomes. This generally causes individuals to experience an imbalance between the external demands and their time resources to fulfill these expectations. Such imbalance causes individuals to perceive time pressure (McGrath, 1976). However, new product development (NPD) literature have mainly focused on the speed-performance (e.g., profitability, quality, product success) relationship with limited consideration of time pressure in the workplace despite its importance on team success (Perlow, 1999). This study is concerned with the experience of

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time pressure in relation to a team process known to be critical to NPD success - team communication.

Communication has been described as the heart of team behavior (Shaw, 1981) and the essence of social systems (Katz & Kahn, 1966). Communication is the process where individuals mutually exchange information. It requires both information providers to offer their intellectual capital to others and information seekers to consult others for their intellectual capital (Van den Hooff & De Ridder, 2004). Communication is an important team process contributing to innovation (Ancona & Caldwell, 1992) and project performance (Keller, 2001). The increased adoption of concurrent engineering to reduce time-to-market has also inevitably augmented the importance of communication in project teams (Loch & Terwiesch, 1998). In recent years, escalating project scale and complexity have naturally underlined the need for tighter coordination and information exchanges in teams (Yassine, Joglekar, Braha, Eppinger & Whitney, 2003). Interdepartmental, supplier and customer integration are also some forms of integration in product development that similarly require effective communication (Leenders & Wierenga, 2002; Petersen, Handfield & Ragatz, 2003). All the above authors emphasized that communication in teams will only progress to play an even more vital role in the future.

Although scholars have experimentally investigated the relationship between time pressure and communication (e.g., De Dreu, 2003; Kelly & McGrath, 1985), these studies were generally centered on individuals and their cognitive processes (accelerating, omitting, and filtering; Edland & Svenson, 1993). In cases when time pressure was examined at the team level, it has been done with temporary groups performing simple tasks in controlled settings (Karau & Kelly, 1992; Kelly, Jackson, & Hutson-Comeaux, 1997; Kelly & Loving, 2004; Kruglanski & Freud, 1983; McGrath, 1991; Parks & Cowlin, 1995). However, real project teams function in complex and highly dynamic environments (Waller, 1997), which suggests that how time pressure affects temporary groups under controlled conditions may not fully replicate ongoing and real project teams (cf. Thomas & Griffin, 1983). This underscores the importance of examining the relationship at the team level in the field. Although some studies (Eisenhardt, 1989a; Perlow, Okhuysen, & Repenning, 2002; Waller, 1999) have contemplated whether communication in teams can remain effective despite shortening
development cycles, the conclusion has remained unclear (Eisenhardt, 2004). We suggest that this might be because communication is a multi-dimensional construct, and the relationship thus needs to be understood by considering the various dimensions of communication.

Therefore, the goal of this study is to examine how time pressure affects team communication in the field. Instead of examining if time pressure increases or decreases communication frequency, which past studies have generally focused on (e.g., Karau & Kelly, 1992; Kelly & Loving, 2004; Parks & Cowlin, 1995), we address how time pressure affects other facets of communication, such as formality (“formal and informal communication”), openness (“capacity and willingness to communicate”), and timeliness (“responsiveness in providing information and proactiveness in acquiring information”). This is because studies have found these communication dimensions to influence teams performing innovative tasks (e.g., Hoegl & Gemuenden, 2001; Lovelace, Shapiro, & Weingart, 2001; McDonough, Kahn, & Griffin, 1999). Moreover, some research had shown that communication frequency may not necessarily be a strong predictor of team effectiveness (Patrashkova-Volzdoska, McComb, Green, & Compton, 2003). In this study, we adopted the multiple case study approach. The richness of data collected by engaging informants who have been on the job for years, and have experienced time pressure and its effect on team communication first-hand will enable us to draw deeper insights into the research question. This line of thought is consistent with Lee's (1999) explanation that case study method can be used as theory elaboration, to use field data to draw connection to existing theory, and to acquire new insights by studying phenomena from the shop floor.

3.1 Theoretical Background

3.1.1 Perceived Time Pressure in Teams

In general, time is perceived to be either absolute (objective) or relative (subjective). We adopt the subjective view that time is uneven and relational, proposing that NPD team members experience time differently and that their perceptions of time pressure are contingent on the work environment (Amabile, Hadley, & Kramer, 2002). Among the theories that explain the relationship between time

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7 The term ‘time pressure’ in this study refers to ‘perceived time pressure’.
pressure and performance, we used the Attentional Focus Model (AFM) (Karau & Kelly, 1992) to offer insights on the relationship. This is because the model has not only espoused findings on stress and time pressure research (e.g., Callaway & Thompson, 1953, Chajut & Algom, 2003; Easterbrook, 1959; Locke & Latham, 1990) but also adopted a consistent theme - narrowing of attention, which has spanned different sources of stress (cf. Wells & Matthews, 1994), to explain the influences of time pressure.

The basic premise behind AFM is that deadlines limit the time resources of individuals, which influences the amount of information that is attended to and exchanged among the team members. Time pressure narrows team members' focus and causes features that appear most central to task completion to increase in relative salience, and features that seem less beneficial to task completion to be less important. As a result, time pressure is likely to benefit communication by inducing team members to focus their efforts on interactions that are essential. For instance, some scholars found actors to acquire and use more information for decision making (Eisenhardt, 1989a), to repeat less information (Parks & Cowlin, 1995) and to avoid exchanging seemingly trivial information (Kelly & Loving, 2004) under time pressure. However, time pressure does not always improve communication. The outcomes often depend on whether actors are able to identify the correct information cues and not close discussion prematurely (Kruglanski & Webster, 1996). Two conditions may affect team members’ abilities in identifying and focusing on the correct cues. One condition is task complexity. This is because complex tasks typically involve a large amount of information, which makes pinpointing salient cues difficult. Therefore, project outcomes can be less than desirable if team members cannot correctly identify critical information at the outset. Moreover, actors are likely to close discussion prematurely if further processing of information is laborious. This is especially so, if actors are bothered, discouraged, and frustrated by their surroundings, like environmental noise (Kruglanski & Webster, 1991) and power (Neuberg & Fiske, 1987). This brings us to the second condition - the negative nature of stress. Here, stress refers to an experience associated with nervousness, tension, and strain (cf. Cooke & Rousseau, 1984), and is evoked by a wider range of stimuli than time pressure. Recently, LePine and colleagues found empirical support for Selye’s (1982) theory that stress possesses positive and negative properties, and each has distinct and opposite
effects on performance (e.g., LePine, Podsakoff, & LePine, 2005; Podsakoff, LePine, & LePine, 2007). The authors found that people displayed behaviors associated with discouragement and frustration under negative stress. Here, we extend findings from stress to time pressure and expect actors to withdraw from discussion prematurely when they experience time pressure negatively.

So far, research has generally treated time pressure as a uni-dimensional construct (e.g. Amabile, Mueller, Simpson, Hadley, Kramer & Fleming, 2002; Andrews & Farris, 1972). However, this method has its limitations given the recent development on nature of stress (e.g., Boswell, Olson-Buchanan, & LePine, 2004; LePine, LePine, & Jackson, 2004; Little, Simmons, & Nelson, 2007; Podsakoff, LePine, & LePine, 2007). In this study, we suggest that time pressure should not be treated uni-dimensionally, or else our investigation outcomes on how time pressure influences communication formality, openness, and timeliness may lack strength (e.g., Beehr, 1985). Here, we suggest individuals to experience some time-related stressors as positive and the rest as negative, and paid particular attention to whether a described event was triggered by challenge or hindrance time pressure. Following LePine, LePine, and Jackson's (2004) study, time pressure that makes a person feel good, joyful, satisfied, and stimulated is considered as positive, and we term the stress as challenge time pressure. Time pressure that annoys, bothers, and discourages is considered as negative, and we term the stress as hindrance time pressure.

Numerous studies have provided evidence that individuals experience a stressful situation varyingly due to individual differences (e.g., Lazarus & Folkman, 1984; Waller, Conte, Gibson, & Carpenter, 2001). Although the theory is well established, it has rarely examined the situational factors that may induce team members to experience time pressure collectively. In this study, we suggest that time pressure can be experienced collectively due to two factors. First is the natural job selection process that induces a team to constitute members of somewhat similar personalities. This is based on Schneider's attraction-selection-attrition cycle, which highlights that organizations overtime attract and retain employees of similar personalities (Schneider, Goldstein, & Smith, 1995). Schneider explained that people who do not fit an organization or its work philosophy eventually leave. This implies that employees who choose to stay are not only similar to one another, but constitute a more homogeneous group than those who were initially attracted to the work setting. Applying this to NPD
contexts, we expect organizations operating in short cycled industries to attract and retain certain kinds of employees given its innovative and demanding work environments. The narrowed variance in individual differences within a project team may thus cause team members to experience time pressure collectively. Nonetheless, this line of argument would not be valid for organizations that consciously staff people of different personalities to maintain heterogeneity in their teams (e.g., Bantel & Jackson, 1989; Hambrick, Cho, & Chen, 1996). Second is the emotional contagion process, which suggests that individuals working in a team requiring high interdependency are likely to 'catch on' to one another's expressed emotion (Barsade, 2002; Hatfield, Cacioppo, and Rapson, 1992; Neumann and Strack, 2000). So far, the theory on stress has fundamentally assumed individuals to be metaphorically non-inductors (cf. Sy, Coté, & Saavedra, 2005) meaning that although persons are subjectively susceptible to stressful conditions, they are nonetheless detached to how their colleagues respond to and manifest the felt stress. However, numerous studies have shown this to be untrue (e.g., Barsade, 2002). For instance, Pugh (2001) showed that even brief contact between bank receptionists and customers led to significant transfer of emotions. All the more, we suggest emotional transfer to be prominent in NPD work context and lead team members to experience time pressure in a collective manner given that they are generally required to work interdependently and be in contact frequently to achieve their project goals (Ancona & Caldwell, 1992). These lines of thoughts are consistent with Brief and George's (1995) proposition that individuals working in the same work contexts are likely to respond to stressors in a fairly consistent manner.

3.1.2 Communication in New Product Development Teams

In this study, we investigated how team members communicate both as information providers and information seekers under the influence of time pressure. In order to understand how time pressure affects team communication, we followed Hoegl and Gemuenden's (2001) work, and attributed effective communication to structured, spontaneous, open, and direct information exchanges. In this study, instead of examining communication directness per se, which is related to the physical and hierarchical distance between team members (Hoegl & Gemuenden, 2001), we looked at directness in terms of communication timeliness between actors. In this section, we highlight the various facets of
communication that were discussed in the literature. These serve as a guiding framework as we proceed to investigate how time pressure influences communication in NPD teams.

**Communication Formality:** A team’s communication channel essentially consists of formal and informal elements and is not reducible to either form (March & Simon, 1958). Communication varies widely, ranging from formal means of highly structured meetings and written communication, to informal means such as spontaneous conversations and unplanned meetings (Smith, Smith, Sims Jr., Henry, O’Bannon, & Scully, 1994). Formal communication is important in clearly defining official sources, helping to create a structure in NPD teams so that individuals know where to gather and deliver information. Nevertheless, heavy reliance on structure to share information may stifle spontaneous and timely communication. Shaw (1981:150) suggested, "if a team is to function effectively, its members must be able to communicate easily and efficiently". Hence a good mix of formal and informal communication is necessary for effective communication. To study communication formality, we focused on how information was exchanged, in formal meetings or in structured documents, or informally, in spontaneous conversations.

**Communication Openness:** Openness has been described as one of the essential characteristics of an effective organization (e.g., Haney, 1967). Redding (1972) argued that openness includes both message sending and message receiving behaviors. In this study, openness refers to an individual’s degree of readiness to exchange information. Openness enables members to raise questions, give suggestions, or highlight impending problems without fear of being ostracized. Numerous studies have found the freedom to express opinions crucial to team effectiveness (Edmondson, 2003; Gladstein, 1984; Lovelace, Shapiro, & Weingart, 2001; Stewart & Barrick, 2000). A lack of openness within a team hinders the integration of knowledge and sharing of experiences, which are the fundamental reasons for having multi-disciplinary teams. To study communication openness, we focused on whether team members were willing to exchange information with one another and if they are not able to do so, in what ways information was not exchanged.

**Communication Timeliness:** Although this facet of communication is not as widely studied as the formality and openness of communication, it has been identified as an increasingly crucial component of information exchange for new product success (McDonough, Kahn, & Griffin, 1999).
The escalating project complexity, scale, and use of concurrent engineering inevitably require team members to tango in many aspects of teamwork, especially information exchange. Studies have, to some extent, associated communication timeliness with physical distance between team members. For instance, research has suggested that team members are more likely to be timely in exchanging information when located in closer proximity (Allen, 1977; Hoegl & Proserpio, 2004; Sosa, Eppinger, Pich, McKendrick, & Stout, 2002). To study communication timeliness, we focus on the behaviors of information receivers / seekers (communication proactiveness) by looking at the extent to which they proactively acquire information, and of information providers (communication responsiveness) by looking at the extent to which they promptly provide information to a team member who needs it to continue with their work.

3.2 Methods

The aim of this study is to examine how time pressure affects team communication, in particular how time pressure affects various dimensions of communication, such as formality, openness, and timeliness.

The empirical evidence for the study was gathered through multiple case study design for several reasons. Earlier studies that examined the relationship between time pressure and communication have mainly focused on individuals as the unit of analysis. There are few studies at the team level. The case study design is the most appropriate not only because there is a lack of research in this area at the team level, but also because such design produces insight into the complex social setting in which these teams operate. Team dynamics events are not easily revealed through quantitative methods (e.g. surveys) and are best analyzed through the use of inductive techniques (Lee, 1999). Second, the inconclusiveness of the literature that investigates communication in short-cycle development industries (Eisenhardt, 2004) also calls for a case study design as it facilitates collection of rich data that helps explain prior inconsistencies; eventually this is helpful in developing theories that are accurate, interesting, and testable (Eisenhardt & Graebner, 2007). Importantly, the multiple case study design was chosen because it enables a replication logic in which cases are treated
as distinct experiments that stand on their own as analytic units, each serving to confirm or disconfirm
inferences drawn from the other cases (Eisenhardt, 1989b). As part of the effort to gather rich data
from the field, this study also uses an embedded design (e.g. multiple level of analysis within a case)
that includes informants from various hierarchies of a project team: manager, leaders, and developers.
The multiple case and embedded design presents a strong methodological combination that induces a
richer model than those of single-case studies (Yin, 1994).

3.2.1 Case Selection

Data were collected from eight new product development teams in Western Europe: in Belgium,
Germany, and The Netherlands. The unit of analysis is an NPD team. We contacted vice presidents
and project managers of high-tech and multinational companies about this study. Cases were selected
based on the characteristics of the NPD teams, and the industries for which these teams were
developing the products. Participating teams developed new products that were innovative either to
the organization or market of the short-cycled industries. The teams had a strong emphasis on speed,
quality, and cost. These characteristics made intense time pressure a common experience in these
teams, and thus made them suitable for this study. Since physical distance may hinder communication
timeliness, we controlled for such interferences by recruiting teams that were located in the same site
(colocated teams). Table 2.1 summarizes the profile of the cases. Three (Microfine, Semicaps,
Accelov) of our initial four teams were in semiconductor industries. Subsequently, we extended our
investigation to other fast-paced industries, like consumer and medical industries, which fit our
selection criteria to examine if our findings can be replicated in other industries and also to control for
environmental variation (e.g., Pettigrew, 1988). This step permitted us to develop a more elaborated
theory (Eisenhardt, 1989b). In this study, we did not purposefully seek out polar types (low time
pressure) cases because our primary interest is on teams that experienced intense pressure as this is an
increasingly common phenomenon in NPD teams and of great deal of interest to managers. Therefore
we selected teams which experienced intense pressure, as we are interested in understanding how
intense time pressure may affect communication, rather than whether the variation in time pressure
has a differential effect on the team process. Furthermore, Instead of deducing the link between time
pressure and communication in a test, we focused on the team members’ accounts of the link between time pressure and communication. We aimed to establish inductively how the link between time pressure and communication may have differential effects. That is, time pressure may be experienced differently under particular circumstances and may therefore have different effects depending on these experiences. This inductive approach also allowed us to consider that time pressure may affect particular dimensions of communication in ways not yet identified in current theory.

In this study, we solicited participating teams where their projects were either in progress or had ended not more than twelve months from the time of interview. This is because combining retrospective and real-time cases is effective in mitigating bias of interview data (Leonard-Barton, 1990). Retrospective cases rely on interviews that build up the number and depth of cases efficiently, and so cover more informants and include more cases. In contrast, real-time cases employ longitudinal data collection of interviews, which help to mitigate retrospective sensemaking and impression management.

3.2.2 Data Collection

In total, 56 interviews were conducted. Preliminary interviews were conducted with seven NPD team members in the Netherlands to refine the interview questions. Subsequently, the first author interviewed 49 informants from the eight cases, consisting of 10 managers, 17 leaders, and 22 developers, at their places of business, one at a time. We collected data from informants from several hierarchies in a project to gain insight on the topic from multiple perspectives. This approach allowed us to formulate a stronger understanding on how time pressure affects communication in a team (Eisenhardt & Graebner, 2007). Although interviews with project managers alone may be sufficient, such approach might lead to bias as their views tend to represent only a fraction of what happened at a project. This is especially the case for project managers in large-scale projects, where they are at least two hierarchies away from their developers.

All interviews were semi-structured (Wengraf, 2001), and used the Critical Incident Technique (CIT) (Flanagan, 1954), which consists of a set of specifically defined procedures for collecting observations of human behavior. CIT was used to help informants recall critical events
related to time pressure. Flanagan (1954) defined a critical event as "an observable human activity that is sufficiently complete in itself to permit inferences and predictions to be made about the persons performing the act" (pg. 327). In this study, a cited event was considered a critical event if it (1) is triggered by time pressure, (2) is related to team communication, (3) is based on the specified project, (4) is a discrete episode, and (5) has sufficient detail to be visualized by the interviewer. The critical events provided rich details because the informants were asked about specific events rather than generalities, interpretation, or conclusions. All interviews took 1 – 1.5 hours each, and were conducted in English.

*Project Manager Interviews:* An entry interview was conducted with the project manager of each team. The interview began by asking the project manager to describe the team structure, project schedule, market competition, and product characteristics. Each project manager was also asked to explain how the project schedule was determined and if milestones had shifted since project launch. Next, the first author asked general questions to better understand the nature of time pressure experienced in the project. For instance, he asked, 'Do you experience time pressure in this project?', 'What causes time pressure in this project?', and 'What helps you cope with time pressure?'. After gaining a general background on each project, he proceeded to ask the project manager to identify and elaborate on occasions when team communication was clearly affected by time pressure. The line of enquiry was as follows: (1) 'Does time pressure affect the way the team communicates?', and 'How?', (2) 'Can you recall of an occasion when that (what you have described) happened?' (3) 'How did the occasion affect the project team (or you and your work)'. At times when the first author was unsure if time pressure was the only cause of the event, he would followed up with (4) 'Were there other factors that led to the occasion?'. The interviews would end by asking the project manager to contribute freely to the topic. Subsequently, for large projects, typically projects with more than eight members, we invited mainly members who were thought to have experienced a considerable amount of time pressure for follow-up interviews. Such selection was based on three reasons. First, our experiences from the preliminary interviews suggested that critical events could be best collected from informants who worked in a project, experiencing a considerable amount of time pressure. Second, informants following such criteria fit the description of Eisenhardt and Graebner (2007) as
'highly knowledgeable informants'. According to the authors, soliciting interview data from such persons reduces bias. Finally, we could only interview limited informants within each case. Therefore, we expect informants who have experienced a considerable amount of time pressure to be more adequate in providing rich and numerous events than the rest of their colleagues.

*Project leader and developer interviews:* Interviews with the managers, leaders, and developers were the same, except that we spent more time with the managers due to additional questions pertaining to issues related to the project background (technology, market, team, schedule). Interviews with leaders and developers began with general questions on their age, work experience, and project responsibilities. Next, the first author followed the same line of enquiry as used for the project manager interviews to ask project leaders and developers to provide us with critical events surrounding time pressure and team communication in their projects. The preliminary interviews gave hints that informants working in time pressure environments have difficulties recalling specific situations surrounding their work, as people channel their cognitive resources to their tasks and rarely have moments to take a step back to evaluate the situations. This posed difficulties to data collection. Nonetheless, we were able to collect a reasonable amount of events through getting in touch with participants in advance and providing them the main interview questions so that they could prepare for the interview session. Although providing the main questions before the interviews may increase the chance of impression management or post-event justification, interviewing multiple informants within a case helps to reduce the likelihood, as they were unlikely to deviate from facts to present a different picture from reality knowing that events from all informants of a project would be content analyzed as a whole. For instance, the first author encountered an interview where an informant's (Accelov) account of time pressure was very different from that of his colleagues. After probing further and conducting more interviews, we verified that the discrepancies were fundamentally due to team characteristics rather than impression management. In all, we did not find sufficient clues to suspect that informants engage in image-management or post-event justification because main interview questions were provided before the interviews. In conclusion, the combination of multiple informants and tandem interviewing addressed some previous criticisms of research relying on informants’ recollections (Schwenk, 1985).
Secondary sources and other data: Two project managers (Semicaps, Phoenix I) gave formal presentations on the project milestones. The rest provided the information informally. Informal interaction with some of the informants during free time provided us with more ideas into the teams’ dynamics and how time pressure was affecting the organizations. Conducting the interviews onsite gave the first author insight into the work environment, and where the team members were located. Specifically, we recorded whether team members were located in one or multiple rooms, and the time needed to walk from one room to another if team members sit in different rooms.

3.2.3 Data Analysis

Interviews were fully transcribed and analyzed. The scripts were read once before extracting the time pressure events. Explanations and follow-up conversations surrounding an event were examined before it was accepted. This was to ascertain that an event was due to time pressure and not caused by other factors.

