University of Bamberg

Promoting Digital Innovation and Transformation

Innovation Champions in the Digital Age

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This dissertation is dedicated to my partner for his strong support and trust in me during my dissertation journey with its ups and downs, to my parents, who taught and encouraged me to be ambitious in pursuing my goals, and to my sister, who has always been there for me as my best friend.

"*Let us be certain of who we want to be. Let us choose for ourselves our path in life, and let us try to strew that path with flowers.*" - Émilie du Châtelet

Foreword

by Prof. Dr. Heinz-Theo Wagner

Innovation champions - the topic of Katharina Drechsler's thesis – is a significant subject matter in innovation research that has been discussed since it was first introduced in the early 1960s. Innovation champions are individuals who vigorously promote innovation, even against resistance, and inject life into companies' innovation processes. The general concept of a champion as well as championing behavior has been explored across different disciplines such as Information Systems, Innovation Management, and Strategic Management. Studies have investigated champions' characteristics and effects, including considerations about the organizational environment.

In particular, in the era of Digital Innovation, characterized by generativity and convergence, the concept of a champion has gained increasing importance for the following reasons. Generativity relates to the characteristic of digital innovation and its underlying technology to create unprompted changes that are driven by distributed and, at least in parts, uncoordinated actors. Convergence brings together previously separated parts such as user experience, organizations, and entire industries. These two characteristics of digital innovation point to the increasing significance – and even indispensable commitment - of innovation champions to vehemently promote innovation because centralized control of activities, adherence to prescribed processes, and confinement to some organizational boundaries, which characterize traditional innovation, no longer hold. However, although research acknowledges the importance of digital innovation and its fundamental difference compared to traditional innovation, there are surprising research gaps regarding the nature, and effects of innovation champions including the characteristics of promoting environmental conditions.

The thesis of Katharina Drechsler aims at these challenges, discusses how the perspective of research on innovation champions should change, and develops a differentiated understanding of the innovation champion in a digital environment. In particular, the thesis addresses the overarching question about the nature of a "digital" innovation champion, and the individual and organizational determinants influencing championing behavior and activities.

Katharina Drechsler's work impresses with its variety of theoretical lenses, concepts, and methods applied, which is appropriate and corresponds to the variety of aspects of innovation champions investigated. This variety is not only appropriate for the phenomenon at hand but also necessary to scrutinize existing concepts related to innovation champions, develop concepts further, clarify relationships between these concepts, and reveal new ones.

The contributions achieved significantly extend our knowledge of innovation champions, capture the "digital" as opposed to traditional theoretical approaches, thus shaping our understanding of champions in a digital context, and elaborate and substantiate promising areas of future research.

For researchers, the thesis offers a variety of perspectives on and a solid fundament for a more sophisticated understanding of innovation champions. This is a must-read for those interested in innovation champions.

Prof. Dr. Heinz-Theo Wagner
(February 2023)

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Most importantly, I owe deep gratitude to my closest family for their unwavering support and encouragement throughout the course of my doctoral dissertation. I am deeply grateful to my parents Martina and Karl for encouraging me to follow ambitious goals in life and for supporting me on this journey. My special thanks also goes to my sister Victoria, for our invaluable friendship and for her great research assistance. My biggest thank you goes to my partner and "media naranja" Ruben, for believing in me, supporting me with his love through all the ups and downs of my journey, and enabling me not to lose sight of the forest for the trees.

Katharina Drechsler
(February 2023)

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Zusammenfassung

German Summary

Die bedeutende Rolle von Innovation Champions für den Erfolg von Innovationsprojekten wurde in der bisherigen Forschung im Bereich Innovationsmanagement umfassend nachgewiesen (vgl. Howell & Shea, 2001; Walter et al., 2011). Innovation Champions sind einzelne Akteure[1], die eine Innovation durch die verschiedenen Phasen des Entwicklungsprozesses hinweg, auch gegen Widerstände und unter Inkaufnahme von Risiken, entschlossen vorantreiben (Howell & Higgins, 1990; Howell & Shea, 2001; Jenssen & Jørgensen, 2004). In ihrem Bestreben, sowohl inkrementelle als auch radikale Innovationen zu fördern, nutzen Innovation Champions eine Reihe von Strategien, wie beispielsweise den Aufbau von Beziehungen und sozialen Netzwerken oder die Sicherung der Unterstützung durch das Management (Jenssen & Jørgensen, 2004).

Das digitale Zeitalter, das durch die Verbreitung digitaler Technologien und die miteinander verflochtenen Phänomene der digitalen Innovation und der digitalen Transformation geprägt ist, stellt aufgrund seiner besonderen Charakteristika das bisherige Wissen über Innovation Champions in Frage. Digitale Innovationen entstehen aus einer Rekombination von bis dato unverbundenen Wissenselementen, die aus verschiedenen Branchen stammen (Barrett et al., 2012; Yoo et al., 2012). Infolgedessen entstehen digitale Innovationen durch die Zusammenarbeit von häufig wechselnden Zusammenschlüssen von verschiedenen Akteuren (Nambisan et al., 2017). Zugleich zeichnen sich digitale Technologien durch ein hohes Maß an Generativität aus, was zu ständigen und spontanen Veränderungen von digitalen Innovationen führt (Yoo et al., 2012; Zittrain, 2006).

Zum einen unterstreichen diese Veränderungen die Rolle von Innovation Champions für die Orchestrierung der sich schnell wandelnden Entwicklungsprozesse von digitalen Innovationen. Zum anderen können sie auch erhebliche Auswirkungen auf die Arbeitsweise und das Arbeitsumfeld von Innovation Champions haben. Obwohl die vielschichtige Rolle von Akteuren im Allgemeinen als wichtig für unser Verständnis von digitalen Innovationen angesehen wird (Nambisan et al., 2017), wurde die spezifische Rolle von Innovation Champions im digitalen Zeitalter in der Literatur kaum untersucht. Diese Dissertation analysiert die individuellen und organisationalen Determinanten erfolgreicher Innovation Champions im digitalen Zeitalter, indem sie die folgende Forschungsfrage stellt: *Was macht Innovation Champions im digitalen Zeitalter erfolgreich?*

Bei der Beantwortung dieser Forschungsfrage werden in dieser Dissertation zwei Arten von Innovation Champions im digitalen Zeitalter untersucht. Einerseits wurde in der vorhandenen Literatur auf die Bedeutung von Champions digitaler Innovationen in Führungspositionen auf

[1]Der Begriff „Innovation Champion“ ist nicht zu verwechseln mit dem Begriff „Hidden Champion“, der häufig für kleine oder mittlere, hochspezialisierte Unternehmen verwendet wird, die Weltmarktführer sind (Simon, 1990).