The first author started out data analysis with within-case analysis by examining how critical events were related to one another in each case (Eisenhardt, 1989b). He content analyzed the events by identifying key words and phrases in every critical event, which enabled him to group events that present similar meanings under initial categories, based on procedures suggested by Wengraf (2001). The process involved using existing theory on team communication (formality, openness, timeliness) and data gathered from the interviews. In general, we found informants from a team to provide events that followed a common thread or circumstances. This ascertained that there was a good agreement among informants on the critical issues in each case. Nonetheless, the first author also identified some standalone events. For example, an informant of Microfine cited time pressure to improve communication, ‘we communicate more when we have time pressure because we need to do things right away (Microfine, D1)’. This event was contrary to events provided by the rest of his colleagues. Such events were, nonetheless, retained to potentially help us gain a comprehensive picture of each case. Importantly, the multiple informants approach allowed us to strengthen our results, reinforce our understanding of each case, and compare informants’ data to look for agreements and discrepancies. The procedure was repeated for all the eight cases.
Next, the first author conducted the cross-case analysis where he looked for the emergence of similar patterns across multiple cases (Eisenhardt, 1989b). To facilitate this process, he used tables and cell designs to compare several categories at once (Miles & Huberman, 1994). From the emerging patterns, he refined the initial categories developed by within-case analysis. The cross-case analysis was particularly useful in understanding the standalone events in each case. Importantly, the first author found recurring patterns of the standalone events in some of the cases, which helped us to understand the conditions under which some informants cited time pressure to enhance team communication. (Please refer to page 22 & 23 (communication proactiveness) for examples of standalone incidents). Eventually, the categories were further refined through frequently revisiting the data to systematically compare and verify the occurrence of specific themes within each case. The analytical process led us to introduce some terms to facilitate understanding of the effects of time pressure on team communication. We defined the Scope of Communication as the extent to which an individual engages in discussion that facilitates task interfacing and integration, and Depth of Communication as the extent to which an individual engages in iterative and thorough discussions before arriving at some decisions. Both terms were related to communication openness. Through content analysis, we also found that information seekers, instead of being passive information receivers, became proactive in soliciting information from other colleagues (readily available sources) to expedite task completion. Interestingly, information seekers, however, appeared to be sluggish if they were required to scan or search generally for new information. This was especially so if the information was not used to speed up task delivery. Therefore, we defined Soliciting as the extent to which a team member searches for specific information from available sources, and Scanning as the extent to which a team member searches for general information from other sources.

Subsequently, the first author tested the developed categories by classifying events collected from the preliminary interviews to the categories. All 14 events clearly fell in one of the categories (see Table 3.1). Next, the second author, who had not been involved in category development, was provided with a description of what the categories entailed and grouped all the 153 events according to the developed categories. Events that were interpreted differently were discussed to reach an agreement. In cases where agreement could not be reached, the differences were noted. After the
discussion, we calculated Cohen Kappa to compute the inter-rater reliability between the two authors.

We used this index because it is chance adjusted, and thus provides a reliable measure. Since Cohen Kappa before and after discussion was 0.67 and 0.83, respectively, the developed categories were considered satisfactory. Table 3.1 presents the frequency counts of the events.

<table>
<thead>
<tr>
<th>Communication Dimensions</th>
<th>Preliminary</th>
<th>Cases</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Accelov</td>
<td>Microfine</td>
</tr>
<tr>
<td>Formal</td>
<td>0</td>
<td>14</td>
<td>1</td>
</tr>
<tr>
<td>Informal</td>
<td>6</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Scope</td>
<td>3</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Depth</td>
<td>4</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Timeliness</td>
<td>0</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Soliciting</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Scanning</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

Cohen Kappa: 0.83, Percentage of Negative events: 92.4%

Finally, we used two criteria to evaluate if cited events were triggered by challenge or hindrance time pressure. First we tried to fathom the general perception of members towards time pressure in each project based on the questions 'What causes time pressure in this project?', and 'What helps you cope with time pressure?'. The answers provided us a strong overview of the team contexts and situations that surrounded the events. Second we paid attention to the words and expressions used to elaborate each event. For instance, informants are likely to use words with unfavorable connotation, such as difficult, busy, isolates, suffers, to illustrate adverse events. For example, 'come on, I am busy with the old project. I cannot give you any numbers (Accelov, M2)’. Hence, we attributed such events to hindrance time pressure. The rest of the events had a more positive connotation. For example, ‘we are talking directly to each other, so going to someone asking and getting an answer. The direct contact is the strong side of our development team (Accelov, D)’. Such events were related to challenge time pressure.
3.3. Results

The multiple-case inductive analysis led to a series of findings explaining how time pressure affects communication of NPD teams. Table 3.1 showed that 94.1% of the cited events were related to hindrance time pressure and that our informants generally perceived time pressure to negatively influence team communication. Therefore, here, we present findings that are related to hindrance time pressure in order to give a more accurate representation of how time pressure affects team communication. These findings suggest that hindrance time pressure is related to the content of formal meetings, reduces the spontaneity, scope, depth, and timeliness of communication on the part of information providers, and increases the soliciting of information but decreases the scanning of information on the part of the information seekers.

Formal Communication

This study found that teams undergoing hindrance time pressure tend to increase effort on progress meetings that focus more on sharing ‘coordination information’, and compromise on technical meetings in which ‘knowledge information’ is shared (Allen, 1977). Although progress meetings helped managers to track pace and keep the team updated, such meetings were usually less beneficial to the developers. Data suggested that technical meetings for small and specialized groups to discuss delicate issues were important especially in times of time pressure. An informant referred to the time in the technical meetings as dedicated periods when team members heard his problems, and gave their opinions. In addition, the content of team meetings tended to change from what used to be productive information sharing to relentless explanation for schedule delays. Sub-team leaders of Accelov and Phoenix I commented:

“… You have to show that you are not the person who causes the delay … you should work on the problem and not on the communication of the actual status (when there is time pressure)!"  (Accelov, L1)

“In the past, communication was at the technical level. Now, communication is more and more on organization (issues). I would say, asking what’s the status of the project … or how many requirements you have covered.” (Phoenix I, L2)
Documentation is the type of formal communication that is most negatively affected by hindrance
time pressure. Here, documentation is the extent to which a team records technical specifications,
diagrams, and descriptions that can be archived for future reference. According to the AFM, time
pressure causes actors to attend to urgent issues, and to delay even the important but less urgent
matters. Data revealed that documentation was one of them. A sub-team leader of Accelov shared:

“Sometimes, we do not have real documentation about blocks of design because of time pressure. If you
want to re-use (the design), you have some problems getting the information… Then you have to struggle,
you have to contact the designer from the old block, and he must stop his work, and must re-read his own
codes.” (Accelov, L2)

Although skipping documentation allows team members to dive right into a new project, teammates
who need to make use of certain knowledge in the old projects will encounter problems in retrieving
the information if it has not been documented.

Informal Communication

The analysis showed that hindrance time pressure negatively affected all participating teams in their
levels of spontaneity in communication. Numerous examples highlighted that members preferred not
to be disturbed and thus displayed a heightened tendency to isolate themselves from others when time
pressure was negatively perceived. Isolation meant that people preferred to close their minds to the
surroundings and work alone. This threatens the ease at which people meet to exchange information,
as and when needed, during office hours. The project manager of the Microfine team said:

“(Designers) come over to ask me a question at my desk and I will look at them with a *You are bothering
me* kind of look … (eventually) they stopped asking me too much questions.” (Microfine, M)

A designer from Oribiotech said that he seldom spent time at the coffee corner when he was rushing
for deadlines. He returned to his desk immediately after taking coffee to complete his work.
Furthermore, people avoided informal discussions to avoid getting unanticipated tasks onto their
already overloaded agenda. The project leader of Semicaps commented:

“You communicate less when you are under time pressure because you don't want to start any discussion.
Maybe because you don't want to say the wrong things, (which gets you more assignments).” (Semicaps, L)
Although these examples suggest that time pressure deteriorates informal communication, we do not have sufficient grounds to claim that hindrance time pressure has undermined informal communication. Informal communication still takes place despite high time pressure. For instance, designers in two cases discovered information that the formal channels failed to capture, at the coffee corner.

**Scope of Communication**

The previous section illustrates that time pressure leads individuals to focus on their personal tasks. Here, we suggest that time pressure also causes individuals to neglect spending time to discuss the boundary conditions that are crucial for successful module interfacing (e.g. between the front-end and back-end sub-teams) and system integration (e.g. between the bottom-level designers and top-level integrators). In short, people withdraw from boundary communication and thus narrow the scope of communication. As a result, time pressure acts as a catalyst in inducing efficient individuals at delivering according-to-spec standalone modules, which, however, are vulnerable to malfunctions when built into the integrative product system. Many studies emphasized the importance of boundary communication, be it information sharing between sub-teams (e.g., Morelli, Eppinger, & Gulati, 1995), or functional groups (e.g. Ancona & Caldwell, 1992; Kahn, 2001). These studies emphasized the importance and also the difficulties involved for teams to communicate boundary information effectively and efficiently given the project's complexity, and the massive amount of information that needs to be exchanged for most contemporary NPD projects.

In addition to the existing challenges to boundary communication, time pressure appears to threaten this aspect of communication when we take the human factors into consideration. Time pressure reduced team members' ability and willingness to engage in discussions that did not directly help them to meet their immediate milestones. Such behavior is consistent with the AFM proposition that people tend to focus on what is urgent. Data showed that individuals omitted boundary communications so that they had more time, at that moment, to firefight and meet deadlines. Consequently, they not only delayed discovering potential problems but also unknowingly created problems that would not have existed if the boundary conditions had been considered. The project
scale, complexity, and time pressure experienced by the Accelov team produced a number of examples. A sub-team leader aptly put it:

“I think people do not want to discuss (about stuff that is outside their level) because they are focusing on their own work packages… The front-enders are not interested in the back-end discussions. In the past, front-enders were more willing to discuss with the back-enders than I see now.” (Accelov, L4)

At times, omitting boundary communication includes not providing available information, for example a design change or new decision, to members of other sub-teams. Time pressure leads people to focus on their tasks, and overlook the social cues to notice the importance of giving information to other sub-teams. A leader in Accelov recalled an instance when a front-end developer delivered a ‘completed’ task to a back-end developer. The back-end person took two days to debug the input before finding the errors. When the front-end developer was contacted, he said that he had been expecting the call two days ago. This vividly showed that the front-end person had been aware of the problem but had not taken the initiative to give the information to the back-end team! The leader had good experience working with the front-end person, and was puzzled why this occurred in this project. The Oribiotech team also had a similar experience as the Accelov team. A project leader shared:

“Time pressure affected the team (such that) everyone was solving their problems ... making solutions that could not be integrated in the total system. It was recently noticed that we were drifting apart. (For instance), I was not aware that the mechanical people needed (a) module. I heard that during the coffee break ... Information was not shared with the whole team because everyone was working very hard on their own subject.” (Oribiotech, L1)

Eventually, the Oribiotech project manager had to organize meetings to realign the team.

**Depth of Communication**

Our finding is consistent with Katz and Kahn’s (1966:232) observation that "parts of the communication that are difficult to decode are neglected for the more easily assimilated parts, even though the former may be more critical for the organization when time pressure is high". The AFM advocates that individuals narrow their attention to the salient information. Here, we add that people
may not even pay attention to seemingly important information if the perceived effort to process it is too demanding. Under the influence of hindrance time pressure, people choose to close their minds as soon as possible to work on the tasks immediately, and do not spend more time brainstorming for a better solution. A designer from Accelov said:

“You want to do something really quick and that works, and (thus) not discussed it well (with others) For example, you don’t think of all the reset situations … (and) what you would do when you have time.”

(Accelov, D)

An example from Accelov strengthened our understanding on this topic. The software project leader and his team identified a risk at a Failure Modes and Effects Analysis (FMEA) session. However, the risk was not sufficiently attended to at the early stages. The team conceived a quick alternative and proceeded with other tasks. Eventually, the risk proved to be a major one and a new solution had to be sought at the last moment. The search unfortunately caused a delay of four weeks. In actual words, the informant said:

“We identified this risk in the FMEA session… Normally (we) sit in a room and talk about the risks even if we are under time pressure. We identified them but there was no time for corrective actions… A (quick) alternative was found. It was small thinking. No one really said we have those risks, and really see what can be done or if there is really an alternative.” (Accelov, L3)

The project manager of Microfine recalled a period when he was time pressed and conversed superficially with a designer about a design implementation. He contributed:

“We briefly discussed, leaving in features that made (the design) too complicated to work. I said, ‘Just leave the features in’, but did not realize how impossible it was to (materialize) it. After I looked at the complexity of what’s coming. It’s too complex. It would never work. A simpler way is to leave out these features.” (Microfine, M)

The designer from Microfine had to redesign the circuit thrice due to the manager's mis-judgment. Data confirmed that the project manager was an expert in the field and should have identified the complexity of the design earlier, had not time pressure been interfering with his judgment, and reducing his openness to discuss the implementation deeper with the designer. Overall, the information providers were less thorough in their communication when they experienced time pressure.
Communication Timeliness

Communication Responsiveness (Information Providers): Data suggested that there were two reasons why information providers were not timely in providing information. First, information providers needed time on top of their existing workload to arrive at an acceptable answer. In that case, delays were largely due to the information provider’s lack of time resources, which refers to a person's *inability* to attend to questions in time. For instance, a designer of Semicaps explained that he was often overloaded with too many tasks causing him not to have time to effectively support his layouter. On multiple occasions, he had not been able to respond quickly to the layouter’s questions because he had not had time to work on the solutions immediately. This delayed the layouter’s task. Both of them were located in the same office. A similar experience occurred in the Microfine team. The project manager recalled that his communication suffered because of severe time pressure. He could not provide timely guidance to his designer, as he was also heavily involved in the architectural design. He added:

“I felt the load was too large on me in the sense that we were all in a small room, I could call them to ‘do this, or do that’. But I overworked myself … people doing (the bottom-level designs) have to wait for a long time (for my feedback) … and realized that is not going to work at the top level.” (Microfine, M)

In both cases, the responses to the information seekers were not timely. Second, in general, providing information is not simply sharing a perspective or making a suggestion, which takes a small amount of time. In many occasions, providing information is time consuming and requires experts to spend hours with the information seekers, for example, when helping another member set up a complicated system. Therefore, people are *less willing* to provide informational support when they are undergoing time pressure because information providers are more concerned with delivering their piece of work before supporting a peripheral task. A sub-task leader of Accelov simply put:

“People stop to support one another because they know that they will be late if they help their colleagues. … in our projects, we normally have very good relations. If someone sees that a person has a problem, he or she will ask if they need help. But in this project, everybody had such a huge amount of things to do that this (helping behavior) was reduced.” (Accelov, L2)
Analysis also suggests that members working in a project consisting of multiple sub-teams are more likely to compromise communication timeliness with members of other sub-teams than with members of the same sub-team. According to the AFM, time pressure leads individuals to attend to salient tasks. We suggest that time pressure also causes members to focus more on personal tasks and those that need to be achieved by their own sub-team. Members from Phoenix II and Phoenix I provided some evidence:

“If (my team members) come with questions, I try to answer because most questions don't take longer than quarter of an hour. (This is) especially for team members. (But), for someone outside the team, it's different. (Responding) sometimes takes longer.” (Phoenix II, D1)

“When you ask something of a person of another sub-team, you cannot rely that the work will be on time because that person has their own agenda. You are lucky if your question fits in.” (Phoenix I, L3)

**Communication Proactiveness (Information Seekers):** In this section, we use ‘soliciting’ to refer to seeking specific information from known sources, and ‘scouting’ to refer to searching general information from other sources (Ancona & Caldwell, 1992). When time pressure is high, members concentrate to accomplish their immediate tasks on time rather than scan generally for information to deliver an improved solution. This is in accordance with the AFM, where individuals focus their attention on specific (diagnostic) and not general (non-diagnostic) information when time pressure is considered high (Karau & Kelly, 1999). Therefore, under such circumstances team members are likely to adopt strategies that make them efficient task deliverers. This makes them direct and proactive information seekers. A member from Phoenix I said:

“When you are under time pressure, you go faster to somebody (to get information). When you are not under time pressure, you just take your time to find (information) yourself, and learn more about what is happening.” (Phoenix I, D2)

We suggest that this proactive behavior makes people believe that they converse more when time pressure is high and seemingly a positive effect that time pressure has on communication. Although we did not find strong agreement on proactive behavior in soliciting information directly from another team member through within-case analysis, we found similar examples from most cases when we
conducted the cross-case analysis. The recurring pattern strengthened our conclusion that time pressure increases communication proactiveness in soliciting information. Some cited events are:

“It is very annoying when I don't have time and someone is always asking me questions. You can't go on with your work. I was working on this table, one meter away (a colleague had) a problem. ... (I told him to come back later with the question). Then, it never came back. So (the question) was not that urgent, but (they talked to me) because I was in the neighborhood.” (Oribiotech, D1)

“When you are under this time pressure … you talk to this guy directly. You call him.” (Accelov, D)

“The designers are pushing to get the data. ... They really contact (their colleagues or the external person) directly to get information.” (Lapson, M)

“If there is time pressure, I will use the chat program or call. ... If it is more urgent, I ask (my colleague) directly.” (Phoenix I, D1)

“I see that a better way to get someone to do something is by going to them.” (Playton, D2)

Time pressure increased the perceived scarcity of time resources. In these situations, people spent less time to scout for information. The cases showed that when time pressure was high, people were either not keen or unable to focus on real improvement. In extreme cases, members were basically more interested in how fast they could deliver, rather than how good their deliverables were.

Co-location: Based on Table 2.1, Microfine, Phoenix I, Phoenix II, and Playton were each located in a room or a hall. Although these teams should display timelier communication than other teams due to closer proximity, this was not the case. For instance, members of Microfine though sat about 3 meters apart, failed to communicate effectively in several occasions due to hindrance time pressure. In the same vein, hindrance time pressure worsens communication between sub-teams in Phoenix I even though the sub-teams were located in the same hall. Therefore, we did not find close proximity to facilitate communication timeliness. Instead, time pressure seems to have stronger effects on communication.
3.4 Discussion

This study contributes to the literature by examining time pressure at the team-level. In general, we found team members to perceive time pressure mostly as a hindrance to communication. In addition, this study also revealed how the relationship occurred. Specifically, we found time pressure to induce teams (a) to focus more on project-related (status) information than task-related information, (b) to focus more on information sharing between members of the same sub-team than with members of other sub-teams in the same project, (c) to become more self-focused and pay less attention to social cues (even within the same sub-team), and (d) to experience a tension in information exchanges between information providers and seekers, as both parties develop different task focuses. As an extension to our findings, we also highlight how our work can be used to shed light on inconclusive results pertaining to (e) information seeking behaviors during stressful moments and (f) the relationship between proximity and team communication. Table 3.2 summarizes these findings and highlights those that are new from previous work.

### Table 3.2: The effects of time pressure on NPD teams

<table>
<thead>
<tr>
<th>Communication Formality</th>
<th>Communication Openness</th>
<th>Communication Timeliness</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Communication within a sub-team</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effects on formal meeting depends on nature of meetings:</td>
<td>Less open (scope / depth) communication.</td>
<td>Effects on communication timeliness depend on the role of the team member:</td>
</tr>
<tr>
<td>- Technical related meetings are reduced.</td>
<td>- Members are more focused on self and are less oblivious to social cues.</td>
<td>- Timeliness is improved if a member is seeking information (more proactive in asking).</td>
</tr>
<tr>
<td>- Project status related meetings are increased.</td>
<td></td>
<td>- Timeliness is worsened if a member is providing information (less responsive in providing).</td>
</tr>
<tr>
<td>Less informal (spontaneous) meetings.</td>
<td></td>
<td>(The tension in communication – dilemma between information seekers and information providers is a clear outcome of the study)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Communication between sub-teams</th>
<th>Less informal (spontaneous) meetings.</th>
<th>Less open (scope / depth) communication.</th>
<th>Timeliness in providing information to members (information seekers) from another sub-team is worsened to a larger extent than for members from within sub-team.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>The extent, however, is more severe for between sub-team than for within sub-team communication.</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Statements in *italics* imply that findings are new as compared to earlier research.
The rest of this section addresses in detail the implications of our findings and some limitations of our investigation.

3.4.1 Implications for Theory

First, this study demonstrates how time pressure influences formal meetings. Our findings revealed that meetings generally became more focused on progress and schedule updates than technical discussion when teams were under hindrance time pressure. For instance, Accelov spent more time in meetings justifying delays than sharing technical information, while Microfine stopped their bi-weekly technical meetings when they ran into difficult deadlines. Time pressure should have induced developers to focus on the essentials, like solving technical problems cooperatively (e.g., technical meetings) (Karau & Kelly, 2004) as such activity intuitively helps teams to achieve tasks and goals. However, instead of investing more energy into technical meetings, we found teams to stop those meetings whenever there is an option and channel time into individual work or progress meetings. Content analysis showed that technical meetings were usually organized by team members on an ad-hoc basis to exchange technical information and were less mandatory than progress meetings, which were planned by project managers. We suggest that project managers’ escalated emphasis on status reporting when their teams ran behind schedule had caused developers to channel limited resources to progress updates and they thus had less resources for technical meetings. (Accelov, Semicaps, Phoenix I). Furthermore, weak relationships in a team may also contribute to overlooking technical meetings. For instance, Microfine, though similar to Accelov, drifted into a stage of canceling its technical meetings, resumed those meetings after its members expressed concerns over the lack of technical discussion. Strong relationships developed from earlier projects appeared to have helped Microfine to evaluate the situation and to resume the technical meetings. Past research has mainly examined how people focus on task-related information under time pressure. We suggest that research is needed to understand how actors channel their cognitive resources between project-related and task-related cues, what are the work contexts that shape their decisions, and how their choices affect overall project success.
Second, our findings show that hindrance time pressure undermines informal communication, and limits scope and depth of communication. Overall, our results extend the literature in three ways. First, our study underscores that hindrance time pressure does not only threaten boundary communication within a team, it is also likely to deteriorate, and possibly to a larger extent, information exchange between sub-teams in a multi-team project (Accelov, Phoenix I, & Phoenix II). Project sub-teams are primarily formed to pursue goals unique to a specific area of an overall project (Sherif, 1962). Naturally, members of a sub-team are likely to feel more immediately responsible for the goals of their sub-team rather than that of the overall project. Additionally, the experience of working closely together in a sub-team may further induce such perception. Since time pressure draws people to focus on tasks closest to themselves, we expect team members to focus first on the need for information exchange within their sub-teams before attending to requests from other sub-teams during periods of hindrance time pressure. So far, research has examined the effects of time pressure on intrateam (small group) communication. Here, we suggest future work to examine the impact of time pressure on interteam communication. Second, our results suggest that hindrance time pressure could threaten team communication to an extent that its members fail to use available information for product development (MicroFine & Accelov). This finding adds to our existing knowledge on deficient information database and flow within a project to further explain why developers, at times, unaccountably overlook information during development stages (e.g., Lu, 2002; Hoopes & Postrel, 1999). Finally, our results extend the AFM by demonstrating that hindrance time pressure does not only narrow people's attention to salient task information, but also induces them to pay less attention to social cues. Cohen (1980) made a similar observation in his review of the aftereffects of stress on social behavior. Here, we suggest that hindrance time pressure may threaten teamwork, such as team coordination, given that the process hinges on exchanges of social cues between team members (Gittell 2002). These findings present opportunities for future investigation.

This study also contributes to the literature by highlighting a potential dilemma in communication processes of fast paced projects. Our results showed that hindrance time pressure induces team members to be proactive information seekers and, at the same time, defensive information providers. We observed that team members under time pressure were direct and took
initiative in approaching people whom they knew possessed specific information. Importantly, this behavior was enhanced if the information expedites the seekers’ task delivery. Unfortunately, team members who were under similar time constraints were often less able and occasionally unwilling to provide information promptly. This was especially so if information exchanges were going to be time consuming and not within the providers’ immediate sphere of responsibility. The conflict of interest between information providers and seekers creates a tension in teams' communication processes and potentially jeopardize team coordination. We expect such conflict to have less negative implications if team members experience challenge time pressure because it is likely to motivate information providers to endure cognitively demanding processing to share information that is important for overall project advancement (De Dreu & Carnevale, 2003).