C-Ebene hingewiesen. So wurden Chief Digital Officers (CDOs) und seltener Chief Information Officers (CIOs) als Champions digitaler Innovationen charakterisiert, deren Hauptaufgabe in der Förderung digitaler Innovationen und Orchestrierung digitaler Initiativen im Unternehmen besteht (Peppard et al., 2011; Tumbas et al., 2017). Andererseits bieten digitale Technologien Unternehmen die Möglichkeit organisationale Prozesse umzugestalten, um ihre Mitarbeiter stärker in Innovationsprozesse einzubinden (Benbya & Leidner, 2018). Unternehmen, insbesondere große Technologieunternehmen, haben dieses Potenzial ihrer Mitarbeiter zunehmend erkannt, indem sie Arbeitsmodelle und Plattformen für Mitarbeiter eingerichtet haben, um kollaborativ an Innovationsprojekten zu arbeiten und Innovation Champions zu fördern.

Diese Dissertation umfasst vier Kapitel mit insgesamt 12 Forschungsartikeln, in denen individuelle und organisationale Determinanten für den Erfolg von Managern und Mitarbeitern zur Förderung von Innovationen identifiziert und unser Verständnis des veränderten Wesens von digitalen Innovationen und digitaler Transformation vertieft werden. Kapitel I zeichnet die Entwicklung des Innovation Champions Konzepts nach, führt das vorhandene Wissen über Innovations-Champions zusammen und zeigt Wege für die zukünftige Forschung auf. Kapitel II konzentriert sich auf Innovation Champions auf der C-Ebene und bewertet ihren Einfluss auf den Unternehmenserfolg. Kapitel III beleuchtet die Rolle der Mitarbeiter als Innovation Champions und untersucht, wie sie in die Lage versetzt werden können, Innovationen in einem Unternehmen zu fördern. In Kapitel IV wendet sich der Fokus von Innovation Champions hin zur Untersuchung digitaler Innovation und Transformation. So wird in Kapitel IV ein Verständnis für den sich verändernden Kontext geschaffen in dem Innovation Champions im digitalen Zeitalter agieren.

Die Ergebnisse dieser Dissertation zeigen auf, dass eine Vielzahl von individuellen und organisationale Faktoren zusammenwirken müssen, wenn Innovation Champions in ihren Bemühungen Innovationsprojekte zu fördern, erfolgreich sein sollen. Bestehende Literatur verdeutlicht, dass im digitalen Zeitalter Champions Innovationen zunehmend als Teil einer vielfältigen Gruppe von Akteuren, die gemeinsam und arbeitsteilig agieren, vorantreiben. Dies erfordert Veränderungen im organisationalen Umfeld der Champions, z. B. in Bezug auf die Zusammenarbeit und Koordinierungsmechanismen innerhalb dieser Gruppen von Akteuren. Zugleich hebt die Untersuchung der Finanzmarktreaktion auf die Ernennung eines CDOs als Innovation Champion auf der C-Ebene, die bedeutende Rolle des Machtprofils ebendieses CDOs für die Wahrnehmung durch die Anleger am Finanzmarkt hervor. Die Analyse zeigt beispielsweise, dass sich die allgemein positive Finanzmarktreaktion für CDO Ernennungen auf neue Positionen für CDOs mit schwachem Machtprofil umkehren kann. Dabei identifiziert die Dissertation empirisch den bedeutenden Einfluss von Prestige- und Expertenmacht für CDOs - zusätzlich zu der allgemein untersuchten strukturellen Macht. Gleichzeitig werden Unterschiede in der Finanzmarktreaktion für CDO und CIO Ernennungen aufgezeigt. Darüber hinaus belegen die Ergebnisse dieser Dissertation, dass der Erfolg von Mitarbeitern, die als Champions agieren, durch die Nutzung einer digitalen Plattform in Kombination mit einem Arbeitsmodell erheblich gesteigert werden kann.

Die im Rahmen dieser Dissertation erarbeiteten Ergebnisse bieten neue Erkenntnisse für Forschung und Praxis. Die durchgeführte systematische Analyse der Literatur ermöglicht es, ein umfängliches Verständnis für Innovation Champions zu gewinnen und die bisher existierenden Literaturanalysen insbesondere durch eine interdisziplinäre Perspektive zu komplementieren. Gleichzeitig erweitert diese Dissertation bisher existierende Erkenntnisse zur positiven Finanzmarktreaktion auf die Ernennung von CIOs (Chatterjee et al., 2001). Durch die Kontrastierung

von positiven und negativen Finanzmarktreaktionen für CIO und CDO Ernennungen im digitalen Zeitalter trägt diese Dissertation zu einem nuancierten Verständnis von Finanzmarktreaktionen für IT Führungskräfte im digitalen Zeitalter bei. Durch die Identifizierung des bedeutenden Einflusses von Prestige- und Expertenmacht für Innovation Champions auf der C-Ebene im digitalen Zeitalter wird darüber hinaus unser bisheriger Kenntnisstand zur Rolle von Macht für funktionale Führungskräfte erweitert und eine neue Theorie der Wirkung von CDOs vorgeschlagen.

Ebenso erweitert diese Dissertation unser Wissen über die Förderung von Champion Aktivitäten unter Mitarbeitern. Dabei bieten die abgeleiteten Designprinzipien, die die Gestaltung einer digitalen Plattform zur Förderung von mitarbeitergetriebenen Innovationen sowie zur Identifizierung von Innovation Champions beschreiben, konkrete Leitlinien zur Schaffung eines innovativen Arbeitsumfelds. Zugleich adressiert das gewonnene Wissen bestehende Herausforderungen im Design solcher Plattformen (de Reuver et al., 2018). Abschließend räumt die Dissertation auf der Grundlage der empirischen und theoretischen Erkenntnisse dieser Arbeit mit Mythen über Innovation Champions auf und entwickelt eine neue Konzeptualisierung von Innovation Champions.