Fourth, this study provides further insight into proactive information seeking behaviors of people in stressful environments, which Aspinwall and Taylor (1997) conclude to be an area that is understudied. The authors propose that stress leads people to accumulate resources to cope with a potentially stressful event. Our findings support their proposition as members solicited information directly from other colleagues to cope with deadlines. At the same time, this result differs from theories that suggest stress reduces information search (Ahituv, Igbaria, & Sella, 1998; Edland & Svenson, 1993; Janis, 1982) and is contrary to Ellis’ (2006) findings that acute stress reduces retrieval where members request information known to be within a colleague's areas of expertise (e.g., Hollingshead, 1998). Here, we suggest that our findings may have bridged a theoretical gap, and offer two explanations. One is that we separated information seeking behaviors into soliciting and scanning, in that a person's search for information depends on its perceived ease of reach and availability. Individuals are not hesitant in collecting information from sources that are readily available. This is because the retrieval process, in this case, is unambiguous and thus immediately improves the certainty of achieving deadlines (Ashford & Cummings, 1985). However, when the source for information is unclear, searching for information is likely to increase one's perceived uncertainty. Hence, we expect members in such situations to refrain from search activities. This is consistent with Janis' (1982) and Ellis' (2006) propositions and findings. Second, previous studies have treated stress as a uni-dimensional construct, without differentiating the positive and negative nature of stress. Its
impact on information seeking behaviors may hence be confusing. Here, we found hindrance time pressure to increase soliciting and reduce scanning. Unfortunately, we did not find data that explains if challenge time pressure will enhance scanning. Nonetheless, we collected few examples that suggest such time pressure to increase soliciting (see Table 3.2).

Finally, our analysis led us to question the assumption that reducing physical distance is positively related to communication (Allen, 1977). In cases when the assumption does not hold true, could hindrance time pressure have possibly influenced the relationship? Although some authors have argued that close proximity is crucial for team performance, most of them hinged on the assumption that proximity increases face-to-face communication (e.g., Porter, 1998; Rosenfeld, 1997). However, results from our study suggest that proximity does not necessarily enhance team communication under time pressure. Durrance (1998) suggested that symbolic and social factors are two barriers to interpersonal face-to-face communication. In support, Ganesan, Malter, and Rindfleisch, (2005) confirmed that relational ties improve the effects of proximity on communication. Our study demonstrated that individuals in a hindrance time pressure environment are task oriented and take little time as well as effort to cultivate strong relational ties with other team members when they become self-focused and pay little attention to social cues. Thus, the effectiveness of close proximity towards effective communication can be undermined when a team is under intense time pressure because communication depends not only on the ease of reach but largely on the willingness and ability of actors to promptly exchange information. Not only does reducing physical distance not necessarily improve communication, close proximity is likely to increase the ease of members being interrupted by other teammates. The sense of being easily interrupted has negative impacts on individual and team performance (Perlow, 1999), and is harmful especially for teams engaged in complex tasks (Speier, Vessey, & Valacich, 2003). Our findings offer an explanation for the lack of positive relationship between close proximity and NPD team performance (e.g., Sethi & Nicholson, 2001). Here, we suggest that scholars consider challenge and hindrance time pressure in their framework when investigating the benefits of close proximity on team outcomes given that time pressure has intensified many times at work since the last decade (Griffin & Hauser, 1996).
This study also has its limitations. One limitation is the possibilities of alternative explanations on our findings. Literature has shown several factors, such as project size, functional diversity, task complexity, project management skills, and information database system to influence communication in teams (e.g., Ancona & Caldwell, 1992; Keller, 2001). These factors might have interacted with time pressure to result in our observed phenomena. The case study approach, unfortunately, is limited on its own to control for these interactions. Nonetheless, we minimized the influences of these alternative explanations on our results through semi-structured and in-depth interview techniques, Critical Incident Technique, interviewing multiple informants per team, and transcribing the recorded interviews fully. Future research, while extending our work quantitatively, should consider controlling for certain prominent antecedents of team communication in the investigation. Second, individuals may perceive time pressure differently (Waller, Conte, Gibson, & Carpenter, 2001). Naturally, the question for this work is to what extent are the results applicable for teams since teams are composed of many individuals? A team is only as strong as its weakest link. We suggest that the most vulnerable member in a fast paced team is probably the one most susceptible to time pressure. Given that tasks are highly interdependent and coordination is an oft-cited important success factor in new product development (Smith & Reinertsen, 1995), having the vulnerable member disrupted by hindrance time pressure is likely to disturb the rest of the team. Here we propose that the results are applicable to teams when the weakest link is considered. Finally, this study was conducted in an NPD environment in Western Europe. Therefore, the results should be applied cautiously to other types of programs or sectors, and geographies. Nonetheless, since time is also becoming a scarce resource in the service and government sectors, we propose that our results are also applicable in those environments. Culturally, we expect extending the results to teams in the East to be questionable as they are generally collectivistic, where people subordinate their personal goals to the team goals (Triandis, Bontempo, Villareal, Asai, & Lucca, 1988). Teams from a collectivistic culture are likely to invest more effort than people in an individualistic culture, like in the West, to maintain communication under hindrance time pressure. We encourage scholars to extend this investigation to teams from a collectivistic culture. Finally, the findings of this study are largely related to hindrance time pressure. A future research would be to develop scales measuring challenge
and hindrance time pressure and quantitatively examine the effects of the two kinds of time pressure on the various communication facets that we had presented.

3.4.2 **Implications for Practice**

This study provides empirical evidences and richly explains to practitioners on *how* hindrance time pressure threatens team communication. Since product success relies delicately on information sharing within and between teams (Sosa, Eppinger, & Rowles, 2004), to know how to sustain communication in a project during stressful times is useful to practitioners. Some insights that emerged from the findings are: (a) technical meetings for small-specialized groups are essential in providing a moment for developers to share problems and knowledge. Such meetings must continue and should not be marginalized by project status meetings. Furthermore, given the importance of documentation for organizations to retain and transfer knowledge for design reuse, which is a strategy for shortening development cycle-time (Blackburn, Hoedemaker, & van Wassenhove, 1996), we urge managers to allocate sufficient time for documentation; (b) managers need to take on the roles of facilitators to direct team members to the essential information, and be conscious of possible communication breakdown across sub-team interfaces when time pressure builds up. Hoegl and Weinkauf (2005) found interteam processes of multi-team projects to be critical, especially at the early stages, in achieving overall project success, and hence suggest the need for time pressure to be manageable at the early stages of a project; (c) members tend to focus on their personal tasks when evaluation and admonition are based on the outcomes of those tasks. A system that rewards members according to individual and team accomplishments may motivate them to look beyond their personal tasks (Wageman, 1995). However, introducing team reward in an individualistic culture may not be as effective (McClurg, 2001), because members from such a culture are likely to perceive rewards that recognize individual achievements as more motivating than team rewards. Additionally, management should use superordinate goals, which refer to "goals that are urgent and compelling for all groups involved but whose attainment requires the resources and efforts of more than one group" (Sherif, 1962:19), to encourage interteam cooperation.
In conclusion, the findings vividly illustrate the complex processes between time pressure and team communication. This study also underlines that time pressure, if perceived as hindering, eventually weakens communication. Our findings caution management that further internally imposed time pressure is likely to heighten such negativity, which unfavorably works against project teams and organizations. Since challenge and hindrance stress have dual and opposite effects on outcomes that are critical to an organization's vitality such as job attitude, withdrawal behaviors, and turnover (Podsakoff, Lepine, & Lepine, 2007), a natural question that emerges is, "how do I cultivate a work environment where my teams can perceive time pressure as motivating, challenging, and worth enduring?" Certainly, the experience of intense time pressure is going to remain, or even escalate, in short-cycled industries. However, organizations that are able to wisely harness time pressure may turn it into a unique competitive advantage.
Chapter 4

A Double-Edged Sword: The Effects of Challenge and Hindrance Time Pressure on Innovation Teams

A model of two-dimensional time pressure was developed, and hypotheses were quantitatively tested in a study of 81 new product development teams from Western Europe. The results showed challenge and hindrance time pressure to respectively improve and deteriorate team performance. At the same time, we also found team coordination to partially mediate these time pressure-team performance relationships, and management support to increase challenge time pressure and to reduce hindrance time pressure. Team identification is also found to sustain team coordination, especially for teams facing hindrance time pressure. Implications with respect to theory and practice are discussed.

The need for innovation has led high-technology organizations to use project teams as the method of choice to deliver new products to market under demanding schedules (Denison, Hart, & Kahn, 1996). The advantage of adopting a team approach, however, is not always fruitful and often depends on whether team members can work effectively together (Ancona & Caldwell, 1992; Cohen & Bailey, 1997). Several studies have identified stress as a factor that potentially enhances (Amabile, Hadley, & Kramer, 2002; Hunter & Thatcher, 2007; Podsakoff, LePine, & LePine, 2007) or threatens team effectiveness (Capers & Lipton, 1993; Ellis, 2006; Keller, 2001; Perlow, Okhuysen, & Repenning, 2002). Among the different kinds of stress, time pressure has emerged as a prominent and ubiquitous stress facing innovation teams (Barczak & Wilemon, 2003). In this study, we seek to examine the effects of time pressure on innovation teams and the contexts in which these teams can be effective while functioning under time pressure.

Research on time pressure has focused primarily on the levels of time pressure to explain the relationship between time pressure and performance, where inferior performance is related to low and

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high levels of time pressure (Isenberg, 1981; Janssen, 2001). This led to a wide acceptance of the inverted-U model, which, however, appeared insufficient to satisfactorily make clear the consequences of time pressure. This is especially so for teams that have performed exceptionally well under intense time pressure (e.g., Amabile, Hadley, & Kramer, 2002; Eisenhardt, 1989a; Gittell, 2003; Lovell and Kluger, 1994). The Houston base crew of Apollo 13, though under tremendous time pressure, managed to maintain creativity and effectiveness to sustain the spacecraft after one of its two oxygen compartments had suddenly exploded (Lovell & Kluger, 1994). The outstanding performance of the base crew not only kept the astronauts alive hours before re-entry to earth atmosphere was possible, but also underscored that intense time pressure should not necessarily deteriorate team outcomes if the stress is perceived positively. The challenge-hindrance stressor framework (Cavanaugh, Boswell, Roehling, & Boudreau, 2000; LePine, Podsakoff, & LePine, 2005) proposed that the relationship between stress and team performance depends not only on the levels, but also on the nature of the stress experienced. As a result, we adopted this framework to conceptualize time pressure, and suggest its effects on teams to hinge on whether a team experiences challenge or hindrance time pressure. In this study, we defined challenge time pressure as the degree to which a team perceives time pressure as a positive stressor, which promotes goal achievement, and hindrance time pressure as the degree to which a team perceives time pressure as a negative stressor, which constrains goal achievement.

This research makes several contributions. First, this study extended the existing research on time pressure by considering the nature of the stress while examining its impact on innovation teams. LePine, Podsakoff, and LePine (2004) argued that this approach offers opportunities to reconcile contradictory results of how stress, time pressure in our case, affects performance (e.g., Baer & Oldham, 2006; Gersick, 1988; Ohly, Sonnentag, & Pluntke, 2006; Perlow, 1999). As such, we conceptualized time pressure as challenge time pressure and hindrance time pressure. Second, we extended the existing research on time pressure by examining it at the team-level of analysis. Specifically, we studied the effects of time pressure on important team outcomes, such as coordination, quality, timeliness, cost, and innovativeness. Third, we extended the literature on stress by investigating the antecedents of time pressure and moderators of the time pressure-performance
relationship. Jex (1998), and Hunter and Thatcher (2007) advocated the importance of such investigations in advancing theories related to stress. Specifically, we accomplished this by examining the effects of management support on time pressure, and the degree to which team identification influence the relationship between time pressure and team coordination. All the mentioned variables are depicted in Figure 4.1.

4.1 Background and Hypotheses

4.1.1 A Two-Dimensional Time Pressure Model

A literature review showed that the relationship between time pressure and performance has been inconsistent. For instance, Amabile, Mueller, Simpson, Hadley, Kramer and Fleming (2002) did not find a significant relationship between time pressure and creativity, while Amabile, DeJong, and Lepper (1976) found them to be negatively related. Similarly, quality, which some found to be negatively associated with time pressure (Brooks, 1975; Clark & Fujimoto, 1991), was also found to be statistically unrelated (Sethi, 2000) or to have a positive relationship with time pressure (Austin, 2001; Reiner & Ericksen, 1990). Although the positive, null, and negative relationships may be a result of the inverted-U relation between time pressure and performance, some direct empirical tests did not reveal such association (e.g., Baer & Oldham, 2006; Hunter & Thatcher, 2007; McDaniel 1990; Ohly, Sonnentag, & Pluntke, 2006; Ohly & Fritz, 2007). An explanation for the inconsistencies

FIGURE 4.1: Proposed Model
may be that there is challenge time pressure as well as hindrance time pressure, and it is the challenge time pressure that relates to superior performance.

Research has focused primarily on the levels of stress to conceptualize time pressure (e.g., Yerkes & Dodson, 1908), in that good time pressure occurs when it is optimal, or just before the downward-sloping part of the inverted-U shaped relation between time pressure and performance. The response-based approach, however, neglected the contributing effects of the nature of time pressure when considering how it affects appraisal and performance. Lazarus and Folkman (1984) suggested that people appraise stressful events as either potentially threatening or potentially promoting mastery, personal advancement, or future gains. The authors explained that, depending on the nature of stressor, they have effects on a person's initial appraisal process, which in turn determines how he or she copes with the stressors. Specifically, actors who appraise stressors as potentially benefiting will adopt an active or problem-solving style of coping (e.g., proactivity, increasing effort), whereas actors who appraise stressors as potentially threatening will adopt a passive or avoidance style of coping (e.g., withdrawal, justifying). Thus, stressors that evoke a problem-solving style of coping tend to promote development and achievement (Barsade, 2002; Elliot & Thrash, 2002; Forgas, 1998; Lyubomirsky, King, & Diener, 2005; Staw & Barsade, 1993), whereas those that induce an avoidance style of coping tend to constrain development and accomplishment (Brown, Westbrook, & Challagalla, 2005; Lazarus, 1991; Weiss & Cropanzano, 1996). Overall, this highlights the potential insights that can be gained by considering the nature of time-related stressors when examining the effects of time pressure on performance.

Although the idea of good and bad stress provides sound explanations for the relationship between stress and performance, it has not been empirically tested until recently. Cavanaugh and colleagues (2000) examined the effects of challenge and hindrance stress on performance with data from managers. The authors found challenge stressors to positively influence job satisfaction and to negatively influence job search, and found hindrance stressors to have opposite effects on the same dimensions. Subsequent empirical studies (Boswell, Olson-Buchanan, & LePine, 2004; LePine, LePine, & Jackson, 2004) and meta-analyses (LePine, Podsakoff, & LePine, 2005; Podsakoff, LePine, & LePine, 2007) further established that stressors follow a two-dimensional factor structure and have
opposite effects on outcomes like motivation, learning, withdrawal, and turnover intentions, depending on the type of stressors considered. The burgeoning body of literature on the challenge-hindrance stressor framework suggests that time pressure, being a stress that has been appraised as benefiting or threatening, follows a two-dimensional factor structure.

4.1.2 Time Pressure – A Team Construct?

Thus far, research on time pressure has mostly focused on its effects on individuals (Andrews & Farris, 1972, Amabile et al., 2002; Baer & Oldham, 2006; Cordero, Farris, & DiTomaso, 1998; Parks & Cowlin, 1995; Peters, O'Connor, Pooyan, & Quick, 1984; McDaniel, 1990; Ohly, Sonnentag, & Pluntke, 2006). In this study, we extended the investigation to the team-level of analysis and add to the few studies that had examined the topic with laboratory groups (Karau & Kelly, 1992; Kelly & Loving, 2004; McGrath & Kelly, 1985). Although stress research has largely remained a study of individuals on the premise that people do not appraise stressful events similarly as a result of individual differences, emotional contagion theory offers to explain the possibility of collective time pressure in highly interdependent teams.

Stress was first hypothesized in the 1950s to be contingent on individual differences when Lazarus and Eriksen (1952) discovered that stress did not produce consistent effects on a group of people, in that stress aroused by a certain condition was great for some but small for others. Numerous studies have supported this theory, and thus suggest that individuals working in a team do not experience stress collectively because of personality differences (e.g., Penley & Tomaka, 2002; Waller, Conte, Gibson, & Carpenter, 2001). However, the theory has fundamentally assumed that individuals are metaphorically non-inductors (cf. Sy, Coté, & Saavedra, 2005) meaning that although persons are subjectively susceptible to stressful conditions, they are nonetheless detached to how their colleagues respond to and manifest the felt stress. Stress generally increases positive or negative emotions (Bolger, DeLongis, Kessler, & Schilling, 1989). Individuals display facial, vocal, and postural cues according to their feelings. These cues serve as obvious information about their emotions. Hatfield, Cacioppo, and Rapson (1992) proposed that people ‘catch’ someone’s feeling by unintentionally mimicking his or her emotional expression. Neumann and Strack (2000) found in their
study that listening to another person's vocal emotional expression is sufficient to evoke a congruent emotional state in the listener. These findings explain the process of emotional contagion where a person or group influences the emotion of another person through conscious and unconscious induction of emotional states (Barsade, 2002; Schoenewolf, 1990). Pugh (2001) demonstrated the exchange of emotions between bank tellers and their customers even through short encounters. Therefore, all the more, we expect emotional contagion to be more significant between individuals working interdependently in a team over an extended period (Bartel & Saavedra, 2000) than between tellers and customers in a bank lobby. Since stressful demands cause people to display emotions that are consistent with the felt stress, emotional contagion is a plausible process through which team members experience time pressure in a collective manner. Hence, we expect members form the same team to experience challenge and hindrance time pressure collectively.

### 4.1.3 The Effects of Hindrance Time Pressure

As the preceding discussion indicates, we expect hindrance time pressure to have detrimental effects on team processes and team performance. Among the team processes, we focused on team coordination because studies have shown team coordination, which reflects the extent to which team members interact and work together synergistically, to be a strong determinant of team performance in complex and fast-paced work environments (Ellis, 2006; Faraj & Sproull, 2000; Gittell, 2001; 2002; Hoegl, Weinkauf, & Gemuenden, 2004). This made the inclusion of team coordination in our investigation particularly insightful for team performance. More importantly, we expect time pressure to influence team coordination by considering the effects of narrowing attention on informational and social cues under time pressure.

Group theorists who study the dynamics of coordination have described team coordination to be, at heart, a process of interactions among its members (e.g., Gittell, 2001). This suggests an intricate relation between time pressure and team coordination. The narrowing of attention, coined by Callaway and colleagues (Callaway & Dembo, 1958; Callaway & Thompson, 1953) and extended by other scholars (e.g., Chajut & Algom, 2003; Karau & Kelly, 1992; Kelly & Loving, 2004; Huguet, Galvaing, Monteil, & Dumas, 1999), suggests time pressure to progressively reduce the range of
informational cues considered in a group. Although this leads actors to focus on salient cues and not waste time on interactions that are seemingly peripheral to task completion (Gladstein & Reilly, 1985), the benefits of attention focus also depend on whether team members are able to make good judgment about the relative importance of the cues. Studies have shown that misjudgment is most likely to occur under hindrance stress (Janis, 1972; Speier, Valacich, & Vessey, 1999; Staw, Sandelands, & Dutton, 1981), when important information is not exchanged and thus not considered by other team members (Kelly & Loving, 2004). Additionally, research has also found people to close their minds prematurely to additional cues under stressful conditions (Kruglanski & Freund, 1983; Kruglanski & Webster, 1996). This occurs most when people are threatened or frustrated, and attending to more informational cues is extremely burdensome. Taken together, we expect hindrance time pressure to weaken the degree to which team members are able to coordinate their work efficiently from an interaction point of view. Additionally, narrowing of attention also suggests that time pressure could very well induce team members to overlook social cues (Cohen, 1980; Driskell, Salas, & Johnston, 1999; Ellis, 2006). This is not unexpected since team members with limited attention resources may be more attentive to task-related cues, which at face value have more direct and favorable impacts on project success than social cues. Nonetheless, social cues, such as facial expressions, silent grumbles, requests for support, feedback, and clarification of timings and priorities, are indispensable for well-coordinated teams. Gittell (2002) described team coordination as a relational activity that depends heavily on a web of relationships in teams. People display social cues extensively during the course of a project. If attended to, these cues, whether subtle or obvious, enhance shared understanding of the project and goals, and consequently, the way team members synchronize workflow processes. Since hindrance time pressure is related to annoyance and discomfort, and also draws team members to focus first on self rather than on team interests (e.g., Driskell, Salas, & Johnston, 1999; Gladstein & Reilly, 1985; Mor & Winquist, 2002), we suggest that the negative stress induces members to overlook social cues. This potentially erodes team coordination.

A literature review showed quality, timeliness, and adherence to budget to be reliable determinants of firm business performance (Clark & Fujimoto, 1991; Kessler & Chakrabarti, 1996;
Langerak & Hultink, 2005). Hence, we included these variables as performance indicators in this study. In addition, since innovation teams are largely assessed based on their ability to innovate (e.g., Keller, 1986), we added team innovativeness as the fourth performance indicator. Here, solution quality is the extent to which a team generate solutions that are new and suitable for the problems encountered. Development timeliness is the extent to which a team meets the milestones and develops the product faster than in previous projects. Adherence to budget is the extent to which a team develops the product within the given budget. Finally, team innovativeness is defined by the team's ability to introduce novel ideas and procedures to accomplish its work.