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Introductory Paper

Promoting Digital Innovation and Transformation

Innovation Champions in the Digital Age

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Promoting Digital Innovation and Transformation

Innovation Champions in the Digital Age

1 Introduction

Where radical innovation is concerned, the emergence of a champion is required. [...] the new idea either finds a champion or dies. - Schön (1963, p.84)

The world is starving for new ideas and great leaders who will champion those ideas. - Lisa Su, CEO of Advanced Micro Devices, Inc. (as cited in Pressman, 2017)

Half a century has evolved since the scholar Donald A. Schön first identified the vital role of innovation champions while studying military innovation. The significance of champions for companies' success has persisted unabated ever since, as the recent quote by Lisa Su, Chief Executive Officer of the semiconductor company Advanced Micro Devices, Inc., highlights. In line with anecdotal evidence, Innovation Management research has demonstrated a strong positive relationship between innovation champions and innovation projects' success (e.g., Howell & Shea, 2001; Walter et al., 2011).

Innovation champions are defined as individual actors[2] who promote an innovation vigorously through the various stages of the development process against resistance and by taking risks (Howell & Higgins, 1990; Howell & Shea, 2001; Jenssen & Jørgensen, 2004). In their endeavor to drive incremental as well as radical innovation, champions sell promising ideas to other members of the organization (e.g., Howell & Higgins, 1990), share information and knowledge (e.g., Chakrabarti & Hauschildt, 1989), build relationships and social networks (e.g., Howell & Shea, 2006), and advocate for management support (e.g., Howell & Shea, 2001).

The digital age, characterized by the widespread diffusion of digital technology and the new intertwined phenomena of digital innovation and digital transformation, challenges extant knowledge on innovation champions due to its distinct characteristics. The increasing ubiquity of digital technologies, such as data analytics (Günther et al., 2017), cloud computing (Du et al., 2016), and the internet of things (IoT) (Oberländer et al., 2018), has caused disruptions in companies' competitive landscape and has mounted pressure on companies to change their strategic direction (Vial, 2019). Numerous companies have undergone digital transformation by fundamentally shifting their value creation process and overhauling their organizational identity (Vial, 2019; Wessel et al., 2021).

The distinct characteristics of digital technology, such as reprogrammability, homogenization of data, and its self-referential nature (Yoo et al., 2010), have triggered fundamental changes in the way companies organize to enable innovation (Nambisan et al., 2017; Yoo et al., 2012) and the nature of innovation (Fichman et al., 2014; Yoo et al., 2010). Thus, the new layered modular architecture of digital innovation affords unparalleled opportunities through "new combinations

[2] The term 'innovation champion' should not be confused with the term 'hidden champion', frequently used to refer to small- or medium-sized, highly specialized companies which are world-market leaders (Simon, 1990).

of digital and physical components to produce novel products" (Yoo et al., 2010, p.725). As a result, digital technologies are characterized by high levels of generativity, leading to the constant, spontaneous change and malleability of digital innovation (Yoo et al., 2012; Zittrain, 2006). This ever-changing nature of digital innovation and its development process underscores the role of innovation champions in orchestrating and managing rapidly changing digital innovation, while it also transforms the work environment of innovation champions.

Furthermore, digital innovation relies on combinations of unrelated stocks of knowledge stemming from different industries (Barrett et al., 2012; Yoo et al., 2012). Consequently, digital innovation is continually created through the collaboration of diverse, distributed and frequently changing assemblies of actors (Bogers & West, 2012; Nambisan et al., 2017). Thus, digital technology changes the nature of agency in digital innovation, i.e., the composition of actors involved in digital innovation, and the way they drive digital innovation, such as their social interactions and knowledge exchange. These changes may also have significant implications for innovation champions, as key innovation actors, regarding their nature and way of working.

In summary, the distinct characteristics of the digital age have fundamentally increased the importance of champions' role in driving digital innovation, while also changing innovation champions' nature, ways of working and working environment. Although the multifaceted role of actors is essential to explaining digital innovation, in general (e.g., Nambisan et al., 2017; Yoo et al., 2012), their complex role and shifts in their environment have scarcely been researched. This is illustrated by a recent call for research on the interactions of innovation actors (Holmström, 2018). To address this knowledge gap regarding innovation champions, as one particular innovation actor in the digital age, this dissertation poses the following overarching research question:

What makes innovation champions successful in the digital age?

In answering this research question, this dissertation focuses on individuals, rather than organizations, acting as champions. Individuals taking on the role of innovation champions can be employees across all ranks of an organization, from the ordinary worker to the executive manager (Jenssen & Jørgensen, 2004; Kawakami et al., 2015). This dissertation explores two types of innovation champions in the digital age, C-level managers and lower-level employees.

First, the existing literature has pointed to the significance of champions of digital innovation in C-level management positions, also called executive champions. Thus, Chief Digital Officers (CDOs), and less frequently Chief Information Officers (CIOs), have been characterized to champion digital innovation by identifying the promotion of digital innovation as one of their key tasks, along with the orchestration of digital initiatives to drive the digital transformation (Peppard et al., 2011; Singh & Hess, 2017; Tumbas et al., 2017). Moreover, CDOs' presence has been shown to amplify the positive relationship between digital knowledge in top management teams (TMT) and companies' level of digital innovation (Firk et al., 2022). However, the direct impact of CDOs on organizational performance and the role of individual and organizational characteristics in influencing this relationship have not been explored in research.

Second, digital technologies allow companies to transform organizational processes and infrastructure to increase their employees' involvement in innovation processes (Benbya & Leidner, 2018; Soukhoroukova et al., 2012). Companies, especially technology companies, have increasingly become aware of their employees' potential and set up work models and platforms for employees

to work collaboratively on innovation projects and encourage championing behavior[3] (Benbya & Leidner, 2018; Ciriello & Richter, 2015). Despite the high potential of such platforms as catalysts of companies' innovation activities, the organizational charactristics enabling championing behavior among employees are less understood.

This dissertation is guided by the champion model proposed by Jenssen and Jørgensen (2004). This model postulates that innovation champions rely on resource acquisition strategies to promote innovation and drive organizational performance. Innovation champions' human and social capital form enablers of their resource acquisition strategies. In turn, the success of these strategies in driving organizational performance is influenced by organizational and environmental characteristics (Jenssen & Jørgensen, 2004). Yet, created almost two decades ago, the model does not account for the distinct characteristics of the digital age. Since digital technologies' specific characteristics challenge the general knowledge of innovation processes, the model is extended to account for innovation champions' changing nature and working environment when they promote innovation in the digital age. Using this extended champion model as a guiding lens allows this dissertation to build a comprehensive understanding of innovation champions' determinants of success.

In exploring innovation champions in the digital age, this dissertation comprises this introductory paper and twelve papers. Figure 1 illustrates the dissertation's overall structure. This **introductory paper** lays the dissertation's groundwork by motivating the research, reviewing related literature, identifying relevant research gaps, and laying out the theoretical foundation. It also outlines the different research methods and analytical approaches used throughout the dissertation and the main research results of the twelve papers. This introductory paper discusses the dissertation's implications for theory and practice and moves towards a novel concept of innovation champions in the digital age by unraveling established myths. Finally, it discusses limitations, proposes opportunities for future research, and concludes.