Lazarus and Folkman’s (1984) transactional theory of stress proposed that threatening situations cause team members to adopt avoidance tactics while dealing with problems. Along this line of argument, several studies have found stressful situations to worsen performance (Gladstein & Reilly, 1985; LePine, LePine, & Jackson, 2004; LePine, Podsakoff, & LePine, 2005; Podsakoff, LePine, & LePine, 2007). Taking these findings a step further, we expect hindrance time pressure to similarly have detrimental effects on project goals, like quality, timeliness, and adherence to budget, as avoidance tactics tend to reduce people’s effort towards goal achievement and team success (Earley, Wojnaroski, & Prest, 1987; Hoegl & Gemuenden, 2001; Weingart, 1992). In regards to innovativeness, Amabile (1983; 1996) explained that innovativeness hinges on four basic cognitive processes, which are problem identification and comprehension, preparation, response generation, and response validation. Each of the processes appears to deteriorate under hindrance time pressure. For instance, people prefer to close their minds to new information (Kruglanski & Webster, 1996), exchange less information (Kelly & Loving, 2004; Parks & Cownlin, 1995), and omit external advice to validate decisions (Perlow, Okhuysen, & Repenning, 2002) during stressful situations. Moreover, research has also shown time pressure to undermine innovativeness when the stress was perceived negatively, for example when it was too much (Andrews & Farris, 1972; Andrews & Smith, 1996) or imposed as a means of control (Amabile, 1993). Taken together, we propose the following hypotheses:

**Hypothesis 1 (H1):** Hindrance time pressure is negatively associated with a) team coordination, b) solution quality, c) development timeliness, d) adherence to budget, and e) team innovativeness.
4.1.4 The Effects of Challenge Time Pressure

In contrast to hindrance time pressure, challenge time pressure is associated with fulfillment and a strong proclivity to succeed. These experiences serve as a motivating force (Selye, 1982). Some forms of time pressure tend to benefit teams as they induce actors to focus on salient cues. The focusing process is generally associated with positive outcomes (Chajut & Algom, 2003). A disadvantage of narrowing attention is that team members may rush to close their mind to additional cues (Kruglanski & Webster, 1996) or to neglect peripheral cues that are actually important. In sum, narrowing of focus attention occurs in both hindrance and challenge time pressure situations. The point of departure is, however, that when a situation is viewed as a hindrance, the narrowed attention increases the chance of misjudgment and self-interest, but leads to understanding information and paying attention to others when the situation is viewed as a challenge. To date, the theory on narrowing attention has seldom addressed the challenge aspect of time pressure. We suggest that although time pressure narrows attention, it does not always cause people to close their minds prematurely or to omit seemingly peripheral cues when the stress becomes intense. The outcome often depends on whether the felt time pressure is motivating or not. Kruglanski (1996) explained, "even though motivation and cognition may be usefully treated as separate systems, they are inextricably intertwined in that nearly all cognition encompasses motivational aspects" (pg. 493). Thus, a person with constrained attention resources may still engage vigorously in related cognitive activities if he or she is stimulated to persist in the course of action (De Dreu & Carnevale, 2003; Mayseless & Kruglanski, 1987; Peter & Warlop, 1999; Van Kleef, De Dreu, & Manstead, 2004). For example, Pieters and Warlop (1999) conducted a field study to investigate the effect of motivation on the extent to which shoppers under time pressure gathered information for purchasing decisions. The authors found the motivated group to exert more effort in acquiring brand information. This suggests that challenge time pressure is likely to prevent team members from simply omitting peripheral cues, leading them to remain attentive to secondary informational cues and social cues. This facilitates team coordination. The case of the Houston base crew working under time pressure to develop quick yet reliable solutions to sustain the Apollo 13 was another example of the positive effects of time pressure on team coordination (Lovell & Kluger,
1994). The base crew had no time to rework solutions and that required everyone to work together and exchange information in a coordinated fashion. Such awareness of interdependencies calls team members to realize that superordinate goals can only be reached if everybody works in a synchronized fashion (e.g., Rusbult & Van Lange, 1996).

Based on studies on positive stress (Podsakoff, LePine, & LePine, 2007; Selye, 1982; Simmons & Nelson, 2001) and our earlier discussions, we expect challenge time pressure to positively affect team performance because it motivates members to invest effort and to adopt problem-solving approaches (Lazarus & Folkman, 1984) to achieve quality and timeliness, and to stay within budget. The goal setting theory also suggests a positive relationship between challenge time pressure and team performance. The theory reveals that difficult goals heighten team performance (e.g., O’Leary-Kelly, Martocchio, & Frink, 1994) because such goals motivate team members to discover, devise, and use tactics that facilitate task accomplishment (e.g., Locke & Latham, 1990; Durham et al., 2000). Since challenge time pressure is associated with difficult yet achievable goals, such time pressure potentially prompts teams to utilize more efficient tactics to attain key project goals (e.g., Clark & Fujimoto, 1991; Keller, 1986). For instance, some studies have demonstrated positive relationships between perception of challenge and performance measures, like quality (Reiner & Ericksen, 1990) and innovativeness (Andrew & Farris, 1972; Amabile, 1988; Amabile et al., 1996). These led us to propose the following hypotheses:

**Hypothesis 2 (H2):** Challenge time pressure is positively associated with a) team coordination, b) solution quality, c) development timeliness, d) adherence to budget, and e) team innovativeness.

### 4.1.5 The Mediating Effects of Team Coordination

On the basis of the first two hypotheses, we expect that challenge and hindrance time pressure will positively and negatively affect team coordination and team performance, respectively. Given that team coordination has also been linked to team performance (e.g., Hoegl & Gemuend, 2001), we suggest that challenge and hindrance time pressure will also influence team performance through team coordination. This formulation is consistent with the idea that innovation teams are frequently surrounded by complex and ambiguous situations (Pich, Loch, & Meyer, 2002), and teams that are
able to maintain interactions and to synchronize their tasks in such environments are more likely to achieve quality, timeliness, and to stay within budget than poorly coordinated teams (Ancona & Caldwell, 1992; Gittell, 2001; 2002; Hoegl, Weinkauf, & Gemuenden, 2004). For instance, a team is better positioned to achieve quality when its members are not only aware of their own task requirements, but also how their work fit into the relevant project segments. Undoubtedly, such awareness takes place when team coordination is strong (e.g., Gittell, 2002). At the same time, we also suggest that team coordination will mediate the relationship between time pressure and innovativeness because response validation, which involves interactions and working together to understand difficult problems, is a critical team process that Amabile (1983; 1996) described to affect innovativeness. Therefore, we propose the following hypotheses:

**Hypothesis 3 (H3):** Team coordination mediates the effect of challenge time pressure on a) solution quality, b) development timeliness, c) adherence to budget, and d) team innovativeness.

**Hypothesis 4 (H4):** Team coordination mediates the effect of hindrance time pressure on a) solution quality, b) development timeliness, c) adherence to budget, and d) team innovativeness.

### 4.1.6 Management Support as an Antecedent to Time Pressure

Support has been frequently shown to play an antidotal role in stressful workplaces (e.g., Baer & Oldham, 2006; Van Yperen & Hagedoorn, 2003). Here, we explore how support may affect the way teams experience time pressure by considering the challenge-hindrance stressor framework. In this study, we focused essentially on support originating from supervisors and managers because, unlike support that stems from within a team, it is conceptually independent of how the team members perceive time pressure. Moreover, many studies have also shown management support to influence the performance of innovation teams (Cooper & Kleinschmidt, 1987; Elkins & Keller, 2003; Rhoades, Eisenberger, & Armeli, 2001). Here, management support refers to top-down interventions that are task-oriented and social in nature (Chong, Van Eerde, Rutte, Chai, & Brombacher, 2005; Pinto, Pinto, & Prescott, 1993; Swink, 2000). We propose that whether a team perceives time pressure as challenging or hindering depends on the extent to which its members attribute time pressure to conditions that are controllable by the management, as opposed to conditions that are inherent in the
job or resulting from market forces (Amabile et al., 2004). The Hubble Space Telescope disaster in 1990 was an example of management not dealing with the controllable factors, which led to extreme time pressure. Capers and Lipton (1993) wrote that Perkin-Elmer's schedule to develop the world's most complex telescope mirror at that time was highly unrealistic. Perkin-Elmer won the project from NASA because it offered the lowest bid. However, the management did not have the resources to pull the project together within the promised schedule, which put all its scientists under intense time pressure. Worst of all, the pressure was clearly due to Perkin-Elmer's bidding error, which made the management unable to actively support the project teams in delivering the telescope mirror. Such lack of management support is often associated with annoyance and discouragement (e.g., Amabile et al., 2004). Conversely, teams that are supported by their management were challenged, even in high strain conditions (Van Yperen & Hagedoorn, 2003). Terry (1994) suggested that management support acts as a situational coping resource that not only alleviates team members' workload but also helps them interpret time pressure positively. Therefore, we propose the following hypotheses:

**Hypothesis 5 (H5):** Management support is a) negatively associated with hindrance time pressure, and b) positively associated with challenge time pressure.

### 4.1.7 The Moderating Effects of Team Identification

Driskell, Salas, and Johnston (1999) introduced the term team perspective, where members place team considerations above personal concerns, to highlight the importance of collective orientation for teams functioning in stressful environments (Driskell & Salas, 1992). Here, we investigate how team identification, which refers to the emotional attachment to and involvement in a team, affects teams under time pressure. Conceptually, we followed Van der Vegt and Bunderson's (2005) work, in that team identification here focused on individuals' emotional relationships with a team rather than the richness of interpersonal relationships between its members.

We suggest innovation teams with high team identification are less vulnerable to hindrance time pressure. As mentioned, hindrance time pressure potentially causes people to become self-focused and less attentive to social cues, which is likely to weaken team coordination. However, we suggest that this situation may not be as detrimental for teams with high team identification. This is
because such teams are committed towards team success (Bergami & Bagozzi, 2000) as well as the well being of their colleagues, which cause the teams to remain attentive to social cues despite hindrance time pressure. This often motivates team members to interact openly, avoid withdrawal behaviors, and support one another (van Dick, Wagner, Stellmacher, & Christ, 2004), even in arduous circumstances. Taken together, we propose:

**Hypothesis 6a (H6a):** Team identification moderates the relationship between hindrance time pressure and team coordination such that the relationship will be less negative for teams experiencing higher rather than lower levels of team identification.

At the same time, we suggest challenge time pressure to improve the coordination of teams as the sense of urgency and inspiring deadlines are likely to induce team members to function more closely together. Here, we expect the advantages of challenge time pressure to be more evident in teams with high team identification than those with low team identification. This is because the former teams are more capable of capitalizing on strong relational network to strengthen the degree of coordination when time pressure is perceived as a challenge. Therefore, we propose the following:

**Hypothesis 6b (H6b):** Team Identification moderates the relationship between challenge time pressure and team coordination such that the relationship will be more positive for teams experiencing higher rather than lower levels of team identification.

### 4.2 Methods

#### 4.2.1 Samples and Data Sources

This study tested the hypotheses with New Product Development (NPD) teams that engage in consumer, electronics, semiconductors, and medical industries from Western Europe: in Belgium, England, France, Germany, and the Netherlands. These industries have a short development cycle time (often less than three years; Datar, Jordan, Kekre, Rajiv, & Srinivasan, 1997) as well as a large emphasis on speed, quality, and cost, making their teams suitable for our sample.

The unit of analysis is an NPD team. A participating team could represent a single-team project, or a sub-team of a multi-team project. The latter sampling approach has rarely been used in
previous studies (e.g., Hoegl, Weinkauf, & Gemuenden, 2004). However, sub-team samples of multi-team projects are interesting and relevant to this study as the impacts of time pressure on innovative team performance are largely determined by how members at the lower hierarchies of product development perceive time pressure. Here, we took an informant sampling approach (Van de Ven & Ferry, 1980) to reduce the time demands from participants and to improve the chance of team participation. An informant sampling approach recognizes that many members of a particular team are qualified to provide assessments of global properties that they experience together and thus "relies on a limited selective sample of people who are the most knowledgeable of the global properties of interest" (Van de Ven & Ferry, 1980: 72) rather than solicit input from all the team members. In addition, we included a stakeholder survey to evaluate the performance of each team. A stakeholder is a second-level project manager or its equivalent of a participating team. The person although is not directly involved in the team’s operation, is knowledgeable about the team and its work and is responsible for the outcomes of the team. In all, we collected data from four or more team members (including the team leader or first-level project manager) and at least one stakeholder from each team. Only on-going projects and those that had been completed recently (not more than twelve months) were recruited to minimize the retrospective bias effects (Ross, 1989).

The survey was conducted electronically in two parts. The names of the team and its team leader were clearly printed on the introduction email and part one of the survey to ensure that informants referred to the correct team and project. Part two was sent to informants one day after they had submitted the completed answers to part one. In part one, management support, challenge time pressure, hindrance time pressure, and team identification were measured. In part two, team coordination and team performance (solution quality, development timeliness, adherence to budget, and team innovativeness) were measured. There were two reasons for a two-part survey design. The first reason was to keep the survey length at each attempt short to duration of approximately 20 minutes in order to facilitate quality response. Second, we introduced a time lag between the sources' input to predictor and criterion (mediator/ performance) variables to separate the measurement of the predictor and criterion variables because most of the variables were measured using the same informants. Such temporal separation leads informants to leave short-term memory and thus helps to
reduce response biases (cf. Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). In addition, informants were assured that their input would be used only for research purposes and be kept with full confidentiality. We also stated explicitly that there would be no right and wrong answers to the questions and that informants should answer all questions honestly. These procedures aim to reduce response apprehension (Podsakoff et al., 2003).

Our final sample consisted of 81 teams of which 74 were still active in the design (19 percent), testing (41 percent), and initial production (31 percent) stages when the survey took place. In total, 500 informants participated in this study, of which 436 were team members and 64 were stakeholders. The response rate was 95 percent in part one, and 99 percent of those who participated in part one also participated in part two. The average interval between the two parts was 16.5 days (s.d. = 13.5). The teams ranged in size from 4 to 18 core members (x = 7.2, s.d. = 3.8); 94 percent of the informants were male; the average age was 38 years (s.d. = 7.6); the average time with the current team was 2.5 years (s.d. = 2.2); 94 percent were from Northern or Western Europe, 3.2 percent from Eastern Europe, 1.4 percent from Southern Europe, 1.4 percent from America or Asia. The informants had worked in NPD related industries for an average of 10.5 years (s.d. = 7.3). Most of them were highly educated, where 48 percent held a bachelor's degree or a diploma, 39 percent had a master's degree, and 7.4 percent had attained a Ph.D.

4.2.2 Measures

All items were assessed with a 7-point Likert scale ranging from (1) "strongly disagree" to (7) "strongly agree", unless stated otherwise. Exploratory factor analysis was conducted with all the scales separately, and items of each scale loaded satisfactorily on a single factor. All scales were adapted from published work, except for the challenge and hindrance time pressure, and management support measures.

4.2.2.1 Challenge and Hindrance Time Pressure Measures

Overview of measure development: The following procedures were carefully taken to develop and test the validity of the scales: (a) Content validity was assessed through 82 practitioners who had worked
or were working in new product development projects, and two independent judges from academia, 
(b) Confirmatory factor analysis using LISREL 8.5 (Joreskog and Sorbom, 1996) was used to test the 
two-factor structure of the time pressure items, (c) Cronbach Alpha was evaluated to test the internal 
consistency of the two measures, and (d) the pattern of correlation relations between the challenge and 
hindrance time pressure and external criteria were examined.

**Evidence of content validity:** The scales were developed in three phases, based on the steps 
taken by Cavanaugh, Boswell, Roehling, and Boudreau (2000), and LePine, LePine, and Jackson 
(2004), to ensure content validity of the scales. In the first phase, we obtained critical incidents on the 
causes of time pressure from a sample of 49 practitioners working in NPD industries. The participants 
were from eight NPD teams in Western Europe. In total, we gathered 167 critical incidents after 
excluding those that were not time pressure related. The incidents were categorized into nine 
categories by the first two authors. The categories provided an overview of factors that cause time 
pressure in innovative work environments. Subsequently, we used the categories, validated time 
pressure scales (e.g., Amabile et al., 1996), and stress scales (Cavanaugh et al., 2000; LePine, LePine, 
& Jackson, 2004) to generate the initial 20 items for challenge and hindrance time pressure. Since the 
scales were intended to measure team responses from the field, we invited another 33 practitioners; 15 
from Europe (46 percent), 14 from Asia/Australia (42 percent), 4 from North America (12 percent), 
who had been involved in developing innovative products for the second phase; to categorize each 
item as either a stressor leading to challenge time pressure or to hindrance time pressure, or not 
clearly falling in the two categories. The classification was conducted using electronic survey and 
based on construct definitions as previously presented. The participants provided sufficient data to 
refine the initial items to 13; five for challenge time pressure and eight for hindrance time pressure. 
These items yielded at least 60 percent agreements among participants as either challenging or 
hindering. In the third phase, we recruited two independent academic judges who were unrelated to 
the research to classify the 13 items into either the challenge or hindrance category with the same 
definitions as above. The judges were allowed to refer to the definitions during the task. The 
categorization of the judges was 88 percent (23 of 26 items) consistent with the prior categorization, 
providing evidence that the scales were satisfactory. Next, following the scale development
procedures of Cavanaugh et al. (2000), and LePine, LePine, and Jackson (2004), we asked 436 team members to evaluate the 13 time pressure items. The ratings were conducted at the individual levels and team levels on the extent to which each item leads to challenge and hindrance time pressure, respectively, with scales ranging from 1 "not at all" to 7 "a great deal". Importantly, we had asked participants to rate each item based on the degree to which it causes challenge time pressure and hindrance time pressure. Such approach provided added certainty that participants associated the items to time pressure when rating them. The final scales consisting of five and eight items measuring challenge and hindrance time pressure, respectively, are listed in the Appendix.

**Testing the two-factor structure and evidence of internal consistency:** To investigate the proposed factor structure, we conducted a confirmatory factor analysis. Here, the fit of a two-factor model was compared to that of a one-factor model. Jaccard, Turrisi, and Wan (1990) suggested that values of greater than 0.90 for the comparative fit index (CFI) and goodness-of-fit index (GFI) to indicate good model fit, while Browne and Cudeck (1993) suggested values of less than 0.08 for the root mean square error of approximation (RMSEA) to imply adequate model fit. The CFA provided good support for the two-factor model using the individual measure ($\chi^2[64] = 108.4; \text{CFI} = 0.97; \text{GFI} = 0.96; \text{RMSEA} = 0.039$) and the team measure ($\chi^2[64] = 213.9; \text{CFI} = 0.94; \text{GFI} = 0.93; \text{RMSEA} = 0.072$). A one-factor model was also tested using the individual measure ($\chi^2[65] = 676.7; \text{CFI} = 0.73; \text{GFI} = 0.81; \text{RMSEA} = 0.15$) and the team measure ($\chi^2[65] = 3305.0; \text{CFI} = 0.32; \text{GFI} = 0.47; \text{RMSEA} = 0.33$). The chi-square difference between the two-factor model and the one-factor model was significant ($\chi^2[1]_{\text{individual measure}} = 568.3, p < 0.001; \chi^2[1]_{\text{team measure}} = 3091.1, p < 0.001$). These results support the two-factor structure of time pressure proposed in this study. Cronbach's alpha for the challenge time pressure ($\alpha_{\text{individual measure}} = 0.73; \alpha_{\text{team measure}} = 0.86$) and hindrance time pressure ($\alpha_{\text{individual measure}} = 0.84; \alpha_{\text{team measure}} = 0.88$) demonstrated good internal reliabilities of the new scales.

**External criteria used to evaluate discriminant validity:** Job satisfaction was used to assess the discriminant validity of challenge and hindrance time pressure. This measure was chosen because prior studies have shown challenge and hindrance stress to relate strongly and in opposite directions with job satisfaction (Cavanaugh et al., 2000; Podsakoff, LePine, & LePine, 2007). We measured job
satisfaction with the five-item scale from Judge, Bono, and Locke (2000). An item of the scale was "I feel fairly well satisfied with my present job". ($\alpha = 0.88$). (See results section).

4.2.2.2 Other Independent Variables

Management Support (six-item) measure was developed based on reviewing NPD literature (Green, 1995; Pinto, Pinto, & Prescott, 1993; Swink, 2000) and specifically, the work of Chong, Van Eerde, Rutte, Chai, and Brombacher (2005), which is based on time pressure and NPD teams. We developed a new scale because most of the validated support scales are associated with social or team support (e.g., Beehr, Jex, Stacy, & Murray, 2000; Bishop, Scott, & Burroughs, 2000) while this study focused on management support. The scale is listed in Appendix. ($\alpha = 0.84$).

Team Identification was computed with the scale from Van der Vegt and Bunderson (2005), which asked informants to rate the extent to which members of their team were emotionally attached to the team. The scale was originally adapted from the four highest loading items of Allen and Meyer's (1990) affective commitment scale. An example of the scale was "To what extent do members of the team feel a strong sense of belonging to the team?" ($\alpha = 0.88$).

Team Coordination was determined with items developed by Lewis (2003). The five-item scale asked informants the extent to which the teams worked together in a synchronized fashion. An example of the scale was "Our team had very few misunderstandings about what to do". ($\alpha = 0.82$).

4.2.2.3 Performance Variables

Solution Quality was measured with items from Atuahene-Gima (2003). Here, we chose to assess quality by examining solution quality instead of product quality for two reasons. First, solution quality is theorized and empirically shown to be a strong predictor of product quality (Sheremata, 2000; Atuahene-Gima, 2003). Second, since most of the participating teams were still in progress at the time of the survey, it was more appropriate to evaluate the quality of the solutions generated than quality of the products. The five-item scale, including two newly developed (reverse-coded) items, asked informants to evaluate the extent to which their team members introduced high quality solutions for the problems faced. An example of the scale is "The solutions found were quality solutions for the
problems we faced”. One item was removed because its item-to-total correlation (0.30) was below the acceptable level of 0.40 (Bennett & Robinson, 2000). \( \alpha_{\text{member}} = 0.70; \alpha_{\text{stakeholder}} = 0.74 \).

*Development Timeliness* was computed using items from Atuahene-Gima (2003) and Sarin and McDermott (2003). The five-item scale asked informants the extent to which their teams had met the planned schedule. "The project achieved all major milestones as planned" was one of the items used. \( \alpha_{\text{member}} = 0.80; \alpha_{\text{stakeholder}} = 0.74 \).

*Adherence to Budget* consisted of three items adapted from Sarin and Mahajan (2001). The items asked the stakeholders the extent to which their teams operated within the given project budget. An example of the items was "The team's project is over budget". \( \text{reverse-coded} \) \( \alpha_{\text{stakeholder}} = 0.77 \).

*Team Innovativeness* was based on the scale from Lovelace, Shapiro, and Weingart (2001). The four-item scale asked informants the extent to which their teams were innovative in their work procedures and outputs. The wordings of some items were rewritten to adapt to the context of our sample. An example of the items was "The deliverables of the team members are innovative". \( \alpha_{\text{member}} = 0.76; \alpha_{\text{stakeholder}} = 0.84 \).

### 4.2.2.4 Control Variables

*Team Size* and *Team Tenure* were included as control variables because prior work had suggested them to be related to innovation team processes and team performance (e.g., Smith, Smith, Olian, Sims, O'Bannon, & Scully, 1994; Zenger & Lawrence, 1989). Team size was measured by the number of core members in each team. Team tenure was measured with team leaders' input on the number of years their members had worked together, including in previous projects.

*Task Complexity* was also included as a control because innovation teams tend to encounter technological difficulties, which pose impasses for them to achieve quality, timeliness, and adherence to budget. For this measure, we used the scale from Sarin and Mahajan (2000) where team leaders were asked to rate the five-item measure. An example of the items was "The team had to use non-routine methods to accomplish its tasks". \( \alpha = 0.82 \).
4.2.3 Aggregation Analyses

Two analyses were conducted to determine the degree to which the responses gathered through the informant sampling approach reflected a shared reality within each team. If a shared reality is evident, we expect to find ratings from different informants on the same team to be similar, and comparatively more similar to one another than ratings from informants from other teams (Bliese, 2000). We conducted the aggregation analysis with the average interrater agreement coefficient ($r_{wg}$; James, Demaree, & Wolf, 1993) and the interclass correlation coefficient (ICC; Kenny & Lavoie, 1985) because both tests were based on different statistical assumptions.

The average $r_{wg}$ values were 0.83 for management support, 0.83 for challenge time pressure, 0.85 for hindrance time pressure, 0.81 for team identification, 0.87 for team coordination, 0.87 for solution quality, 0.83 for development timeliness, and 0.90 for team innovativeness, which suggested that informant ratings within a given team were highly consistent with one another since the average $r_{wg}$ was above 0.70 (George, 1990). A one-way analysis of variance was conducted with each variable. The outcomes suggested that informant ratings all differed significantly ($p < 0.001$) between teams.

4.3 Results

Table 4.1 presents means, standard deviations, and zero-order Pearson correlations among all variables. The correlations are all below 0.8, which indicates acceptable collinearity (Kennedy, 1985). In addition, we checked the Variance Inflation Factor (VIF) of the independent variables to identify multicollinearity. The largest VIF was less than 2 so multicollinearity was not a problem. Skewness ranged from 0.02 to 1.06; kurtosis ranged from 0.02 to 1.15. These results indicate that the variables are well below the levels (skewness: 2; kurtosis: 5), which requires transformation for variables (Ghiselli, Campbell, & Zedeck, 1981).
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<td>0.59</td>
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<tr>
<td>Hindrance Time Pressure</td>
<td>4.15</td>
<td>0.68</td>
<td>-.43**</td>
<td>-.17</td>
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<tr>
<td>Team Identification</td>
<td>4.28</td>
<td>0.68</td>
<td>.54**</td>
<td>.57**</td>
<td>-.14</td>
<td></td>
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<tr>
<td>Solution Quality</td>
<td>4.68</td>
<td>0.65</td>
<td>.39**</td>
<td>.28†</td>
<td>-.30**</td>
<td>.32**</td>
<td>.72**</td>
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<tr>
<td>Development Timeliness</td>
<td>4.19</td>
<td>0.80</td>
<td>.42**</td>
<td>.46**</td>
<td>-.34**</td>
<td>.41**</td>
<td>.75**</td>
<td>.64**</td>
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<tr>
<td>Team Innovativeness</td>
<td>4.65</td>
<td>0.55</td>
<td>.49**</td>
<td>.55**</td>
<td>-.17</td>
<td>.64**</td>
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<tr>
<td>Solution Quality</td>
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<td>.11</td>
<td>.19†</td>
<td>-.02</td>
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<td>.22*</td>
<td>.11</td>
<td>.23*</td>
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<tr>
<td>Development Timeliness</td>
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<td>1.01</td>
<td>.27†</td>
<td>.38**</td>
<td>-.20†</td>
<td>.30**</td>
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<td>.47**</td>
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<tr>
<td>Team Innovativeness</td>
<td>4.61</td>
<td>0.99</td>
<td>.23†</td>
<td>.33**</td>
<td>.00</td>
<td>.27†</td>
<td>.21†</td>
<td>.06</td>
<td>.30**</td>
<td>.29**</td>
<td>.37**</td>
<td>.63**</td>
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</tr>
<tr>
<td>Adherence to Budget</td>
<td>4.52</td>
<td>1.14</td>
<td>.27†</td>
<td>.31†</td>
<td>-.21†</td>
<td>.19†</td>
<td>.48**</td>
<td>.29**</td>
<td>.59**</td>
<td>.27†</td>
<td>.42**</td>
<td>.65**</td>
<td>.40**</td>
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<tr>
<td>Team Size</td>
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<td>3.80</td>
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<td>.10</td>
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<td>.15</td>
<td>.00</td>
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<td>-.04</td>
<td>.00</td>
<td>.02</td>
<td>-.05</td>
<td>-.16</td>
<td>-.05</td>
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<tr>
<td>Team Tenure</td>
<td>1.40</td>
<td>0.99</td>
<td>-.26</td>
<td>.00</td>
<td>.18</td>
<td>-.11</td>
<td>-.02</td>
<td>-.07</td>
<td>-.02</td>
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<td>-.02</td>
<td>-.15</td>
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<tr>
<td>Task Complexity</td>
<td>4.90</td>
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<td>.02</td>
<td>-.07</td>
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<td>.10</td>
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<td>.22†</td>
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<td>-.08</td>
<td>.08</td>
<td>.05</td>
<td>.25*</td>
<td>-.34**</td>
<td>-.19†</td>
</tr>
</tbody>
</table>

*n = 81 (teams); m Ratings from the team members and team leaders (1st level project managers); s Ratings from the stakeholders (2nd level project managers or its equivalent)

** p < .01; * p < .05; † p < .10
To assess the discriminant validity of challenge time pressure and hindrance time pressure, we observed that the two measures were oppositely related to all the variables in this study. The negative correlation ($r = -0.17$) between the challenge and hindrance measures further argued for their discriminant validity. Finally, we tested the two measures with job satisfaction. We found challenge time pressure ($r = 0.34$, $p < 0.001$) and hindrance time pressure ($r = -0.24$, $p < 0.001$) to be significantly correlated with job satisfaction in the predicted direction as in earlier studies (Podsakoff, LePine, & LePine, 2007). This provides further evidence for discriminant validity of the new scales.

4.3.1 Correlation and Mediation Analyses

The results in Table 4.1 show negative associations between hindrance time pressure and all performance dimensions measured, except for team innovativeness and stakeholders' rating on solution quality. Hence, H1a, H1c, and H1d were supported, H1b was partially supported, and H1e was not supported. Concomitantly, we found that challenge time pressure was positively correlated to team coordination and all performance dimensions rated by team members and stakeholders. Therefore, H2a, H2b, H2c, H2d, and H2e were supported. Finally, the positive correlation between management support and challenge time pressure, and the negative correlation between management support and hindrance time pressure gave support to H5a and H5b, respectively.

According to Baron and Kenny (1986), three conditions should be satisfied before one can determine whether mediation exists. Namely, the independent variables and mediator must be correlated, the independent and dependent variables must be correlated, and the mediator and dependent variables must be correlated. Eventually, the effect of an independent variable on a dependent variable should be significantly less when the mediator is included in a regression equation than when it is not included. Table 4.2 reports the regression results to test mediation. All regression equations included the control variables of team size, team tenure, and task complexity. The results in Table 4.1 suggest that most conditions for mediation were satisfied for team coordination. Since hindrance time pressure was not correlated to team innovativeness, and stakeholders' rating on solution quality, conditions for mediation in those situations were not entirely satisfied. Overall, the results justify examining mediating effects by testing the hypothesized direct and indirect effects of challenge and hindrance.
### TABLE 4.2
Hierarchical Regression Analysis of the Mediating Role of Team Coordination on Team Performance

<table>
<thead>
<tr>
<th>Control Variables</th>
<th>Team Member Ratings</th>
<th>Stakeholder Ratings</th>
<th>Adherence to Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Solution Quality</td>
<td>Development Timeliness</td>
<td>Team Innovativeness</td>
</tr>
<tr>
<td></td>
<td>M1</td>
<td>M2</td>
<td>M1</td>
</tr>
<tr>
<td><strong>Control</strong></td>
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<td></td>
</tr>
<tr>
<td>Team Size</td>
<td>.04</td>
<td>.04</td>
<td>.00</td>
</tr>
<tr>
<td>Team Tenure</td>
<td>- .02</td>
<td>- .06</td>
<td>.01</td>
</tr>
<tr>
<td>Task Complexity</td>
<td>.05</td>
<td>-.02</td>
<td>.19</td>
</tr>
<tr>
<td>Challenge Time Pressure</td>
<td>.23**</td>
<td>-.12</td>
<td>.41**</td>
</tr>
<tr>
<td>Hindrance Time Pressure</td>
<td>-.26†</td>
<td>.01</td>
<td>-.26†</td>
</tr>
<tr>
<td>Team Coordination</td>
<td>.78**</td>
<td>.66**</td>
<td>.43**</td>
</tr>
<tr>
<td>Incremental R²</td>
<td>.39</td>
<td>.27</td>
<td>.11</td>
</tr>
<tr>
<td>R²</td>
<td>.14</td>
<td>.53</td>
<td>.32</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>.09</td>
<td>.49</td>
<td>.27</td>
</tr>
</tbody>
</table>

* † p < .01; ‡ p < .05; ‡‡ p < .10; standardized regression coefficients are reported
time pressure on most of the performance variables. Finally, we used the Sobel test (Baron & Kenny, 1986) to confirm the statistical significance of mediation.

The models in Table 4.2 (Model 1 and 2) show that, after adding team coordination as a mediator, challenge time pressure has a positive indirect effect on all performance variables, except for stakeholders' ratings on quality and innovativeness. The results, therefore, supported H3b ($Z_{\text{member}} = 3.94, p < 0.001; Z_{\text{stakeholder}} = 2.29, p < 0.021$) and H3c ($Z_{\text{stakeholder}} = 2.21, p < 0.027$), and provided partial support to H3a ($Z_{\text{member}} = 2.35, p < 0.019$) and H3d ($Z_{\text{member}} = 3.19, p < 0.001$). The models also showed team coordination to mediate hindrance time pressure and members' ratings on quality and timeliness. Since hindrance time pressure was not correlated to the rest of the performance criteria, H4a ($Z_{\text{member}} = -2.51, p < 0.012$) and H4b ($Z_{\text{member}} = -2.87, p < 0.004$) were partially supported while H4c and H4d were not supported.

4.3.2 Moderation Analyses

To test for moderation, the product of the independent variable and moderator must be significantly associated with the dependent variable (Baron & Kenny, 1986). Prior to multiplying the variables, we centered them around zero to avoid multicollinearity between the independent variables, moderators, and interaction variables (Aiken & West, 1991). We see in Table 4.3 that the product of hindrance time pressure and team identification (Model 3a and 4a) ($t = 2.02, p < 0.024$) was associated with improved team coordination. Implementing the same procedure, we did not find the product of challenge time pressure and team identification (Model 3b and 4b) to be associated with improved team coordination. Thus, H6b was rejected. Next, the significant interaction effect was plotted at one standard deviation above and below the mean. We conducted additional analyses to test the statistical significance of the simple slopes (Aiken & West, 1991).

The slope tests in Figure 4.2 show the relationship between hindrance time pressure and team coordination to be stronger when team identification was low. The plot also shows the relationship to be insignificant when team identification was high. The outcomes are
consistent with H6a, in which we proposed that the association between hindrance time pressure and team coordination will be less negative when team identification is high. Thus, H6a was supported. The results indicate that high team identification mitigates the negative effect of hindrance time pressure on team coordination.

### TABLE 4.3
**Hierarchical Regression Analysis of the Moderating Role of Team Identification**

<table>
<thead>
<tr>
<th></th>
<th>Team Coordination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M 3a</td>
</tr>
<tr>
<td>Control</td>
<td></td>
</tr>
<tr>
<td>Team Size</td>
<td>-.04</td>
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<td>Team Tenure</td>
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<tr>
<td>Task Complexity</td>
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<td>Direct Effects</td>
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<td>Hindrance Time Pressure</td>
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<tr>
<td>Challenge Time Pressure</td>
<td></td>
</tr>
<tr>
<td>Team Identification</td>
<td>- .35**</td>
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<tr>
<td>Moderation Effects</td>
<td></td>
</tr>
<tr>
<td>* Team Identification</td>
<td>.18*</td>
</tr>
<tr>
<td>Incremental $R^2$</td>
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<tr>
<td>$R^2$</td>
<td>.42</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>.39</td>
</tr>
</tbody>
</table>

**p < .01; * p < .05; † p < .10; one-tailed for hypothesized effects and two-tailed for controls**

### FIGURE 4.2
**Effects of Hindrance Time Pressure on Team Coordination at Different Values of Team Identification**

- High Team Identification Focus (n.s.)
- Low Team Identification ($p < .001$)
4.3.3 Additional Analyses

To provide additional evidence for the model proposed in Figure 4.1, we examined if hindrance and challenge time pressure mediate management support and team coordination based on the mediation test procedures illustrated previously. Table 4.1 shows that all three conditions for mediation outlined by Baron and Kenny (1986) were satisfied. Table 4.4 (Model 5 and 6) demonstrates that the positive effect of management support on team coordination was significantly reduced after adding hindrance ($Z = -2.40, p < 0.016$) and challenge time pressure ($Z = 2.56, p < 0.010$) into the same model. In conclusion, we found support that hindrance and challenge time pressure mediate the relationship between management support and team coordination.

### TABLE 4.4

<table>
<thead>
<tr>
<th></th>
<th>Team Coordination</th>
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<tbody>
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<td>M 6</td>
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<tr>
<td>Control</td>
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<tr>
<td>Team Size</td>
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<tr>
<td>Team Tenure</td>
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<tr>
<td>Task Complexity</td>
<td>.05</td>
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<tr>
<td>Management Support</td>
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<tr>
<td>Hindrance Time Pressure</td>
<td>.27**</td>
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<td>Challenge Time Pressure</td>
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<tr>
<td>$R^2$</td>
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<td></td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>.24</td>
<td>.35</td>
<td></td>
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</table>

$^{*}p < .01; ^{†}p < .05; ^{‡}p < .10$

4.4 Discussion

Literature has accentuated the importance of teams by labeling them the backbone of profitable organizations. However, more research is still needed to understand if and how teams can remain viable under time pressure. Although recently a burgeoning body of research on stress has been carried out (e.g., Ellis, 2006; Hunter & Thatcher, 2007; Podsakoff, LePine, & LePine, 2007), time pressure has emerged as a prominent type of stress that calls
for focused attention (Barczak & Wilemon, 2003; Dhondt, Kraan, & Van Sloten, 2002; Robinson & Godbey, 1996). This study provides evidence that time pressure follows a two-dimensional factor structure, and subsequently shows challenge time pressure to positively, and hindrance time pressure to negatively affect team coordination and critical team performance indicators. We also found management support to increase challenge time pressure and to reduce hindrance time pressure in innovation teams. Team identification is also shown to be a team characteristic that sustains team coordination, especially for teams facing hindrance time pressure.

4.4.1 Implications for Theory

An important contribution is in showing that time pressure follows a two-dimensional structure, which in turn further explains the impacts of time pressure on performance. Unlike previous studies, we did not assume time pressure to consistently have an inverted-U relation with its determinants. Moving away from the response-based approach, we treated time pressure as a multi-faceted construct and developed new scales to measure time pressure. Since it had been frequently cited to have positive and negative effects on performance (e.g., Amabile, Hadley, & Kramer, 2002), we adopted the challenge-hindrance stressor framework and posited time pressure to follow similar patterns of influence on teams. We found time pressure to be positively associated with team coordination and performance criteria measured in this study, when time pressure led to a satisfying, enjoyable, and stimulating experience. Otherwise, time pressure had a detrimental effect on most fronts. Interestingly, based on our findings, we would expect the relationship between time pressure and performance to follow an inverted-U curve if the response-based approach is assumed, since aggregating the effects of challenge and hindrance time pressure would lead to either a positive, null, or negative conclusion depending on the relative strength of the time-related stressors. This study offers to explain why some studies found or suggested positive, null, or negative relationship between time pressure and quality (e.g., Austin, 2001; Clark & Fujimoto, 1991; Eisenhardt, 2004; Seith, 2000). We suggest that treating time pressure as a
uni-dimensional construct, while it has two distinct properties, has caused the mixed outcomes. Our findings demonstrate that the impact of time pressure on quality or other dependents can be better understood by considering whether actors perceive time pressure as a challenge or a hindrance. At the same time, we do not expect the challenge-hindrance stressor framework to simply replace the inverted-U model. For instance, we do not anticipate challenge time pressure to persistently have positive effects on performance given that stress regardless of its nature, produces strain (Podsakoff, LePine, & LePine, 2007) and leads to exhaustion (Westman & Eden, 1997). These are likely to offset the initial positive responses, if the challenge stress exist for too long or interact with prominent hindrance stress (Pearsall, Ellis, & Stein, 2007). In this study, we offer an alternative explanation for the inconsistencies that inverted-U model could not explained in previous studies relating to time pressure (e.g., Baer & Oldham, 2006), and recommend future work to consider time pressure as a two-dimensional construct while attempting to examine its effects.

In addition, our work served to extend the challenge-hindrance stressor framework, which was first introduced by Cavanaugh and colleagues (2000). The authors noted that "the dimensionality of the self-reported stress construct is in need of further theorizing and empirical investigation" (pg. 70). While previous work focused on generic stressors (e.g. LePine, LePine, & Jackson, 2004; Pearsall, Ellis, & Stein, 2007; Podsakoff, LePine, & LePine, 2007), we applied the framework to a specific kind of stressor. Our results have demonstrated the validity and explanatory power of the framework when applied to time pressure, and have enabled us to better understand time pressure and its interactions with team outcomes. It is important to note that we do not expect the challenge-hindrance stressor framework to apply to all kinds of stress. Nonetheless, we recommend that the framework be extended to some stressors, such as job scope (Xie & Johns, 1995), role ambiguity (Behrman, Bigoness, & Perreault, 1981), or interruptions (Jett & George, 2003) because studies have found mixed results in the way respondents appraise these stressors and their effects on performance. In doing so, we expect the framework to potentially reconcile and further explain some of the discrepancies that were witnessed in previous work.
Another important contribution is in examining time pressure at the team level, and the connection thereof with critical team outcomes. Such research has been scant and rigorous work is needed to advance theory, given the increased use of teams in fast-paced environments. Importantly, this study provides empirical evidence that time pressure can be experienced collectively and operationalized at the team level. This is especially so for hindrance time pressure, which is not surprising as studies have shown emotion transfer to be more evident for unpleasant than pleasant emotions (Bartel & Saavedra, 2000; Rozin & Royzman, 2001). Since the focus of this study was not to examine the underlying processes that facilitate shared reality of time pressure in a team, we did not measure emotional contagion. We urge scholars to explore these processes so that research can better explain the contexts in which time pressure or other stress can be felt collectively, which presents theoretical and practical importance. Concomitantly, we extended the challenge-hindrance stressor framework to the team level. So far, the framework has been examined at the individual level (e.g., LePine, Podsakoff, & LePine, 2005). This study responded to Podsakoff, LePine, and LePine’s (2007) call to test the framework at other levels and to examine it with other critical organization criteria.

So far, no empirical test had been done to explore factors that precede challenge and hindrance stress, or moderate the effects of stress on team outcomes. A significant contribution of this study is that it addresses the above, so that organizations will be able to effectively manage time pressure at work. The results confirmed that management plays an important role in determining the extent to which its teams experience time pressure as challenging. For instance, a management that encourages and actively manages its team resources and priorities portrays a caring work environment where problems are not simply thrown over the fence but management stays involved in solving them. This reduces the negative perceptions of time pressure. Importantly, our findings also provide evidence that team identification mitigates the negative effects of hindrance time pressure on team coordination. This supports the arguments of Asch (1952) and Cannon-Bowers, Tannenbaum, Salas, and Volpe (1995) that team actions are viable only when its members place higher
priorities on team interests than on personal interests. An argument that we have offered is that teams are likely to remain attentive to social cues if they experience high levels of team identification. Literature has shown that individuals under time pressure focus on the tasks at hand. Although this is logical, it is, however, based on the argument that actors tend to consider task-related cues to be more important than social cues for project success. This study suggests that team members are likely to regard cues, task-related or not, as salient as long as they are perceived to be essential for project achievement. For example, a team is likely to treat social cues saliently if its members are convinced of the importance of synchronizing the work flow or supporting one another. In such a case, paying attention to social cues, which help sustain coordination, can be as equally important as focusing on task-related cues. In all, our work joined Hunter and Thatcher's (2007) work to encourage more research to explore the antecedents of stress and moderators of the stress-performance relationship.

This study also assessed a team process through which time pressure affects team performance. This section contributes in a number of ways. First, our work has shown team coordination to be a strong mediator between time pressure and team performance. This relationship had not been empirically tested before. We suggest future work to explore the coordination mechanism or structure, such as routine or boundary spanning (cf. Gittell, 2002; Olson, Walker, & Ruekert, 1995) that may effectively sustain team coordination during moments of hindrance time pressure. Second, our results serve to encourage more studies to open the 'black box' intervening time pressure and team performance. Such investigation will not only illuminate the underlying team processes but, more importantly, will allow further work to uncover the related boundary conditions under which a team process can be further enhanced under challenge time pressure, or protected against hindrance time pressure.

Surprisingly, we did not find hindrance time pressure to significantly reduce team innovativeness for both members' rating ($r = -0.17$, $p = $ n.s.) and stakeholders' rating ($r = 0.0$, $p = $ n.s.). This is contrary to our expectations. However, some studies that investigated the antecedents of creativity had also reached similar conclusions. For example, Amabile and
colleagues (1996) conceptualized workload pressure as a negative stress, and found no significant negative relationship between workload pressure and creativity. Similarly, Amabile and Gryskiewicz (1989) using a different method could not find a significant negative relationship between the two dimensions. Here, we offer three perspectives. First, the innovativeness measure may be particularly susceptible to inflation when collected through self-report. Amabile and colleagues (2002) found participants to rate themselves as more creative than they actually were when compared to the ideas introduced by each person. The inflated innovativeness measure could have led to an insignificant negative relation between hindrance time pressure and team innovativeness. The inflated measure might have also contributed to the high correlation between challenge and innovativeness both here and in Amabile and colleagues’ (1996) work. Second, individuals working in environments that emphasize innovation may, in general, possess characteristics that make their propensity to innovate undisturbed by hindrance time pressure. Barron and Harrington (1981) in their review found creative individuals across various fields (art, music, science and technology) to have similar characteristics, such as broad interests, attraction to complexity, self-confidence, and a firm sense that one is creative. Self-confidence, for instance, may be a characteristic that enables individuals to remain innovative even in hindrance time pressure situations, since studies have also found confident individuals to cope well under stress (Schaubroeck & Merritt, 1997; Jex & Bliese, 1999). The third perspective is that innovativeness or creativity has four dimensions; expected, proactive, responsive, and contributory creativity (Unsworth, 2001). If the proposition is true, hindrance time pressure may influence each dimension differently. This implies that conceptualizing innovativeness as a unitary construct may lead to inaccurate outcomes and interpretations.

In this study, we collected member and stakeholder ratings to determine team performance. We found a high correlation between the two groups of raters for development timeliness ($r = 0.61, p < 0.01$) and team innovativeness ($r = 0.29, p < 0.01$), but not for solution quality ($r = 0.11, p = \text{n.s.}$). We suggest that stakeholders are generally concerned about whether a project can deliver in time and is within budget. Although quality is also of
major interest to them, stakeholders are typically more aware of the product quality at the various milestones than of the solutions generated during the development process. Members' and stakeholders' evaluation of solution quality may thus differ. This might explain the weak correlation between the two groups of raters for solution quality.