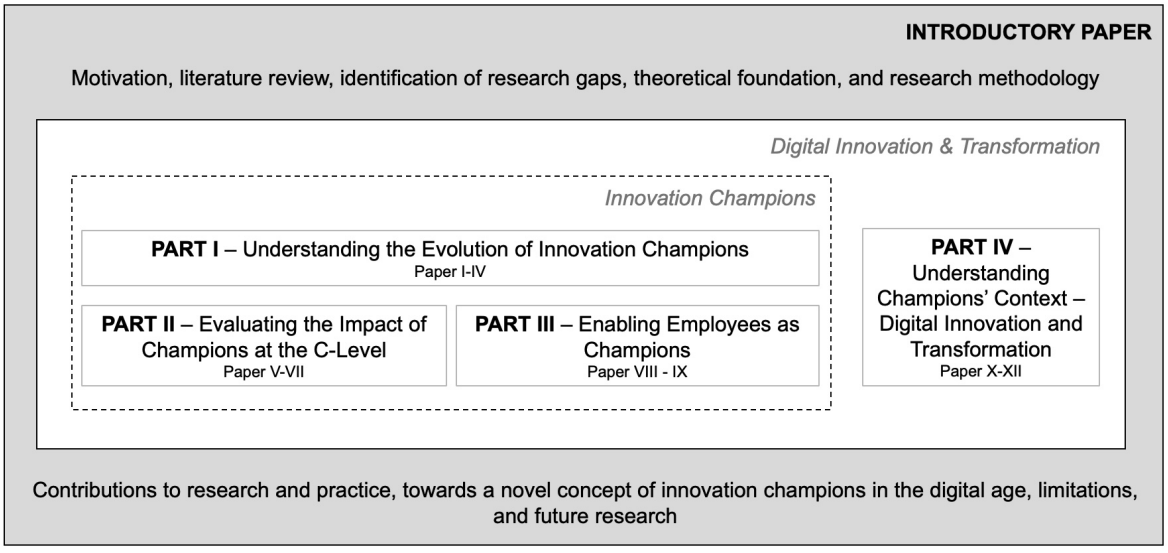


Figure 1: Structure of the dissertation

The four parts of the dissertation, comprising twelve research papers, form the centerpiece of the dissertation by answering the research gaps identified in the introductory paper. **Part I**

[3]It should be noted that employees' championing behavior falls within a spectrum (e.g., Markham & Griffin, 1998), with many employees exhibiting some championing behavior. Still, few take over innovation champions' role by satisfying all definition criteria and demonstrating assertive championing behavior (see Section 2.1.1).

traces the evolution of innovation champions by reviewing existing knowledge on innovation champions and identifying avenues for future research. In doing so, Part I forms the stepping stone for Part II to Part IV, as it motivates their research focus. **Part II** focuses on innovation champions at the C-level and evaluates their impact on organizational performance. **Part III** spotlights the role of employees as innovation champions and explores how they can be enabled to promote innovation in a company. **Part IV** turns from focusing on innovation champions towards studying digital innovation and transformation. Thus, Part IV builds an understanding of the changing context in which innovation champions operate by exploring the distinct nature of digital innovation and transformation.

2 Theoretical Background

This dissertation's related literature and theoretical foundation are presented in the following. First, in Section 2.1 the concept of innovation champions is introduced and extant literature is reviewed. Subsequently Section 2.2 discusses the digital age, which forms the research context of this dissertation, and its distinct characteristics based on existing research. Bringing the two research streams together, Section 2.3 describes the role of innovation champions in the digital age and provides a literature review. Based on the conclusions drawn from existing literature, five research questions are subsequently derived in Section 2.4. Finally, Section 2.5 introduces the essential theoretical lenses and research streams on which the different papers within this thesis draw: social network research, socio-technical systems (STS) theory and managerial power theory.

2.1 Innovation Champions

This Section traces the origin of the innovation champion concept and provides a definition and characterization of the innovation champion role (Section 2.1.1). Additionally, other roles that overlap with the champion role are shortly described (Section 2.1.2).

2.1.1 The Concept of Innovation Champions

The essential importance of innovation champions for successful ideas and innovation was first and foremost recognized more than half a century ago. In studying military innovation, Donald A. Schön discovered the essential role of innovation champions in the innovation development process and presented the following characterization of innovation champions who promote innovation projects within an organization:

> "Essentially, the champion must be a man willing to put himself on the line for an idea of doubtful success. He is willing to fail. But he is capable of using any and every means of informal sales and pressure in order to succeed. No ordinary involvement with a new idea provides the energy required to cope with the indifference and resistance that major technical change provokes. It is characteristic of champions of new developments that they identify with the idea as their own, and with its promotion as a cause, to a degree that goes far beyond the requirements of their job. In fact, many display persistence and courage of heroic quality. For a number of them the price of failure is professional suicide, and a few become martyrs to the championed idea." (Schön, 1963, p.84-85)

Since this rather ideal and extreme image of an innovation champion was presented by Schön (1963), numerous definitions of innovation champions have been proposed in extant literature (see

Walter et al. (2011) or Roure (2001) for an overview). In this dissertation, innovation champions are defined as *actors who promote an innovation vigorously through the various stages of the development process against resistance and by taking risks* (Howell & Higgins, 1990; Howell & Shea, 2001; Jenssen & Jørgensen, 2004). This definition integrates several characteristics of innovation champions on which literature usually agrees. Thus, innovation champions contribute to a project by showing significant personal commitment (e.g., Jervis, 1975; Markham, 1998), a characteristic that differentiates champions from very motivated employees. Moreover, they move beyond their formal job requirements, for instance, by taking risks to promote a project (e.g., Howell & Shea, 2001; Shane et al., 1995).

Generally, the role of the innovation champion constitutes an informal role, which can be taken up by anybody within an organization, independent and in addition to their assigned responsibilities (Markham et al., 2010). Existing research has generally considered the role to be taken up by individuals, and not organizations, which is echoed in this dissertation. Innovation champions can be found among ordinary employees and high-ranked managers (Jenssen & Jørgensen, 2004; Kawakami et al., 2015). In Information Systems (IS), CIOs have frequently been considered champions of information technology (IT) innovation (Kawakami et al., 2015). Men and women are generally regarded to be equally qualified for the champion role today (e.g., Howell & Boies, 2004; Shane et al., 1995), whereas Schön (1963) focused on men only. Moreover, innovation champions drive incremental and radical innovation in companies of all sizes and industries (Markham & Griffin, 1998).