4.4.2 Limitations

This study is not without limitations and it is important to note them. First, this study relied on self report for data collection. This may amplify the correlation between the independent and dependent variables due to common method. However, common method alone does not necessary produce significant shared bias unless the variables of interest share sources of bias (Spector, 2006). Likelihood, our variables (time pressure, team coordination, team performance) are susceptible to such shared bias as the measurements are prone to mood state, social desirability, and halo effects. In response, we solicited stakeholder (external rater) inputs to measure team performance as an attempt to uncover and minimize potential inflated correlation between the variables (Van Yperen & Snijders, 2000). Data analysis showed that inflated correlations were evident while considering the member-member ratings. However, most correlations have remained statistically significant when member-stakeholder ratings were considered. Second, causal inferences have to be cautiously applied when adopting a cross-sectional design. For example, one might argue that a team that rated time pressure as hindering is likely to paint a grim picture of its team processes and performance. However, our data is still relatively reliable in this aspect as we introduced a measurement time lag between predictor and criterion variables to reduce response bias. The time lag also provided opportunities for causality to occur (Ancona, Goodman, Lawrence, & Tushman, 2001). Third, although English is widely used in Western Europe for business, it is not the native language of most informants. This may increase error variance as people interpret the survey items varyingly. Albeit, this poses some concerns, our informants were highly educated (94.4 percent of them held at least a bachelor's degree or a diploma) assuring us that our informants did have a sufficiently good grasp of English to answer the survey satisfactorily. Moreover,
people who did not feel confident responding to the survey due to language difficulties were readily excused from the exercise. Finally, this study was conducted with short-cycled new product development teams in Western Europe. Although, the sample is suitable for the topic given that such teams are generally working under tight deadlines, the outcomes have to be applied with caution when generalized to innovation teams from the East. This is because such teams may perceive time differently (Ancona, Okhuysen, & Perlow, 2001) and hence experience some time-related stressors, as characterized in this study, differentially. In addition, people from a collectivistic culture are more likely to place higher priorities on team goals than personal goals than peers in an individualistic culture (Triandis, Bontempo, Villareal, Asai, & Lucca, 1988). Thus, Eastern teams may invest more effort in sustaining team performance when encountering hindrance time pressure. Here, we encourage scholars to extend the challenge-hindrance stressor framework to teams from a collectivistic culture since previous work had collected data mainly from the West.

4.4.3 Implications for Practice

An insight that emerged for practitioners is that not only the level of time pressure, which has been the primary focus of past studies, but also its nature plays a central role in determining how time pressure affects team outcomes. This interestingly suggests that teams can remain viable even under intense time pressure if it is perceived as challenging. A sure step for practitioners would be to creatively nurture an environment where time pressure is perceived more as a challenge, and less as a hindrance.

In addition, our results are consistent with Pearsall, Ellis, and Stein's (2007) proposition that teams perform most effectively under high challenge stress and low hindrance stress. Although time pressure is a rising experience at the workplace, our findings suggest that the stress may become an organization's competitive resource if wisely managed – not through twitching or attempting to induce 'optimal' time pressure levels in innovation teams (Brooks, 1975; Gallstedt, 2003) but through cultivating a top-down supportive and collaborative work environment to minimize the negative effects of time pressure. Examples
of creating such an atmosphere include actively and clearly prioritizing tasks/projects especially for team members working on multiple projects; being available to meet resource needs and not to just check that activities are completed; and emphasizing the importance of overall project goals to encourage members to attend to cues that sustain team coordination. Overall, our work underscores that time pressure is a daily work experience that is not entirely outside the mastery of organization and team leadership. And a management that cares and constructively molds a conducive work atmosphere will see time pressure functioning as a stimulant for effective teamwork and performance.

4.5 Conclusion
A double-edged sword can simultaneously help and hinder. Time pressure at the workplace has the same characteristic - able to promote or impede performance at the team level. The findings challenge scholars and practitioners to rethink the way time pressure influences innovation teams, and demonstrate the advantages of using the challenge-hindrance stressor framework to examine the effects of certain stress.
Chapter 5

Bringing Employees Closer: The Effect of Proximity on Communication when Teams Function Under Time Pressure

Some studies have assumed close proximity to improve team communication on the premise that reduced physical distance increases the chance of contact and information exchange. However, research showed that the relationship between team proximity and team communication is not always straightforward. In this chapter, we examined the relationship, by taking into account the role of challenge and hindrance time pressure at work, with 81 New Product Development teams (NPD) from Western Europe. This chapter found evidence that team proximity improves communication only when teams experience high levels of challenge time pressure or low levels of hindrance time pressure. Implications with respect to theory and practice are discussed.

Communication is a critical process for innovation teams to achieve their goals successfully (Ancona & Caldwell, 1992; Keller, 2001). Functional experts working in a team require a meeting of minds for information to be effectively exchanged and used for goal achievement. Among the strategies that have thus been deployed to facilitate team communication, colocation is frequently pursued in research and practice (e.g., Allen, 1977; Hoegl & Proserpio, 2004; Keller & Holland, 1983; Te’eni, 2001; Van den Bulte & Moenaert, 1998). Although much work has shown team proximity, which in this study refers to the degree of closeness in terms of physical distance, to enhance team communication and team performance, the outcomes of the studies were at times inconsistent. Importantly, several

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researchers have found a weak or no relationship between team proximity and team outcomes (Conrath, 1973; Kahn & McDonough III, 1997; Keller, 1986; Kessler, 2000; Sethi, 2000; Sethi & Nicholson, 2001). This suggests that the association could be more complex than initially theorized. Since team proximity has been identified as a strategy to improve communication (e.g., Te’eni, 2001), further empirical research is needed to explain those inconsistencies. Furthermore, the increased use of geographically distributed teams (Victor & Stephens, 1994) also imply a heightened need for effective colocated teams and hence this line of research, given that success of any multi-site project is contingent on the effectiveness of its local-site teams.

In this study, we suggest the relationship between team proximity and team communication to depend on some contextual conditions. Scholars have highlighted some contextual factors, such as project centralization (Kahn & McDonough III, 1997), team faultlines (Lau & Murnighan, 2006), and strength of ties (Ganesan, Malter and Rindfleisch, 2005) to influence the relationship. So far, no work has yet contemplated the role of stress, in particularly time pressure, in the equation despite its connection with psychological distance (e.g., Chajut & Algom, 2003; Kruglanski & Webster, 1996). In this study, the concept refers to cognitive and affective abilities as well as readiness of actors to exchange information. Although earlier studies on team proximity have generally emphasized its dependence on physical distance between members, we suggest that team proximity is also a function of psychological distance. This is because team members, despite sitting next to one another, are unlikely to share information if they are psychologically distanced, which occurs when people are under intense time pressure (e.g., Hoopes & Postrel, 1999). Furthermore, examining the role of time pressure on the proximity-communication relationship is also timely because escalating market competition over the last decade has made work an increasingly stressful experience (Barczak & Wilemon, 2003). Therefore, considering time pressure potentially shed further light on the proximity-communication relationship.

This study contributes to research in two major ways. First, this study extends the team proximity literature by examining how time pressure moderates the effect of team
proximity on team communication. By adopting the challenge-hindrance stressor framework (cf. Podsakoff, LePine, & LePine, 2007) into existing literature on NPD teams, we theorized and found empirical support that challenge time pressure and hindrance time pressure improves and deteriorates, respectively the relationship between team proximity and team communication. The second contribution stems from the conceptualization of the two-dimensional time pressure constructs. This development adds to research by considering the nature of stress, which researchers have argued to advance understanding on the influence of stress on team outcomes (Lazarus & Folkman, 1984; LePine, LePine, & Jackson, 2004; Selye, 1982). In the context of new product development, the distinction between challenge and hindrance time pressure can help to shed light on shortening product development cycle and its effects on team performance (Hoopes & Postrel, 1999; Perlow, Okhuysen, & Repenning, 2002) as we have seen in this study.

5.1 Background and Hypotheses

Scholars have posited colocation to improve team communication. In this paper, we focus on three factors through which team proximity was proposed to affect team communication (Hinds & Kiesler, 2002). First is team awareness. Olson, Teasley, Covi, and Olson (2002) highlighted that team members located in close physical proximity tend to have more understanding of one another’s strengths, working styles, and moods than of people that are located further away. Similarly, Covi, Olson, and Rocco (1998) found in an interview study that being aware of one another’s job scope helps team members to know when, what, and how to communicate with one another. The second factor is the reduced amount of effort needed to initiate a conversation. According to Kraut, Fussell, Brennan, and Siegel (2002), the effort to initiate a conversation is lower when team members are in closer physical proximity. This is due to higher likelihood of chance encounters (Allen, 1977; Porter, 1998) and ease of coordinating planned meetings. The reduced effort also implies that team members can become more efficient in sharing information and correcting misattribution (e.g., Cramton, 2001). Third is team identity, which refers to a common perspective of
cohesiveness and mutual acceptance among team members (Earley & Mosakowski, 2000). Team identity is developed when team members meet face-to-face frequently (Sherif & Sherif, 1969) and work together over a period of time (Katz, 1982). Several studies have shown team identity to facilitate team communication (e.g., Hinds & Mortensen, 2005).

Although colocation facilitates information exchange, its influences on communication may not be straightforward. This is because the relationship, as highlighted in the beginning of this article, also depends on psychological distance between members of a team (Hinds & Kiesler, 2002). Christensen and Shenk (1991) found people who are psychologically distanced to communicate less. And if they do communicate, they are less constructive. Hoopes and Postrel (1999) also observed team members to overlook sharing of critical information because they might be psychologically distanced by difficult deadlines. Therefore, we suggest time pressure, which is a prominent experience in new product development environment, is closely related to psychological distance between team members (Kruglanski & Webster, 1996), and is able to cause people to alter their frequency and pattern of communication even when they are in close proximity.

Before proceeding further on how time pressure may affect the relationship between team proximity and team communication, this paragraph explains the rationale behind conceptualizing challenge time pressure and hindrance time pressure. Studies on time pressure have adopted Yerkes and Dodson's (1908) response-based approach, which focuses on the levels of time pressure to explain its effects on performance (e.g., Amabile et al., 2002; Baer & Oldham, 2006). However, the approach may not sufficiently explain the association between time pressure and performance, given that the stress-performance relationship is also contingent on the nature of stress experienced (cf. Selye, 1982). Lazarus and Folkman (1984) advocated that actors' problem-solving tactics vary with the nature of stressors experienced. For instance, people who appraise stressful events as potentially benefiting tend to take proactive actions to overcome the difficulties imposed by the stressful situations. Conversely, people who appraise stressful events as potentially threatening tend to withdraw from or be passive in stressful situations. Therefore, challenge stress contributes to good performance
while hindrance stress leads to bad performance. Recently, research using the challenge-hindrance stressor framework has provided strong evidence for Lazarus and Folkman's proposition (e.g., Cavanaugh, Boswell, Roehling, & Boudreau, 2000; LePine, LePine, & Jackson, 2004; Podsakoff, LePine, & LePine, 2007). Therefore, this study used LePine and colleagues' framework to conceptualize time pressure, as challenge or hindrance time pressure to enable us to better differential and gain stronger insights on the possible influences of time pressure on the relationship between team proximity and team communication.

Hypotheses

As revealed by some studies, team proximity improves communication due to three underlying factors. People in close proximity tend to experience team awareness, require less effort to initiate conversation, and experience a strong sense of team identification. These factors explain the direct relationship between proximity and communication. However, we also expect the relationship to depend on the time pressure experienced by teams since beyond physical distance, challenge time pressure and hindrance time pressure appear to affect the three underlying factors by altering team members’ cognitive and affective readiness and ability to exchange information. We term this mechanism psychological distance.

Challenge time pressure is associated with fulfillment and a strong proclivity to succeed. These experiences serve as a motivating force in teams (Selye, 1982). Under such circumstances, a person with constrained attentional resources can still engage vigorously in cognitive activities if he or she is stimulated to persist in the course of action (De Dreu & Carnevale, 2003). Pieters and Warlop (1999) conducted a field study to explore the effects of motivation on how people gather purchasing information under time pressure. The authors found the motivated groups to exert more effort in acquiring information than other groups. This indicates that challenge time pressure can facilitates information exchange; even to the extent of leading people to acquire peripheral information and social cues. Thus, teams that
experience challenge time pressure are likely to experience lower psychological distance between one another.

Since challenge time pressure is associated with lower psychological distance, teams that experience high challenge time pressure are cognitively and affectively more ready than low challenge time pressured teams to take advantage of close physical proximity to exchange information (Hinds & Kiesler, 2002). This is because lower psychological distance encourages people to find opportunities to tap into proximate resources and network to meet deadlines. Hence, we expect challenge time pressured teams to experience the following. First, such teams will capitalize on their awareness (knowledge) of the teams’ capabilities and resources in order to exchange useful information to fulfill the teams’ objectives (Ashford & Cummings, 1985). Second, such teams will be more spontaneous and take seemingly even less effort to engage in constructive conversation due to the lowered psychological distance (Kruglanski & Webster, 1996). Finally, such teams will experience a deeper sense of team identity given the lowered psychological barriers to unite to overcome the challenging tasks ahead (Gittell, 2003). These experiences demonstrate that high challenge time pressure has positive effects on the three underlying factors that govern the relationship between team proximity and team communication, which explains why challenged time pressure teams communicate better than other teams that are located within the same physical proximity but are not challenged by time pressure. Therefore, we propose the following hypothesis:

**Hypothesis 1 (H1):** Challenge time pressure moderates the relationship between team proximity and team communication such that this relationship improves for teams that experience high rather than low levels of challenge time pressure.

In contrast to challenge time pressure, hindrance time pressure is associated with hassles and constraints to goal achievement. Cognitive closure theory suggests time pressure to threaten information exchange if the stress is perceived to be hindering (Kruglanski & Webster, 1996). People in such a situation tend to engage in shallow communication and close their minds to re-think solutions to problems, or even choose not to revisit available information to minimize
onerous processing of complex information. This suggests that hindrance time pressure leads people to overlook peripheral information and social cues (Kelly & Loving, 2004). Hence, teams that experience hindrance time pressure are likely to experience higher psychological distance between one another.

Since hindrance time pressure is associated with higher psychological distance, teams that experience high hindrance time pressure are cognitively and affectively less ready and able than low hindrance time pressure teams to take advantage of close physical proximity to exchange information (Hinds & Kiesler, 2002). This is because heightened psychological distance discourages people from seeking additional information, including from proximate resources and network to meet deadlines (Driskell, Salas, & Johnston, 1999). Thus, we expect hindrance time pressured teams to experience the following. First, such teams tend not to capitalize on their awareness (knowledge) of the teams’ capabilities and resources as they are more concerned about meeting immediate deadlines than exchanging more information, which requires both effort and time (Kruglanski & Webster, 1996). Second, such teams will be more focused on their individual tasks and avoid engaging in conversations despite the physical proximity due to the higher psychological distance (Kruglanski & Webster, 1996). Finally, such teams also tend to experience a weaker sense of team identity as members avoid social cues and are more self-focused in completing their individual tasks (Kelly & Loving, 2004). These experiences demonstrate that high hindrance time pressure has detrimental effects on the three underlying factors that govern the relationship between team proximity and team communication, which explains why teams not affected by hindrance time pressure communicate better than other teams that are located within the same physical proximity but are affected by hindrance time pressure. Therefore, we propose the following hypothesis:

**Hypothesis 2 (H2):** Hindrance time pressure moderates the relationship between team proximity and team communication such that this relationship improves for teams that experience low rather than high levels of hindrance time pressure.
5.2 Methods

5.2.1 Research Setting and Procedures

The research was conducted with 81 NPD teams in Western Europe (Belgium, England, France, Germany, and the Netherlands). These teams functioned in short-cycled industries and developed innovative products for the consumer, electronic, semiconductor, and medical sectors. The unit of analysis was a team, which could be from a single-team or a multi-team project. When the survey took place, overall 74 teams were still active: in the design (19%), testing (41%), or initial production (31%) stages. In total, 437 informants contributed data to this study, 356 of whom were team members and 81 were project managers. The teams consisted of 4 to 18 core members (x = 7.2, s.d. = 3.8); 94% were male; the average age was 38 years (s.d. = 7.9); the average time with the current team was 2.5 years (s.d. = 2.3). Our informants had worked in NPD related industries on an average of 10 years (s.d. = 7.4), and most of them were highly educated with 94% having at least a bachelor’s degree or a diploma. A large proportion of our sample was natives from Northern or Western Europe (93.6%). The rest were from Eastern Europe (3.7%), Southern Europe (1.6%), America or Asia (1.1%).

We invited teams for this survey by approaching vice presidents and project managers of organizations developing new products to take part in this study. Contacts who were interested then identified one or more suitable teams from their departments for our follow-up. About 40% of the contacts that we approached recommended teams to participate in the survey. A team was assessed for participation based on a few criteria. The team (a) has at least 4 members, including the project manager, to take part in the survey; (b) was functioning in short-cycled industries, (c) was developing innovative products, (d) were located in Western Europe, and (e) worked in the same site. In this study, we adopted an informant sampling approach to attract a higher team response rate through reducing the total amount of time needed from each participating team (Van de Ven & Ferry, 1980). The informant sampling approach recognizes that many members of a team are suited to provide
good assessment pertaining to their work and team. Hence, we depended on "a limited selective sample of people who are knowledgeable of the global properties of interest" (Van de Ven & Ferry, 1980: 72) rather than on all the team members to provide us with the data needed.

The survey was sent electronically in two parts to all informants. The team and project manager’s names were printed on introduction emails to ascertain that informants made reference to the correct project while engaging in the survey. Part two was sent to informants a day after they had submitted complete answers to part one. We took the two-part survey design for two reasons; a) to keep the survey length at each attempt short to facilitate quality response, and b) to introduce a time lag between input to the moderator (challenge and hindrance time pressure) and criterion (team communication) variables because these variables were measured by the same informants. Podsakoff, MacKenzie, Lee, and Podsakoff (2003) recommended such a time lag as it creates a temporal separation between the measurements of the predictor and criterion variables. This method, though, takes more effort, leads informants to leave short-term memory and thus reduces response biases. The average time lag for receiving the two parts was 16.5 days (s.d.=13.5). Finally, informants were assured that their input would be used only for research purposes and be kept completely confidential. The response rate for part one was 94%, and 98% of those who completed part one also completed part two.

The approach of the study has naturally made our results less susceptible to common method variance. We shall discuss this from three angles. First, this study is a team-level research. Research has shown variables measured using multiple informants to be less susceptible to common method bias. This is because aggregating responses provides a more complete measurement of the focal team characteristics, which increases the reliability of the response (Kumar, Stern, & Anderson, 1993; Atuahene-Gima & Murray, 2004). Second, not all our measurements are subjective measures. While the criterion variable (team communication) is a subjective measure, the predictor variable (team proximity) is an objective measure; hence one that is less susceptible to mood state, social desirability, and
halo effects. This potentially reduces the chance of main effects inflation and common method variance (Podsakoff, MacKenzie, Lee and Podsakoff, 2003). Third, the primary interest of this study is related to moderation effects. This reduces the susceptibility of our results to common method variance. Research has found that though common method bias tends to inflate main effects, it also tends to suppress interaction effects (McClelland & Judd, 1993; Evans, 1985). Since we found significance in the moderation analysis (as demonstrated in the results section), common method bias did not appear to be an issue in this study.

Nonetheless, we proceed to design the data collection process carefully, and minimized common method bias by implementing the recommendations put forth by Podsakoff et al. (2003). We did so by separating the measurements temporally and psychologically. Respondents were asked to measure team proximity, challenge time pressure, and hindrance time pressure in the first survey, and measure team communication in the second survey. This approach introduced a time lag and led respondents to leave short term memory. The average time lag for receiving the two parts was 16.5 days (s.d.=13.5). Since the response formats of team proximity and team communication were different, the two measurements were separated methodologically. Such separation reduces the respondents’ ability and motivation to use previous answers to infer missing details.

5.2.2 Measures

Prior to data analysis, we established that the answers of the respondents within teams were more similar than those between teams by computing the $r_{wg}$ and ICC(1). Means of the combined ratings of informants belonging to the same team were subsequently computed and used for further analysis.

Team Proximity was measured based on the method described by Keller (1986) where the author asked each participant to estimate the walking distance between his or her primary work station to those of each of three other team members who were the most valuable source of information for the respondent's work in the project. In this study, the distances were measured in meters. We encountered some data (5.6%) where informants
indicated the walking distances between them and one or more colleagues to be greater than 200 meters, for example in the range of 500 to 1500 meters. This was to be expected, since innovative projects are increasingly using multi-site teams to develop new products (Evaristo & Van Fenema, 1999). A team member's valuable sources of information may, therefore, be located in another site. Since data of distance greater than 200 meters occurred almost randomly within any particular team, we approximated these data to 200 meters in our analysis. We suggest that this is a reasonable choice because according to Allen (1977), a walking distance of more than 30 meters between two individuals is usually considered remote. Hence, considering distances greater than 200 meters in the analysis would bring little benefit conceptually. Moreover, given the random nature of these data, computing the actual distances (greater than 200 meters) might undesirably increase the means and variances of proximity for some teams. A factor analysis of the three distances to other team members of each respondent showed these data to load satisfactorily on one factor, explaining 61.5% of variability. Thus, the three data points were averaged (e.g., x meters) for each respondent, and reversed coded (200-x) to compute the proximity for their respective teams.

Team Communication was assessed using the ten-item scale developed by Hoegl and Gemuenden (2001). The items asked informants the extent to which members of their team communicated frequently, spontaneously, directly, timely, and openly with one another. Three examples of the scale are "There was frequent communication within the team", "Important information was kept away from other team members in certain situations (reversed-coded)", and "The team members were happy with the timeliness in which they received information from other team members". One item was excluded from the scale because its item-to-total correlation (0.14) was far below the acceptable level of 0.40 (Bennett & Robinson, 2000). The scale was measured with a range from 1 "to little extent" to 7 "to great extent". ($\alpha = 0.87; r_{wg} = 0.92; ICC(1) = 0.12$).

Challenge and Hindrance Time Pressure were measured using a five-item and an eight-item scale, respectively. As discussed in chapter 4, a rigorous process consisting of three phases based on the procedures conducted by Cavanaugh, et al. (2000) and LePine,
LePine, & Jackson (2004) was used to develop the scales. In the first phase, we interviewed 49 practitioners (8 teams) from Western Europe working in NPD industries to gather examples on the causes of time pressure. In total, we gathered 167 examples and classified them into nine categories. Subsequently, these were evaluated with validated time pressure scales (e.g., Amabile et al., 1996) and work stress scales (e.g., Cavanaugh et al., 2000) to generate an initial 20 items for challenge and hindrance time pressure. In the second phase, we invited another 33 NPD practitioners to categorize each item as either a stressor leading to challenge time pressure, leading to hindrance time pressure, or not clearly falling in either of the categories. The classification was conducted using electronic survey and was based on the construct definitions presented earlier. The participants provided sufficient data to refine the initial items to 13; five for challenge time pressure and eight for hindrance time pressure. Importantly, this phase ensured that the items were refined based on perspectives from the field. In the third phase, we recruited two independent academic judges who were unrelated to the research to classify the 13 items into either the challenge or hindrance category. The judges were allowed to refer to the construct definitions during the task. The categorization of the judges was 88 percent (23 of 26 items) consistent with the prior categorization, providing evidence that the scales were satisfactory. Finally, we invited the 437 team members from this study to evaluate the 13 time pressure items. The ratings were conducted at the individual levels and team levels on the extent to which each item leads to challenge and hindrance time pressure, respectively, with scales ranging from 1 "not at all" to 7 "a great deal". This step provided added certainty that participants were able to associate the items to challenge and hindrance time pressure accordingly when rating them. The Cronbach Alpha of the two scales ($\alpha = 0.86 |_{\text{challenge}}, \alpha = 0.88 |_{\text{hindrance}}$) provided good evidence that the scales are acceptable.

Importantly, informants were also asked to repeat their rating of the 13 items for both scales. This allowed us to validate statistically if any of the challenge time pressure items belong to the hindrance time pressure scale, and vice versa. An example of the challenge time pressure scale is "The technological complexity that the team needs to overcome to complete this project on time". ($r_{wg} = 0.83$; ICC(1) = 0.10 |_{\text{challenge}}). An example of the hindrance time
pressure scale is "The lack of time buffer that is planned for this project". \( r_{wg} = 0.85; \) ICC(1) = 0.15. A CFA was also conducted. We found good support for the two-factor model \( \chi^2[64] = 213.9; \) CFI = 0.94; GFI = 0.93; RMSEA = 0.072. A one-factor model was also tested \( \chi^2[65] = 3305.0; \) CFI = 0.32; GFI = 0.47; RMSEA = 0.33. The chi-square difference between the two-factor model and the one-factor model was significant \( \Delta \chi^2[1] = 3091.1, p < 0.001 \). These results support the two-factor structure of time pressure proposed in this study. The ICC(1) of 0.10 for challenge time pressure indicated that the scale accounted for a reasonable proportion of the variance in individual responses. Although the ICC(1) was not as high as the "hurdle rates" of 0.12, aggregation is still acceptable if research questions and hypotheses of a study require a particular level of analysis (James, 1982). Following the work of Keller (2001) and Kirkman, Rosen, Tesluk, and Gibson (2004), challenge time pressure was aggregated to team mean.

In addition, we also conducted CFA with the three factors (i.e. two types of time pressure and team communication). The results yielded reasonable support for the three-factor model \( \chi^2[206] = 896.69; \) CFI = 0.93; GFI = 0.84; RMSEA = 0.088, NFI=0.9, SRMR = 0.067). Although the GFI is on the low side, we suggest that the model is acceptable given the validity of other statistics like CFI, SRMR, and NFI (Kelloway, 1998).

Team Size and Team Tenure were included as control variables because prior work had suggested them to relate to team communication (e.g. Ancona & Caldwell, 1992; Katz, 1982; Keller, 2001). Team size was measured based on the number of core members in each team. Team tenure was measured with project managers' input on the number of years, including in previous projects, their members have been working together.

5.3 Results

Table 5.1 provides the team-level correlations and summary statistics for the variables. None of this study's variables had a variable inflation factor above 2.0, indicating that multicollinearity was not a significant problem. In addition, the condition indices for the
model were also evaluated. All of the condition indices (<1.77) were far below the 15-mark. This further indicates that our model does not have multicollinearity problem.

### TABLE 5.1

Means, Standard Deviations, and Correlations

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Team Proximity (meter)</td>
<td>168.8</td>
<td>24.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Team Communication</td>
<td>5.10</td>
<td>0.50</td>
<td>.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Challenge Time Pressure</td>
<td>4.36</td>
<td>0.59</td>
<td>.12</td>
<td>.50</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>4. Hindrance Time Pressure</td>
<td>4.15</td>
<td>0.68</td>
<td>-.04</td>
<td>-.37</td>
<td>-.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Team Size</td>
<td>7.21</td>
<td>3.80</td>
<td>.06</td>
<td>.01</td>
<td>.10</td>
<td>.06</td>
<td></td>
</tr>
<tr>
<td>6. Team Tenure (year)</td>
<td>1.40</td>
<td>0.99</td>
<td>.02</td>
<td>-.15</td>
<td>.00</td>
<td>.18</td>
<td>.10</td>
</tr>
</tbody>
</table>

*a n = 81 teams; b measured in meters & reversed coded; c measured in years; ** p < .01; * p < .05; + p < .10

The table shows that the correlation between team proximity and team communication is non-significant (r = .10, p = n.s.). Table 5.2 presents the results of the moderated hierarchical regression analysis used to test H1 and H2. After centering our independent variables (Aiken & West, 1991), we introduced the control variables and main effects into a regression equation. Next, to test our predictions that team proximity is more significant related to team communication (a) when challenge time pressure is high than when it is low (H1), and (b) when hindrance time pressure is low than when it is high (H2), we introduced the interaction term of team proximity and challenge time pressure and the interaction term of team proximity and hindrance time pressure to the model at the same time. As shown in the table, the coefficient associated with the interaction term of team proximity and challenge time pressure was significant (β = .21, p < .05). The coefficient associated with the interaction term of team proximity and hindrance time pressure was moderately significant (β = -.15, p < .10). An inspection of the interaction plots (Figures 5.1 and 5.2) with simple slope tests (Aiken & West, 1991) revealed that only the slopes related to high challenge time pressure and low hindrance time pressure were significant. The plots show that teams communicate more effectively when their members are located proximately when they experienced high challenge time pressure or low hindrance time pressure. The findings are consistent with our hypotheses. As a result, both H1 and H2 were supported. Additionally, the results also
suggest that bringing team members closer yields virtually no benefit on team communication in low challenge or high hindrance time pressure situations.

**TABLE 5.2**
Hierarchical Regression Analysis of the Moderating Role of Challenge and Hindrance Time Pressure

<table>
<thead>
<tr>
<th>Variables</th>
<th>Team Communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
</tr>
<tr>
<td>Team Size</td>
<td>.03</td>
</tr>
<tr>
<td>Team Tenure</td>
<td>-.15</td>
</tr>
<tr>
<td>Main Effects</td>
<td></td>
</tr>
<tr>
<td>Team Proximity</td>
<td>.04</td>
</tr>
<tr>
<td>Challenge Time Pressure</td>
<td>.45**</td>
</tr>
<tr>
<td>Hindrance Time Pressure</td>
<td>-.27**</td>
</tr>
<tr>
<td>Moderation Effects</td>
<td></td>
</tr>
<tr>
<td>Team Proximity x Challenge Time Pressure</td>
<td>.21*</td>
</tr>
<tr>
<td>Team Proximity x Hindrance Time Pressure</td>
<td>-.15*</td>
</tr>
<tr>
<td>Incremental R²</td>
<td>.20</td>
</tr>
<tr>
<td>R²</td>
<td>.15</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>.02</td>
</tr>
</tbody>
</table>

*p < .01; *p < .05; *p < .10; Standardized regression coefficients are reported
One-tailed for hypothesized effects and two-tailed for other effects

**FIGURE 5.1**
Effects of Challenge Time Pressure on Interaction between Team Proximity and Team Communication

High Challenge Time Pressure (p = .06)
Low Challenge Time Pressure (p = n.s.)
5.4 Discussion

This paper addresses the tenet that team proximity improves team communication. Our findings demonstrate that effective communication in teams depends not only on physical distance (the ease of reach) but also on perceived time pressure, such that high challenge and low hindrance time pressure environments are conducive to team communication. Although team proximity is a well-researched topic, bringing time pressure into the picture enabled us to gather further insight into this area.

Our findings contribute to theory in two ways. First, this study took into account a work context, and showed that challenge and hindrance time pressure separately influences the benefits of team proximity towards team communication. We found that teams under high hindrance time pressure do not benefit from close proximity, given the natural tendency for premature cognitive closure and the use of avoidance coping tactics when problems surface. Similarly, teams experiencing low challenge time pressure do not gain from close proximity. This is an interesting outcome as it underscores the importance of challenge for teams to function effectively (e.g., Wageman, 2001). Thus, simply reducing physical distances is unlikely to promote communication if motivational or human factors are neglected (cf. King & Majchrzak, 1996).
Importantly, this study demonstrates the strength of the challenge-hindrance stressor framework in advancing theory and explaining inconsistencies. Past studies determined time pressure by considering only its levels. We suggest that this study might not have been able to uncover the moderating effects of time pressure if we had conceptualized time pressure in the conventional way. For example, if levels of time pressure are measured, high time pressure may or may not moderate the proximity-communication relationship, depending on whether a team perceives time pressure as highly challenging or highly hindering. In most cases, the outcomes would also be masked due to the aggregated effects of challenge and hindrance time pressure. This would possibly lead to insignificant conclusions. In addition, our results have highlighted the advantages of conceptualizing time pressure as a two-dimensional work stress and also served to extend the framework introduced by LePine and his colleagues. So far, it had been applied to examine individual-level outcomes. In this study, we extended the framework and used it to address inconsistencies at the team-level.

On a separate note, though we found insignificant relationship found between team proximity and team communication, we suggest that this result is not unreasonable given that some studies have also found a similar outcome (e.g., Conrath, 1973). In fact, this is a consistent part of the findings of this study. Since communication is a matter of heart and mind (Kruglanski, 1996), mere physical distance alone may not have significant effects.

This study is not without limitations. The first limitation is that we did not collect data concerning team awareness, effort to initiate conversations, or team identity to provide an empirical argument for the non-significant relationship between team proximity and team communication. This portion of the study needs to be investigated in the future. Another limitation is the small sample size of 81 teams. The third limitation is that we did not take into account the physical barriers, such as partitions or doors, in the offices while examining the relationship between team proximity and team communication. Hatch (1987) found physical barriers to improve communication as barriers help a team to define its boundaries and sense of identity. Hatch's findings implied that close proximity does not necessarily improve team communication if there is no landmark to signify a team boundary, and simply placing
multiple teams in a huge open hall does not facilitate communication within a team. This could be a competitive explanation for not finding a significant relationship between team proximity and team communication in this study.

The outcomes of this study are important for managers and practitioners. The results showed that simply locating team members close to one another does not guarantee improved communication. This is especially so for teams functioning in short-cycled industries. The effects of close proximity depend on whether team members are willing to make use of the short distances between one another to exchange information. Management with the intent to adopt co-location as a means to facilitate communication should also attempt to cultivate a work environment where employees experience challenge time pressure. Accordingly, we encourage managers to identify and eliminate factors that cause hindrance time pressure. One the one hand, managers could attempt to reduce hindrance time pressure by designing realistic project schedule and deliverables, and by planning downtime in between projects so that teams can recuperate from high strain projects during these intervals. These can be achieved through active engagements with team members. In addition, providing team members with reasonable levels of autonomy for decision making and managing the frequency of status reporting also helps teams to feel that they are trusted. On the other hand, managers could increase challenge time pressure by underlining the importance of the project. It is fundamental for managers to understand what challenges the team and induces them to work together? Is it the complexity of a particular technology? Or is it the collective desire to advance consumer life styles, to develop a sustainable solution, or to see a breakthrough in a medical field? Managers that are able to keep their teams focus on achieving a goal are likely to witness the team endures time pressure and perceives it as stimulus. In fact, our time pressure scales show that at the team level, dependency and commitment are two team components that induce team members to experience time pressure as a challenge. Based on that finding, we encourage managers to plan activities and trainings that will help teams to develop a stronger sense of interdependency and team commitment before putting them through high time pressure missions.
Chapter 6

General Discussion

In this concluding chapter, we summarize, integrate, and discuss the main theoretical contributions of the research presented in the preceding chapters. Subsequently, we address some strengths and limitations of our work. Finally, we end with suggestions for future research and recommendations for practitioners.

What can we learn from the Hubble Space Telescope incident illustrated in Chapter 1? Clearly, Perkin-Elmer had a difficult schedule to develop the telescope mirror. Capers and Lipton (1993) attributed the unrealistic schedule to Perkin-Elmer's low bid for the mirror project, leaving the company with insufficient resources to pull together the development of a very complex mirror. This unfortunately led to some fatal mistakes during the polishing and testing process, which compromised the quality of the mirror. Although some may associate the poor performance to high levels of time pressure, we suggest that the disaster may be better explained by looking at the nature of time pressure experienced. The sequence of events at Perkin-Elmer concludes that its scientists were largely influenced by hindrance time pressure. For instance, the difficult schedule was fundamentally a result of the competitive bidding process (Capers & Lipton, 1993), where the lowest bidder wins the project regardless of whether the bid is realistic or not. A schedule that originates from an absurdly low bid is not only impossible to achieve, but also leads to time pressure that discourages and frustrates team members. Such time pressure has negative consequences on the process and performance of teams as demonstrated in our research.

This thesis presents opportunities to further our understanding on time pressure - its antecedents, coping resources, and effects on team processes and team performance. We
present an overview of this thesis in Table 6.1, showing how the various chapters (2,3,4,5) have addressed the objectives that were presented in chapter 1. The findings of respective studies are also summarized in the same table. Subsequently, we conclude our work by presenting the theoretical contributions, strength and limitations, future research directions, and practical implications of this thesis.

6.1 Theoretical Contributions

6.1.1 Contributions to the Time Pressure Literature

A key contribution to theory is in conceptualizing time pressure as a two-dimensional construct. Our results showed that our approach complements the inverted-U model that researchers have been using to explain relationships between time pressure and performance (Chapter 4). The two-dimensional time pressure model clearly explained why intense time pressure does not necessarily deteriorate performance, and demonstrated the outcomes to depend on whether time pressure is considered a challenge or hindrance stress. At the same time, we maintain that the two-dimensional time pressure model does not simply replace the inverted-U model. For example, the relationship between challenge time pressure and performance is likely to follow an inverted-U shaped when actors are subjected to a long period of challenge time pressure, since prolonged challenge stress increases strain and exhaustion (Westman & Eden, 1997) and subsequently reduces performance.

The second contribution is in developing the challenge and hindrance time pressure scales. The conceptualization of two-dimensional time pressure calls for development of new scales to measure the two types of time pressure. The case study interviews (Chapter 2 & 3), challenge and hindrance stressor scales (Cavanaugh, Boswell, Roehling, & Boudreau, 2000; LePine, LePine, & Jackson, 2004), and existing time pressure scales (e.g., Amabile, Mueller, Simpson, Hadley, Kramer, & Fleming, 2002) all contributed towards constructing the challenge and hindrance time pressure scales. Not only did the new scales provide empirical evidence that time pressure could be conceptualized as two dimensional, the scales also give scholars ways to measure time pressure in similar innovative work environments (Chapter 4).
### Table 6.1
An Overview of Objectives and Findings of the Thesis

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Studies</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 To explore the antecedents and situational coping resources of time pressure in NPD team contexts</td>
<td>Chapter 2</td>
<td>• Found 9 antecedents and 10 situational coping resources. These categories can be broadly classified as externally and internally (management/team) related categories. (Table 1.3 &amp; 1.4)</td>
</tr>
<tr>
<td></td>
<td>Chapter 4</td>
<td>• Management Support increases challenge time pressure, and reduces hindrance time pressure. • Team identification, independently, reduces the negative effects of hindrance time pressure on team coordination</td>
</tr>
<tr>
<td>2 To examine the relationships between time pressure and team processes, and team performance.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. To examine the impact of time pressure on team communication (formality, openness, and timeliness).</td>
<td>Chapter 3</td>
<td>• Hindrance time pressure increases progress meetings, and reduces technical meetings and documentations. Teams also reduce scope and depth of communication when under hindrance time pressure. Concomitantly, teams are less responsive in giving information, take less initiative to scan generally for information, but are more proactive in soliciting information from one another. • We could not find determining results on the effects of challenge time pressure on team communication.</td>
</tr>
<tr>
<td>b. To reconcile some of the discrepancies related to the effects of time pressure on performance, and examine the impact of time pressure on team outcomes.</td>
<td>Chapter 4</td>
<td>• Time pressure can be conceptualized as a two-dimensional construct - challenge time pressure and hindrance time pressure. • Challenge time pressure has positive impact on team processes (team coordination) and team performance (solution quality, development timeliness, adherence to budget, and team innovativeness). On the other hand, hindrance time pressure has negative impacts on all the above measurements, except for team innovativeness. • Results demonstrated that the positive and negative impacts of time pressure on team outcomes could also be explained using the challenge-hindrance stressor framework.</td>
</tr>
<tr>
<td>3 To explore the role of time pressure while understanding the impact of team proximity on team communication.</td>
<td>Chapter 5</td>
<td>• The relationship between team proximity and team communication is moderated by time pressure, such that challenge time pressure increases the association while hindrance time pressure reduces the association.</td>
</tr>
</tbody>
</table>

**Note:** Refer to Section 6.1 (page 128 – 134) for theoretical contributions and to Section 6.4 (page 134 – 143) for contributions to practice.
Another significant contribution is in extending time pressure research to the team level of analysis. Research requires more attention on how stress affects team outcomes. However, only few studies have attempted to explore this area empirically (Drach-Zahavy & Freund, 2007; Keller, 2001; Lansisalmi, Peiro, & Kivimaki, 2000; Semmer, Zapf, & Greif, 1996). Even so, these studies have focused on generic stressors. This study is the first to provide quantitative evidence that time pressure could be measured as a team construct (Chapter 4). Emotional contagion theory has provided theoretical insight into how individuals of a team may experience time pressure collectively even though people tend to perceive stress differently. The theoretical reasoning coupled with empirical support (strong $R_{wg}$ and modest ICC(1)) for aggregating time pressure measurements as team level constructs serve to encourage stress-related research at the team level.

The fourth contribution is in identifying antecedents and coping resources of time pressure (Chapter 2). Although some may argue that there are several research that documented the causes of and coping strategies related to stress, our study is unique in four ways. First, our study focused on time pressure, which is a specific kind of stress because it is triggered fundamentally by a lack of temporal resources. Second, we used a multiple case study approach instead of the conventional laboratory method to examine the topic. Third, our results are specific to teams in innovative contexts, where stress is not commonly researched. Finally, our work identified situational factors that increase team members' coping resources. Previous studies on coping strategies have mainly looked at how individuals cope with stress (e.g., Lazarus & Folkman, 1984). Among the 19 categories, we found the following antecedents (project overrun, change requests, long periods of time pressure) and coping resources (prioritization, shielding, customer involvement, team commitment) least explored in stress and coping literature. Although these categories were found while examining product development teams, the findings may be applicable to teams in other settings, such as the service, hospital, or military sectors.

Finally, this thesis contributes to the time pressure literature by examining its relations with several critical team dimensions (Chapter 3 & 4). We found challenge time
pressure to improve team coordination and team performance (solution quality, development timeliness, adherence to budget, team innovativeness), and hindrance time pressure to worsen team coordination and team performance, except for team innovativeness. Not only were we interested in how challenge and hindrance time pressure influence team outcomes, we took further steps to find out how time pressure can be better managed. For instance, we found management support to increase challenge time pressure and to reduce hindrance time pressure. Team identification have also been found to sustain team coordination, especially for teams facing hindrance time pressure. All in all, our findings have enabled scholars to gain a more comprehensive view on time pressure – what are the antecedents?, what moderates (helps to cope)?, and what are its effects on certain team processes and team performance?

6.1.2 Contributions to the Product Innovation Literature

Previous studies have generally assumed that speeding up new product development affects project performance directly, without considering the possibilities of a “black box” between accelerating the development process and its outcomes. Lawrence (1997) argued that exploring the intervening subjective or process variables between variables might add explanatory variance to inconsistent relationships. An inconsistency that has been highlighted is the relationship between speeding up and product quality. Some studies have shown speeding up to improve quality (Austin, 2001; Reiner & Ericksen, 1990), while others demonstrated a negative relationship between the two (Brooks, 1975; Clark & Fujimoto, 1991). Another inconsistency is the relationship between speeding up and information sharing. Eisenhardt (1989a) found through a case study that teams make use of more information in a fast velocity environment. However, Perlow, Okhuysen, and Repenning (2002) did not find similar outcomes. Eisenhardt (2004) highlighted this inconsistency in a review and stressed a need for further investigation.

In this study, we demonstrate that these inconsistencies could be explained by bringing the effects of time pressure into the picture. Naturally, we expect speeding up to increasingly constrain team members' cognitive resources, and to cause actors to experience
time pressure. Although speeding up has an intricate effect on people's cognitive resources, human issues, like time pressure, have rarely been considered in product innovation studies (cf. King & Majchrzak, 1996). We suggest time pressure to be a critical element in the "black box" that could offer insight into the discrepancies that we have encountered in the literature. Team members may experience challenge, hindrance, or both types of time pressures depending on how speeding up was implemented. Chapter 4 showed that challenge and hindrance time pressure had opposite effects on solution quality. We could therefore deduce speeding up to have positive or negative effects on team outcomes, like quality, depending on whether a team experiences time pressure as a challenge or hindrance stress. This thinking offers to resolve inconsistency observed by Eisenhardt (2004) and several scholars on the relationships between speeding up and performance. Finally, this study demonstrates the advantages of applying findings from psychological research to the product innovation literature.

6.1.3 Contributions to the Challenge-Hindrance Stressor Framework

This thesis also serves to strengthen the challenge-hindrance stressor framework in three ways (Chapter 4 & 5). First, we add to a burgeoning research on the framework by applying it to a particular kind of stress. Thus far, LePine and his colleagues have examined the framework on generic stress (Cavanaugh, Boswell, Roehling, & Boudreau, 2000; LePine, LePine, & Jackson, 2004). By applying the framework to time pressure, we were able to address some of the inconsistencies that have surfaced in time pressure literature, especially on the positive relationship between high levels of time pressure and team outcomes. This research suggests that the challenge-hindrance stressor framework could be applied to other kinds of stress, like role ambiguity, to provide a more holistic view on the effects of those stressors on outcomes.

Second, this thesis examined the challenge-hindrance stressor framework at the team level of analysis (Chapter 4). The framework has so far been examined at the individual level of analysis. In this study, we explored how challenge and hindrance time pressure were related to some critical team outcomes that were not previously examined. Our results were
consistent with LePine and colleagues' propositions that challenge and hindrance stress will respectively lead to positive and negative performance. This study showed that the challenge-hindrance stressor framework to be extensible to the team level.

Third, this study used challenge and hindrance time pressure as moderators to explore why team proximity does not necessarily improve communication in teams (Chapter 5). We suspect that we would not have been able to uncover the moderating effect of time pressure on the proximity-communication relationship if we had conceptualized time pressure like in the earlier studies, as a unitary construct, (e.g., Andrews & Smith, 1996; Amabile, Mueller, Simpson, Hadley, Kramer, & Fleming, 2002; Baer & Oldham, 2006). This is because a unitary construct cannot distinguish between the challenge and hindrance aspects of time pressure, when only the levels of time pressure are measured. In such cases, high levels of time pressure may or may not moderate the proximity-communication relationship, depending on whether a team experiences high challenge or high hindrance time pressure. Furthermore, treating time pressure as an unitary construct is likely to result in insignificant conclusions, as the outcomes would be masked due to the aggregated effects of challenge and hindrance time pressure. In sum, our findings in Chapter 5 supports Podsakoff, Rich, LePine, and Saul's (2007) work in showing the usefulness of the challenge-hindrance stressor framework in illuminating some of the difficult to explain phenomenon in stressful work environments.