In prior literature, innovation champions have been identified as a critical success factor for innovation (e.g., Howell & Shea, 2006; Markham, 1998) and linked to higher organizational performance (e.g., Walter et al., 2011). In promoting innovation, champions use numerous behaviors and strategies to attain resources or active support among employees and management (e.g., Howell & Shea, 2001; Jenssen & Jørgensen, 2004). Thus innovation champions sell promising ideas to others in the organization (e.g., Howell & Boies, 2004), overcome obstacles (e.g., Walter et al., 2011), inspire other employees and management with their vision for an innovation project (e.g., Mansfeld et al., 2010), exchange information and knowledge (e.g., Reid & de Brentani, 2004), and build relationships and networks (e.g., Greene et al., 1999).

This characterization illustrates one of the difficulties of the innovation champion concept: who fulfills the role of the innovation is not easy to determine due to the breadth of the concept and the leeway for subjective interpretation (van Laere & Aggestam, 2016). Accordingly, the identification of champions needs to follow a clearly defined process and involve agreement among key stakeholders within the organization and researchers. This dissertation follows established guidelines to identify champions carefully (e.g., Howell & Boies, 2004; Howell & Shea, 2001). Thus, the identification of innovation champions and other roles needed to be confirmed by several researchers or stakeholders. In addition, innovation champions had to meet all characteristics described in the definition mentioned above.

Prior research has shown that certain traits and skills frequently characterize innovation champions. Thus, innovation champions are described as creative (e.g., Hayton & Kelley, 2006), enthusiastic (e.g., Howell & Shea, 2006), self-confident (Howell et al., 2005), and risk-taking individuals (e.g., Roure, 2001). Moreover, they have a high learning orientation (e.g., Schweisfurth & Raasch, 2015) and excel in supporting other employees, for instance, by influencing the organizational climate or guiding others (e.g., Watts & Henderson, 2006). Innovation champions heavily rely on their social network, especially informational relationships, to promote innovation projects

(e.g., Dougherty & Bowman, 1995). Furthermore, innovation champions are influenced by environmental and organizational characteristics. For instance, innovation champions' strategies depend on the national culture in which innovation champions act (Shane et al., 1995). Within companies, a culture promoting innovation can enable innovation champions to excel (Hornsby et al., 2002). Even the lack of resource control can serve innovation champions, as it allows for diverting funds towards innovation projects (Abetti, 1997).[4]

The champion model proposed by Jenssen and Jørgensen (2004) synthesizes this characterization of innovation champions. Thus, innovation champions rely on resource acquisition strategies, which are combinations of behaviors and activities, to drive innovation projects and contribute to organizational performance, as illustrated in Figure 2. At the same time, innovation champions' human and social capital, such as education, experience, and social relationships, influence their resource acquisition strategies. To broaden this view, this dissertation not only considers human and social capital, but considers all individual characteristics. For instance, traits have also been shown to influence innovation champions' resource acquisition strategy (Howell & Higgins, 1990). The resource acquisition strategies and the success of these strategies in driving organizational performance are impacted by organizational characteristics, such as an organization's structure or strategy, and environmental characteristics, such as industry characteristics (Jenssen & Jørgensen, 2004). In this dissertation, the adapted model is used as an organizing framework.

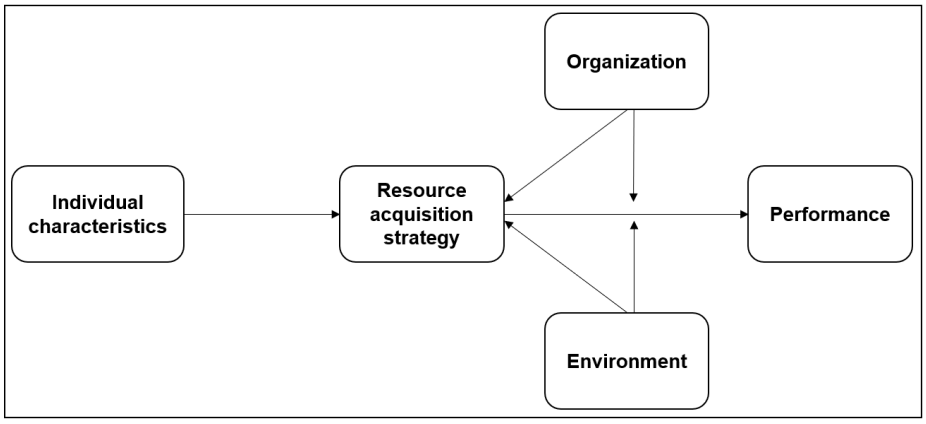


Figure 2: Innovation champion model adapted from Jenssen and Jørgensen (2004)

Existing literature considers champions to fall within a spectrum ranging from heightened interest in developing a product to the enforced realization of an innovation project against resistance (Markham & Griffin, 1998; Rosenau et al., 1996). Instead of differentiating between champions and non-champions only, degrees of championing have been identified (Howell & Shea, 2001; Walter et al., 2011). Employees may perform some championing behavior but not qualify as champions overall. This dissertation follows this line by considering champions and championing behavior but differentiating between the two. In this context, it is also important to note that the champion role frequently overlaps with other identified roles that may perform championing behavior, such as the sponsor (Kelley & Lee, 2010) or knowledge broker (Kirkels & Duysters, 2010). The following section discusses other important actors who champion innovation.

[4] In this section, a brief characterization of innovation champions is provided. A detailed summary of extant literature on innovation champions can be found in Part I of this dissertation, which systematically explores extant knowledge of innovation champions.

2.1.2 Other Innovation Actors Championing Innovation

Other innovation actors who champion innovation projects include sponsors, knowledge brokers, boundary spanners, corporate entrepreneurs, and promoters. Some roles, such as knowledge brokers and boundary spanners, expand beyond the innovation process and encompass their own literature streams. In this dissertation, actors taking over these roles are considered in some research papers, in addition to the innovation champion, if they champion innovation.

Closely related to the role of the innovation champion is the **executive champion** or **sponsor**, who uses his or her hierarchical position and executive power to promote innovation projects by making resources available, advising and consulting the project members, or protecting and endorsing an innovation project (Hayton & Kelley, 2006; Maidique, 1980; Tushman & Nadler, 1986). Sponsors have frequently been considered to describe one specific manifestation of the champion, distinctively characterized by their high hierarchical position (Kawakami et al., 2015).