6.1.4 Contributions to the Team Proximity Literature

The topic of team proximity surfaced after analyzing the case study results for Chapter 3. The collected incidents, coupled with literature review, led us to investigate the relationship between team proximity and team communication further. In general, literature on team proximity has assumed that the shorter the distance between team members, the more effective the communication between them because of the removed physical distance for communication. In Chapter 5, our results contribute to the literature by revealing that such assumption is not always valid and that future work exploring the effectiveness of team proximity should consider its boundary conditions. Our findings showed that team proximity
improves team communication only when challenge time pressure is high or when hindrance
time pressure is low. Therefore, locating team members in close proximity do not necessarily
facilitate communication if they are not motivated or are cognitively unable to exchange
information effectively. This part of our thesis responds to Hunter and Thatcher’s (2007) plea
for more scholars to consider boundary conditions to better understand the relationships
between team dimensions at work.

6.2 Strengths & Limitations

On the whole, this research presents various strong points. A strong point of this study was to
involve practitioners at the early stages, before the multiple case study was conducted, to help
us identify areas that would add value to both academia and practice. For instance, a
presentation about ‘The impacts of time pressure on new product development teams’ was
held at Munich, Germany in January 2005. The session involved more than 35 participants;
many were managers of companies like Siemens, Infineon, and National Semiconductors.
They actively provided their views on time pressure at work, and subsequently led us to our
first research question - 'What are the antecedents of time pressure?'. At the same time, we
also conducted preliminary interviews with 8 new product developers and managers in the
Netherlands to refine the case study questions.

The second strong point is methodological. Previous investigations on time pressure
were mainly conducted in controlled environments (e.g., Amabile, DeJong, & Lepper, 1976;
Instead of using student groups in laboratory settings, we approached people who were
working in time pressured industries and collected stories related to time pressure directly
from the employees, who on average had 10 years of working experience in new product
development. Importantly, data collected from people on the shop floor allowed us to gain
realistic insight into the causes and effects of time pressure while considering the work
contexts and team dynamics. Moreover, the use of the literature review and multiple case
study enabled us to develop a survey framework that was based both on scholarly writings and incidents from the field.

Another strong point was that we involved informants from various hierarchies of a project team; developers (members), 1st level project managers (leaders), 2nd level project managers (stakeholders) in all our studies. In general, project managers are accurate sources of information at the project levels, and have been used in many innovation-related studies (e.g., Langerak & Hultink, 2005). However, engaging team members and leaders in this study was benefitting to the research outcomes. This is because time pressure, being the fundamental focus of this research, could be most appropriately understood through involving participants from the lower level hierarchies of a project as well. They are the ones who directly experience the effects of time pressure on their development work, while managers typically experience time pressure in terms of keeping the project within schedule and budget. At the same time, collecting data from the stakeholders also added strength to our analyses and conclusions, especially so when their evaluations of the teams were taken together with the team's self evaluations. Results from various hierarchies of a project thus provided a balanced view to the teams' performance.

Prior to suggesting some future research directions, it is important to consider the research outcomes in the contexts of its limitations. A limitation that spanned both the case and survey study was the use of English in our interviews and questionnaires. Although English was the most appropriate language for this study given that our participants were from different parts of Western Europe, a disadvantage was that non-native English speaking informants might lack full comprehension of the questions during the interviews or while completing the survey. Even though all participants were taught English in school and use it at work, it might limit the richness and accuracy of the data collected. A possible solution for the survey study would have been to translate our questions to German, Dutch, and French. However, translating English into various languages could be problematic due to difficulties in retaining the original meaning of sentences after translation. Despite the disadvantages of using a non-native language to conduct the research, we took a number of measures to
mitigate the possible negative effects. For instance, our interviews were recorded, fully
transcribed, and inter-rater agreement was reached. Furthermore, informants were readily
excused from the study if they felt that English was hindering their participation.

The second limitation is in the use of a cross-sectional design to test the elaborated
survey framework. Causal inference should be established carefully when cross sectional data
are concerned. The Baron and Kenny model will yield the most accurate outcome in
mediation tests when the data were collected longitudinally. However, due to difficulties in
conducting multiple waves of data collection in the field, our data are largely cross-sectional;
with different data being collected over two periods with an average time lag of 16.5 days.
Although the time lag is useful in separating short-term memory, the time lag is limited, as
the mediation and/or dependent variable should be measured at least twice (Cole & Maxwell,
2003).

In sum, we had a good sample size to test the survey framework. 81 innovation teams
consisting of 500 informants from three hierarchies of a project offered us abundant data to
adequately test our hypotheses. Nonetheless, the number of teams was still considered small
to use a method, such as structural equation modeling to test all relevant variables in a single
model. Hence, multiple regression analysis was used to test relationships, such as mediations
and moderations, separately. Although multiple regression analysis is commonly used in
social science research, the method does not allow model fit tests, which would have added
strength to the overall results. Nevertheless, future research could profit from larger samples
that allow for structural equation modeling.

6.3 Directions for Future Research

Our research has provided a number of opportunities for future investigation. Here, we
discuss the various areas that call for extended examination following the sequence of the
chapters.

In Chapter 2, we concluded the findings with a simple model, where the antecedents
of time pressure and its situational coping resources can be categorized as external or internal
(management/team) factors. The model, which was conceived using a qualitative case study, presented many opportunities for continuing research. The duration of this research did not permit us to test our findings quantitatively. Some constructs, such as project overrun, long periods of time pressure, prioritization, shielding, team commitment, and customer involvement, offer potential for future investigation. This will further our understanding on what causes teams to experience challenge and hindrance time pressure, and under what circumstances do teams perceive more of challenge and less of hindrance time pressure.

The findings in Chapter 3 demonstrate how time pressure affects various dimensions of communication (scope, depth, timeliness) in teams. In general, research has treated team communication as a unitary construct. Here, we propose scholars to conceptualize team communication based on the dimensions we have found, and to investigate the relationship between the multi-dimensional communication construct and time pressure (or other antecedents), and team performance using a quantitative approach. This may uncover interesting insight. For example, timeliness though an increasingly important characteristic of communication due to increased emphasis on schedule performance, has remained an area that only few scholars have studied (e.g., Waller, 1999). Furthermore, scanning (asking general questions) and soliciting (asking specific questions), could also offer to explain why time pressure seems to increase proactive questioning in some occasions, but not in others.

Another area that calls for future research is the team processes through which challenge and hindrance time pressure influence critical team performance. Previous work has highlighted a dire lack of understanding on how stress affects team performance (cf. Littlepage & Karau, 1997). Although Chapter 4 has shed some light on this topic by indicating the importance of team coordination as a mediating factor between time pressure and team outcomes, this area remains comparatively understudied and offers tremendous opportunities for group researchers. Not only does uncovering more mediating factors enlightening, it also allows scholars to take proactive steps to investigate how the negative (or positive) effects of time pressure on team performance can be mitigated (or enhanced).
Chapter 4 demonstrated the benefits of uncovering a mediating factor (team coordination) and the respective moderator (team identification).

So far, this study has focused on performance criteria that generally have short-term implications for organizations. Future studies should consider other performance criteria, such as learning, employee turnover (Argote, Insko, Yovetich, & Romero, 1995), firm adaptability (Lewin, Long, & Carroll, 1999), or intra-organization conflict that have long-term implications on organization vitality.

In this study, we have argued that team members could experience time pressure collectively based on emotional contagion theory. We expect this theory to apply in our context because time pressure affects most team members working in short-cycled industries (Barczak & Wilemon, 2003). Under such circumstances, people are more likely to identify with and transfer emotions that are related to time-related stressors as compared to team members in industries or jobs where time is not a key factor towards task accomplishment. We recommend scholars to explore whether team members experience other types of stress, such as role ambiguity or job insecurity, collectively. We suspect that it may be difficult to find empirical evidence to support aggregation of items relating to job insecurity for instance, based on emotional contagion theory if job insecurity is affecting only a small proportion of a project team. That said, such aggregation might be meaningful if investigations are done in organizations undergoing a merger or acquisition. And emotional contagion theory may serve to explain how job insecurity is experienced collectively in a team.

Finally, this research was conducted only in new product development context. This limits the external validity of our findings. Although innovation teams aptly served as the sample of our investigation given that such teams are typically under time pressure, the results need to be applied cautiously to other work sectors. This is because factors leading to time pressure may differ as a result of work environments. For instance, people working in hospitals are likely to experience time pressure differently from innovation team developers, as employees in the former scenario often have to deal with safety, and life-and-death situations. Thus, what leads to challenge and hindrance time pressure may also vary, causing
the scales that we had developed for this study to be less appropriate for the healthcare sector. Nevertheless, we suggest that the theory related to the two time pressure dimensions to be extensible to other work sectors, while the respective effects of time pressure and how the constructs are measured needs re-examination. In addition, as discussed in Chapter 4 and 5, extending our findings directly to other geographies, especially the Middle East or Far East may appear problematic as the perceptions of time pressure change with culture, norms, and legal policies. Therefore, extending this research to countries in the East may reveal interesting and insightful outcomes.

6.4 Contributions to Practice

This study has originated from a need to understand the effects of time pressure in corporate settings. Hence, our results are immediately applicable to practitioners. This is especially so given that our data was collected from informants working in time pressured projects. There are several recommendations that could be offer to practitioners as a result of this research.

A contribution to practice is in providing a framework (Chapter 2) to illustrate what leads to time pressure and what helps team members to cope with intense time pressure. So far, antecedents of and coping strategies during stress have been gathered through investigation relating to generic stress (e.g., Lazarus & Folkman, 1984) and in contexts that were generally different from fast-paced environments. This may limit the extensibility of earlier results to innovation teams. This research demonstrates that time pressure stems from external and internal factors. While management has little control over external factors (market forces & technological complexity), it is able to reduce time pressure by eliminating certain antecedents, such as management attention, unrealistic schedule, project overruns, and long periods of time pressure. All these originate from within the project or organization. There are other antecedents of time pressure, like multiple project staffing, interruptions, fuzzy specifications and change requests, which are inherent in new product development and may be difficult to avoid given the nature of product development. Management could, nevertheless, make choices to abate the unpleasant influences of these factors. For instance, a
team member may find working in multiple projects stimulating. However, such enjoyment is likely to cease if the person is assigned to too many projects at one time. The benefits then erode and actors become more likely to experience hindrance time pressure. Similarly, research has shown interruptions to be advantageous (Jett & George, 2003). However, interruptions are associated with detrimental effects when they often become too frequent, which unfortunately leads to negative emotions (Jett & George, 2003) and reduce team members' ability to focus (Perlow, 1999). These examples show that though some antecedents are inherent parts of innovative and fast-paced environments, their negative effects could be reduced if appropriate actions are taken.

At the same time, this thesis (Chapter 2) also presents several situational factors that help team members to cope with time pressure. Importantly, the results recommend management to pay attention to cultivating a committed, supportive, and confident team climate, especially for teams functioning with extremely difficult deadlines. Our findings suggest that teams that experience more coping factors than negative antecedents of time pressure tend to remain effective under intense time pressure (e.g., Microfine). This again highlights the importance of creating a work environment that increases the situational coping resources of NPD teams (see Table 1.3 & 1.4).

The case study also explored the effects of time pressure on communication in teams (Chapter 3). We found time pressure to cause team members to place priority on personal tasks and to affect various communication dimensions (formality, scope, depth, timeliness). Although content analysis showed that most of the cited incidents appeared to be consequences of hindrance time pressure, whereas challenge time pressure may lead to more positive outcomes, we recommend management to actively facilitate information sharing and put in place coordination mechanisms within and across sub-teams when members are in hot phases of a project. This is because members are likely to overlook coordination details and collaboration efforts when teams face hindrance time pressure. Furthermore, time pressure appeared to have worse effects on communication across sub-teams than within sub-teams of a project. This is not surprising since members from the same sub-team are more likely to
support one another than colleagues belonging to other sub-teams, when time is scarce. This outcome highlights that management of multi-team projects needs to creatively encourage collaboration across sub-teams. This could be achieved through emphasizing superordinate goals and implementing reward structure that encourage teamwork and focus on team activities.

This research also recommends management to rethink the way time pressure may affect team performance. Past research has taught practitioners to associate the relationship between time pressure and performance with the inverted-U model. A popular notion that surfaced as a result is that people perform optimally only if their levels of felt time pressure are at the peak of the inverted-U curve. This thinking has induced management in search of optimal time pressure to inspire its people to deliver. However, the inverted-U concept is difficult to apply in practice given that optimal points are vastly arbitrary and tend to differ more between individuals in a team than if they are asked to agree if a time-related stressor cause positive or negative outcomes. This research offers practitioner to consider the effects of time pressure by considering the challenge and hindrance nature of time pressure. Although the idea that time pressure has positive and negative effects on performance has existed for more than two decades (Selye, 1982), practitioners have rarely used the idea to explain the time pressure-performance relationship. Here, the case study provided signs that time pressure may follow a two-dimensional factor structure. This proposition was tested and demonstrated through the survey study (Chapter 4). Importantly, challenge and hindrance time pressure have opposite effects on team processes (coordination) and team performance (quality, timeliness, and cost). The outcomes imply that teams can perform well under time pressure if they experience high challenge time pressure and low hindrance time pressure. This understanding reveals that teams can remain viable even under intense time pressure if the stress is perceived as joyful, satisfying, and stimulating. This study also suggests that management can play an active role in influencing how its team perceives time pressure at the workplace. The scales that were developed to measure the two-dimensional time pressure provide hints on how management can heighten challenge time pressure and reduce hindrance
time pressure. For example, hindrance time pressure may be reduced by indicating clearly when a high time pressure period will end and by ensuring that it does not continue for too long. Challenge time pressure, on the other hand, may be heightened by impressing the importance of accomplishing a team task on time (see Appendix: Challenge & Hindrance Time Pressure Scales). In the same vein, our findings (Chapter 4) also demonstrate the importance of management support in increasing challenge time pressure and decreasing hindrance time pressure in teams. Actions like encouragement, involving team members in decision making, prioritizing tasks, providing adequate resources, having explicit goals, and commitment to make the project successful all work together to create a sense of management support.

Importantly, our investigation revealed that hindrance time pressure have less negative effects on team coordination, if a team experiences high team identification. Theory explains that hindrance stress threatens team coordination by causing team members to overlook social signals, such as facial expression, feedback, and requests for support and information. These signals are important for team members to synchronize their workflow processes. Our findings suggest that teams that are aware of the need for interdependency, or are emotionally attached to one another, to remain paying attention to social cues even under hindrance time pressure situations. This explains why teams with high team identification to coordinate well despite high hindrance time pressure. Our results highlighted that management should nurture their teams to develop team identification. If successfully developed, such teams could be positioned strategically in projects where time pressure is intense and where the stakes are high. Often the nurturing process requires retaining team membership so that team members are able to grow in collectiveness over time through working together on numerous projects. Such recommendation may contradict the matrix organization design where employees are allocated to projects according to skill sets. In many occasions, members of even high performance teams are seldom retained to work together in another project. Nonetheless, it may be time to rethink the matrix organization design given
that it was a strategy conceived more than four decades ago (Mee, 1964) when market competition was not yet as intense and time pressure not as pressing as today.

Finally, this research examined the role of challenge and hindrance time pressure to further explain the proximity-communication relationship in teams (Chapter 5). The results demonstrate that co-location does not necessarily improve team communication and the outcomes depend, in part, on the nature of time pressure that is affecting colocated teams. Interestingly, teams benefited from colocation only when they experienced high challenge time pressure and low hindrance time pressure. This highlights to practitioners that simply colocating members does not reap fruits for team communication. Team members need to be challenged by the work environments to exchange information with one another.

6.5 Closing Remarks
This thesis demonstrates that time pressure is like a double-edged sword, and is able to enhance or hinder team outcomes. Can teams strive under intense time pressure? Certainly - but only if time pressure is perceived to be challenging. Importantly, this thesis also uncovered many situational factors that help teams to perceive time pressure positively. At this point, we urge both scholars and practitioners to make use of our findings to further our understanding on how teams can remain effective in face of intense time pressure.
References


George, J. M., & James, L. R. 1993. Personality, affect, and behavior in groups revisited: Comment on aggregation, levels of analysis, and a recent application of within and between analysis. *Journal of Applied Psychology*, 78: 798-804.


Appendix

Measures

General Questions

For all participants:

• Age (since your last birthday):
• Gender:

  Male / Female
• What is your highest education qualification?

  Diploma / Bachelors / Masters / Ph.D / Others
• How many years have you been involved in new product development?
• How many months have you been working in this team?
• Which function of product development are you currently in?

  Software / Mechanical / Electrical / Systems / Others (please state)
• Which of the following region is the country of your nationality?

  N/W/E/S Europe / Asia / Africa / North America / South America / Australia & NZ

Challenge Time Pressure

To what extent do the following cause the team to experience positive time pressure [makes the team feels good, joyful, satisfied, stimulated] in the project? (1 = strongly disagree to 7 = strongly agree)

• The importance of completing this project on time.
• The degree to which team members depend on one another to finish this project on time.
• The urgent need for successful completion of the work the team is doing.
• The extent to which the team committedly works together to complete the project on time.
• The technological complexity that the team needs to overcome to complete this project on time.

Hindrance Time Pressure

To what extent do the following cause the team to experience negative time pressure [makes the team feels annoyed, bothered, discouraged] in the project? (1 = strongly disagree to 7 = strongly agree)

• The impossibility to fulfill the project schedule
• The lack of time buffer that is planned for this project.
• The excessive reporting of the project team status required by the management.
• The number of changes on the team tasks at the late stages of the project.
• The inability for the team to do more iteration to improve the project deliverables.
• The amount of constant switching between tasks for the team in a day.
• The persisting period of high time pressure the team experienced.
• The imbalance in my team members' personal lives due to the time pressure from this project.

Management Support
For each statement, use the following scale to indicate which is most descriptive of your management (project manager and above). (1 = strongly disagree to 7 = strongly agree)

The management:
• provides adequate resources for the team to achieve its goals.
• involves the team in decision making.
• is committed to make this project a success.
• encourages the team.
• provides explicit project goals.
• prioritizes tasks for the team.

Team Identification
For each statement, use the following scale to indicate which is most descriptive of your team. (1 = to little extent; 7 = to great extent)

To what extent do you:
• feel emotionally attached to the team?
• feel a strong sense of belonging to the team?
• feel as if the team’s problems are their own?
• feel like part of the family in the team?
**Team Coordination**

For each statement, use the following scale to indicate which is most descriptive of your team. (1 = strongly disagree to 7 = strongly agree).

* Our team worked together in a well-coordinated fashion.
* Our team had very few misunderstanding about what to do.
* Our team needed to backtrack and start over a lot. *(reserved coded)*
* We accomplished the task smoothly and efficiently.
* There was much confusion about how we would accomplish the task. *(reserved coded)*

**Team Communication**

For each statement, use the following scale to indicate which is most descriptive of your team. (1 = strongly disagree to 7 = strongly agree).

* There was frequent communication within the team.
* The team members communicated often in spontaneous meetings, phone conversation, etc.
* The team members communicated mostly directly and personally with each other.
* There were mediators through whom much communication was conducted. *(reserved coded).*
* Project-relevant information was shared openly by all team members.
* Important information was kept away from other team members in certain situations. *(reserved coded).*
* In our team there were conflicts regarding the openness of information flow. *(reserved coded).*
* The team members were happy with the timeliness in which they received information from other team members.
* The team members were happy with the precision of the information received from other team members.
* The team members were happy with the usefulness of the information received from other team members.

**Solution Quality**

Focusing on problems that your team encountered during the project, to what extent do you agree or disagree with the following statements? (1 = to little extent; 7 = to great extent).
• The solutions found were quality solutions for the problems we faced.
• The solutions implemented lack thorough checks and evaluation. (reserved coded)
• The solutions found improved the overall quality of the product.
• The solutions found for the problems encountered were very creative.
• The solutions found generally need to be reworked. (reserved coded)

**Development Timeliness**

Focusing on the pace of development, schedule delays, and rework, to what extent do you agree or disagree with the following statements? (1 = agree very little to 7 = agree very much)

• The product duration met the planned time schedule.
• The project achieved all the major milestones as planned.
• The length of the project met the planned objectives better than previous projects.
• The speed of development was faster than previous projects.
• This product could have been developed in a shorter time. (reserved coded)

**Adherence to Budget**

To what extent do you agree or disagree with the following statements? (1 = agree very little to 7 = agree very much).

• The team operated in a cost-efficient manner.
• The team did a good job adhering to its budget.
• The team’s project is over budget. (reserved coded)

**Team Innovativeness**

To what extent do you agree or disagree with the following statements? (1 = to little extent; 7 = to great extent).

• Team members introduce many innovations and new ideas.
• Team members are not adaptable to changes. (reserved coded)
• Team members gave little consideration to new methods and procedures to accomplish its work. (reserved coded)
• The deliverables of team members are innovative.
• Team members’ overall technical performance is above expectation.

*Job Satisfaction*

For each statement below, use the following scale to indicate what is most descriptive of your current job. (1 = to little extent; 7 = to great extent).

• I feel fairly well satisfied with my present job.

• Most days I am enthusiastic about my work.

• Each day of work seems like it will never end. *(reserved coded)*

• I find real enjoyment in my work.

• I consider my job rather unpleasant. *(reserved coded)*

*Task Complexity*

For each statement below, indicate the extent to which you agree with it. (1 = strongly disagree to 7 = strongly agree)

• The task-output delivered by our team was technically complex to achieve.

• The team had to use non-routine methods to accomplish its tasks.

• The process associated with achieving the team tasks was relatively simple. *(reserved coded)*

• Development of this product required pioneering innovation.

• The product developed by our team is/was complex.
Curriculum Vitae

Darrel Chong was born on October 20, 1978 in Singapore. He graduated from the National University of Singapore (NUS) with Bachelors (Hons) in Electrical and Computing Engineering in 2003. In the same year, he was accepted into a joint PhD program offered by the Industrial Systems Engineering Department of NUS and Technology Management Department of Technische Universiteit Eindhoven (TUe). This thesis is the result of extensive collaboration with MNCs like Philips, NXP, ASML, Infineon, and Oce in the Netherlands, Germany, and Belgium to investigate the effects of time pressure on new product development teams. His research is published in *Journal of Product Innovation Management*, *IEEE Transactions on Engineering Management*, and presented at *Academy of Management Conference*.

He currently holds a position of regional marketing manager (Asia Middle East) of APL Logistics, a business unit of NOL Group based in Singapore. The group specializes in container shipping, terminal, and supply chain management, and has revenue of US$9.3 billion in 2008. Darrel was also a recipient of the Keppel Group Scholarship (2000-2003), and IEEE RAB Achievement Award (2007).