The **boundary spanner** has a proven track record of promoting innovation by drawing on his or her numerous and established relationships inside and outside an organization to connect different actors (Fleming & Waguespack, 2007). Thus, boundary spanners acquire and direct information essential for an innovation project and promote the interaction of a project team with other members of the organization, or the organization with its environment (Ebers & Maurer, 2014; Tushman & Scanlan, 1981).

Knowledge brokers function as intermediaries by transferring information and knowledge between unconnected actors (Burt, 2004; Kirkels & Duysters, 2010). In innovation literature, one type of knowledge broker has been shown to champion innovation: the gatekeeper. Gatekeepers collect information on new technology trends and market opportunities externally and then share selected information with the stakeholders of an innovation project (Kandemir & Acur, 2012; Ramirez & Dickenson, 2010).

Corporate entrepreneurs and **intrapreneurs** have also been considered to champion innovation projects (Greene et al., 1999; Hayton & Kelley, 2006). Corporate entrepreneurship describes the creation of a new venture, strategic renewal, or innovation within an incumbent company (Sharma et al., 1999) from the top. In contrast, intrapreneurship comprises a bottom-up approach (Blanka, 2019). Within corporate entrepreneurship championing innovation only constitutes one element among several, such as innovating, brokering, and sponsoring (Hayton & Kelley, 2006). At the same time, employees taking over the role of corporate entrepreneurs or intrapreneurs are, similar to champions, characterized by a proactive and risk-taking promotion of innovation (e.g., Blanka, 2019; de Jong et al., 2015).

Among German-speaking innovation scholars another concept is frequently used to denote actors championing innovation: **promoters** (e.g., Hauschildt & Kirchmann, 2001; Witte, 1973). Whereas the power promoter, similar to the sponsor, is an executive who uses his or her hierarchical power to promote innovation, the process promoter drives innovation by using his or her organizational knowledge and network to promote innovation projects (Hauschildt & Kirchmann, 2001). Innovation projects are usually facilitated by a combination of different promoters, whereby individuals may take over different roles (Witte, 1973).

2.2 Research Context: The Digital Age

The term digital age or information age characterizes the current time period, marked by the availability of large amounts of data through IT (Collins English Dictionary, 2022). While the exact beginning of the digital age is debated, the widespread diffusion of IT in the 1970s (Castell, 1996) and the combined availability of personal computers and distributed networks in the late 1980s (Isaacson, 2014) are generally considered essential milestones. More recently, the ubiquitous creation, dissemination, and access to information were significantly accelerated by the widespread use of the Internet after the invention of the World Wide Web by Tim Berners-Lee in 1989 (Isaacson, 2014). Thus, Internet users climbed from around 400 million in 2000 to 3.4 billion in 2016 (Roser et al., 2015). Other significant developments were the rapid extension of the capacity to store information digitally (Hilbert & López, 2011) and the exponential growth in the number of transistors on microchips, also known as Moore's law (Moore, 1965), that led to the rapid and widespread adoption and diffusion of digital technology.

This widespread diffusion of digital technology is also intertwined with two other phenomena: digital innovation and digital transformation. Cascades of digital innovation arising from the distinct characteristics of digital technology lead to a fundamental transformation in companies' IT, structure and strategy (Drechsler et al., 2020; Vial, 2019). These phenomena have significant implications for innovation champions' nature and way of working . Before discussing these implications in Section 2.3, the distinct characteristics of digital technology (Section 2.2.1), digital innovation (Section 2.2.2), and digital transformation (Section 2.2.3) are outlined, as described in extant literature.

2.2.1 Digital Technology and the Layered Modular Architecture

Digital technologies are, compared to analogous technologies, characterized by distinct characteristics, such as reprogrammability, homogenization of data, and self-referential nature (Yoo et al., 2010). Digital technology can be used for numerous functions, or reprogrammed, due to the "separation of the semiotic functional logic of the device from the physical embodiment that executes it" (Yoo et al., 2010, p.726). Moreover, all data is stored in a homogeneous data format (binary numbers) on a digital device, which makes the storage, transfer, and processing of any data on any device possible (Yoo et al., 2010). Furthermore, the creation of new types of digital technologies relies on digital technologies themselves, making them self-referential in nature (Yoo et al., 2010).

Building on these specific characteristics of digital technology, Yoo et al. (2010) describe the **layered modular architecture** of digital technology, which is depicted in Figure 3. It encompasses four loosely coupled layers: device, network, service, and content. The device layer consists of the physical machinery (e.g., computer hardware) and logical capability (e.g., operating system). The network layer encompasses elements for physical and logical transmission (e.g., cables and network protocols). The service layers includes the applications that enable users to create, process, store and display data. The content layer consists of all types of data and the accompanying metadata (Yoo et al., 2010). This architecture of digital technology has given rise to a radically new kind of innovation: digital innovation.

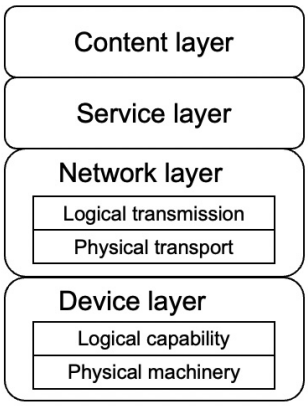


Figure 3: Layered modular architecture (Yoo et al., 2010, p.727)

2.2.2 Digital Innovation and Generativity

Digital innovation describes the "carrying out new combinations of digital and physical components to produce novel products" (Yoo et al., 2012, p.725).[5] The concept of digital innovation is deeply rooted in the layered modular architecture of digital technology. Newly designed layers or layers' components can be readily recombined without accounting for the specific characteristics of each layer (Yoo et al., 2010). Consequently, digital technologies offer unprecedented opportunities to create new products and services. The layered modular architecture also leads to a combination of more diverse and heterogeneous knowledge in creating new digital innovations (Barrett et al., 2012; Yoo et al., 2012). This development has been driven by a shift from single products to connected products, which incorporate digital technology in physical products, so-called smart products (Porter & Heppelmann, 2014; Yoo et al., 2012). Developing such smart products frequently require knowledge from different industries and unrelated bodies of knowledge (Seo, 2017; Yoo et al., 2012).

At the same time, the layered modular architecture illustrates a specific and universal characteristic of digital technology: **generativity**. Innovation within one layer can result in cascades of innovation in other layers and the overall product. A new digital innovation resulting from the use of digital technology could, in turn, improve that same technology, creating digital innovation. Moreover, innovation in one layer can take place independent of the other layers, and without the knowledge of the inventors or stakeholders of the technology, leading to unpredictability in the emergence of digital innovation (Eaton et al., 2015). Thus, the layered modular architecture of digital technology results in high levels of generativity (Yoo et al., 2010), described as "a technology's overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences" (Zittrain, 2006, p.1980).

Generativity has also been characterized as "a socio-technical system where social and technical elements interact to facilitate combinatorial innovation" (Thomas & Tee, 2021, p.9). Digital innovation has been shown to depend on a suitable combination of technology and a collective of innovation actors[6] (Avital & Te'eni, 2009). Thus, the generativity of digital technology not only describes a technological characteristic, but also has implications for the nature of the innovation process and for the innovation actors involved in the innovation processes. This underlines the nature of digital innovation as a socio-technical phenomenon that encompasses technological and social aspects. Digital innovation processes are characterized by blurring boundaries and a distributed innovation agency (Nambisan et al., 2017; Yoo et al., 2012). Additionally, digital innovation is subject to opposing logic or paradoxes that challenge its governance (Tilson et al., 2010). These characteristics are outlined in the following.

In the past, the innovation process was assumed to have clear boundaries, whereby a company developed a product or service within a predefined scope and specific organizational boundaries following a delineated process (Angle & Van de Ven, 2000). Innovation Management literature generally assumes that the innovation process is strictly separated from the outcome. Research, therefore, either focuses on the innovation process or outcome (e.g., Ahmad et al., 2013). In contrast, the innovation process of digital products and services is characterized by **blurring**

[5] This dissertation relies on the definition by Yoo et al. (2012) in studying innovation champions in the digital age, since this definition focuses on innovation creation, which is innovation champions' playing field. This contrasts with other, more recent definitions of digital innovation that also encompass the external adoption of innovation (e.g., Hund et al., 2021).

[6] Innovation actor is used as a generic term to refer to all types of stakeholders and actors of innovation, not only innovation champions.

boundaries. Thus, digital products' and services' features are frequently altered or added after their launch (Hanseth & Lyytinen, 2010), a characteristic enabled by the layered modular architecture. Recent literature on digital innovation has demonstrated the interdependence of innovation process and outcome (Bailey et al., 2012; Fleming & Waguespack, 2007). Therefore, digitization has enabled the extension of innovation development processes past the formal launch in terms of time and scope (Nambisan et al., 2017).

Additionally, digital innovation processes are characterized by **distributed innovation agency** (Nambisan et al., 2017; Yoo et al., 2012), representation a situation where the decision power and actions necessary for developing digital innovation are scattered across different actors. Actors participating and driving the innovation process have increasingly become heterogeneous (Nambisan et al., 2017). Within the layered modular architecture, heterogeneous actors can develop new components for each layer independent of other layers (Yoo et al., 2010). Moreover, actors involved in digital innovation show greater diversity of motives, goals, and skills (Bogers & West, 2012; Boland et al., 2007). Additionally, less pre-definition of innovation agency has been suggested in existing research (Nambisan et al., 2017). Changing innovation actors, not necessarily part of the same organization and outside the control of the original innovator (Bogers & West, 2012), participate in the innovation process temporarily at different stages depending on the required competencies (Lyytinen et al., 2016; Yoo et al., 2012). Different phases of the innovation process can be divided among separate groups of actors due to the loose coupling of the various stages of digital innovation (Wang et al., 2016). Moreover, recent research has demonstrated that digital, non-human actants can also constitute significant contributors and actors of digital innovation (Seidel et al., 2019).

In line with this development, digital innovation have been characterized by democratization (von Hippel, 2005), giving rise to phenomena such as open innovation (Chesbrough, 2003) and distributed innovation (Boudreau, 2010). Frequently, consumers and users are part of the innovation process and recombine digital technology components to create digital innovation (Henfridsson et al., 2018). At the same time, each actor involved in digital innovation is characterized by a high level of autonomy (Boland et al., 2007; Hanseth & Lyytinen, 2010) and follows his or her motive or goal in developing digital innovation (Ghazawneh & Henfridsson, 2013; Hanseth & Lyytinen, 2010). Yet, the different actors do not act in isolation but are connected through discourse with other innovation actors (Øvrelid & Bygstad, 2019; Thomas & Tee, 2021). Overall, this move towards a more distributed agency may result in the formation of a network organization or economy (Benkler, 2006). Thus, loosely connected innovation actors may autonomously contribute to innovation projects without being constrained by hierarchies. In line with these two developments, Yoo et al. (2012, p.1402) have suggested eliminating the term 'team' in favor of fluidly changing 'task-expertise-people' units (Brandon & Hollingshead, 2004).

The characteristics mentioned above lead to two paradoxes innate in digital innovation, which pose a challenge for the management and governance of digital innovation. The **paradox of change** characterizes the tension between stability and flexibility inherent in digital innovation (Tilson et al., 2010). Digital innovation needs some stability for new actors to participate and new processes and products to be developed (Tilson et al., 2010). Yet, flexibility is also necessary to allow actors to exploit the layered modular architecture's opportunities and constantly create new innovation. For instance, the technology that forms the backbone of companies' operations and efficiency may be subject to constant change in the digital age (Yoo et al., 2012). However, new solutions for the technology base can only arise if some level of stability and agreement on the technical foundation (e.g., interfaces, data definitions) exists upon which new solutions can be built (Tilson et al., 2010). Developers have been reported to face this tension between

stability and flexibility on the individual level because they need to balance the coherence of new developments with the existing software code (stability) while also embracing rapid advancements (flexibility) (Brunswicker & Schecter, 2019).

The **paradox of control** characterizes the tension between central control and individual autonomy in digital innovation (Tilson et al., 2010). On the one hand, digital innovation need to enable individual autonomy and openness to allow numerous actors to participate in their creation (Tilson et al., 2010). Generativity can only occur if openness and autonomy are ensured (Eaton et al., 2015). On the other hand, digital innovation endeavors still need to be subject to central control, so that innovation projects do not become too fragmented and disconnected (Yoo et al., 2012). Unrestricted autonomy can endanger the stability of the digital technology used in the innovation process (Tiwana et al., 2010). Control also ensures that an innovation project follows a pre-specified purpose and direction to ensure value creation (Tilson et al., 2010).

In their literature review on generativity, Thomas and Tee (2021) argue that the governance of digital innovation needs to consider these two tensions of digital innovation by assuming two attributes expressly, access and control. Both can be managed using boundary resources, tools at the interface between technology and innovation actors (e.g., APIs and SDKs) (Thomas & Tee, 2021). Governing access can be accomplished by placing restrictions on who can contribute to digital innovation or by influencing the complexity of the technology used in innovation processes, which impacts how easily contributions can be made (Zittrain, 2006). Managing control can be achieved through rules covering the technological, economic and cognitive aspects of the innovation process and its actors (Thomas & Tee, 2021). While rules regarding technology may limit the technologies available in the innovation process, rewards or sanctions can create incentives for actors to focus on certain types of innovation. Using cognitive rules, a shared understanding or identity can be built (Thomas & Ritala, 2021). Thus, digital technology plays a significant role in governing and enabling digital innovation.

At the same time, extant literature suggests that this essential role of digital technology in shaping **new ways of developing innovation** is not restricted to digital innovation but extends to traditional innovation. In the past, innovation in companies mostly used to be limited to a company's research and development (R&D) department (Haapasaari et al., 2018). The availability of digital platforms, defined as a combination of software and hardware elements, organizational processes and standards, which mediate interactions between different groups of users (de Reuver et al., 2018), has opened up the new possibility of working collaboratively on innovation projects (Bresnahan & Greenstein, 2014; Gawer & Cusumano, 2014; Tiwana et al., 2010). Accordingly, user-driven innovation (von Hippel, 1986, 2005) and open innovation (Chesbrough, 2003) have recently gained considerable importance. Here, companies rely on external knowledge input and idea generation through digital platforms to develop and refine innovation (Kallinikos et al., 2013; Lyytinen et al., 2016; Nambisan et al., 2017). However, using digital platforms and sharing knowledge with external stakeholders, such as users, challenge existing norms and rules of ownership (Boland et al., 2007). To address this issue especially large technology companies have started encouraging idea generation and entrepreneurship within their organizational boundaries in order to ensure their competitive advantage (Birkinshaw & Duke, 2013). This phenomenon has been refereed to as intrapreneurship (Desouza, 2011).

Overall, digital technology not only changes the innovation process itself but also challenges the way companies organize to enable innovation. For instance, new forms of organizing are needed to manage the tension between stability and flexibility in the digital innovation process. Similarly, companies need to create mechanisms to manage the tension between control and

autonomy among innovation actors. The following section outlines how companies organize to promote innovation in the digital age. It characterizes organizational and technological changes that may lead to a far-reaching digital transformation in some companies and thereby uproot innovation champions' working environment.

2.2.3 Digital Transformation

Digital innovation has implications for companies' structure, strategy, and culture (see Hund et al. (2021) for a systematic review). First, the shift towards distributed actors involved in digital innovation has made it, for instance, necessary for companies to shift from hierarchical to networked forms of organizing (Benkler, 2006; Lyytinen et al., 2016). Second, the organizational strategy must consider the constant evolution of digital products and services for companies to realize the full potential of digital innovation (Nylén & Holmström, 2015). The increasing intertwining of digital technologies and organizational processes (Pagani, 2013) may even necessitate merging business and IT strategies into a digital business strategy (Bharadwaj et al., 2013). Third, companies need to develop new digital capabilities to match the requirements and logic of digital innovation (Lanzolla et al., 2021; Tumbas et al., 2018). The ever-changing nature of digital innovation requires a shift of the organizational culture, which maps a company's shared values. Thus, a shift towards a higher willingness to share ideas, experiment and take risks may be necessary (Lokuge et al., 2019; Singh & Hess, 2017).

Over time, digital innovation is going to be part of many organizational processes and products or services a company offers (Bharadwaj et al., 2013; Vial, 2019). Consequently, waves of digital innovation in a company or industry, which are caused by the ubiquity of digital technologies, such as data analytics (Günther et al., 2017), cloud computing (Du et al., 2016), and IoT (Oberländer et al., 2018), may lead a company to not only make incremental changes to the way it organizes for digital innovation, but to undergo further-reaching **digital transformation**. Thus, companies may fundamentally shift their value creation process, redefine their value proposition, and overhaul their organizational identity (Vial, 2019; Wessel et al., 2021). Additionally, companies may reconsider their governance structure and overall strategic direction (Bharadwaj et al., 2013; Tumbas et al., 2018). Prior research has therefore defined digital transformation as "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies" (Vial, 2019, p.121).

2.3 Innovation Champions in the Digital Age

The aforementioned changes regarding the nature of innovation, the innovation process and companies' environment have lead scholars to generally question the validity of existing theories and models in innovation research (e.g., Benner & Tushman, 2015; Yoo et al., 2012), which are based on assumptions no longer valid, such as centralized agency and the bounded nature of innovation (see previous section). Digital innovation, characterized by the distinct properties of digital technology and giving rise to broader range of organizational and social changes, form a socio-technical change process for innovation actors (Thomas & Tee, 2021), including innovation champions. Accordingly, existing knowledge and our understanding of innovation champions in the digital age may be challenged.

Against this backdrop, this section explores the current state of knowledge on innovation champions in the digital age and paves the way for the derivation of research questions based on existing gaps in our understanding (see Section 2.4). In the following, Section 2.3.1 briefly summarizes

related literature on champions in Information Systems. It identifies two main research streams surrounding innovation champions in the digital age and presents an extended champion model. Sections 2.3.3 and 2.3.2 then review these two research streams using the extended champion model as an organizing lens.

2.3.1 Related Literature in Information Systems

Within the small strand of literature on champions in IS, the concept of champions has predominantly been conceptualized differently than in Innovation Management literature, where it originated (see Section 2.1.1). The term 'IT champion' has been used to describe individuals who drive the adoption and diffusion of new technologies in an organization (Bassellier et al., 2003; Beath, 1991). Thus, extant IS literature defines IT championing as "being proactive in promoting and supporting innovative IT utilization" (Lin et al., 2014, p.2). Prior research has emphasized the significant role of champions for IT implementation of predominantly externally developed or acquired technology and in influencing users' technology beliefs and adoption decisions (e.g., Beath, 1991; Dong et al., 2007; Lee & Shim, 2007; Negoita et al., 2022; Tona et al., 2016).

Only recently, IS has turned to study champions from an innovation development perspective by exploring their role in promoting innovation throughout the development process in the digital age (e.g., Benbya & Leidner, 2018; van Laere & Aggestam, 2016). When reviewing this strand of literature[7], two themes can be differentiated: innovation champions enabled by digital technology and champions of digital innovation. Both may have significant implications for our understanding of innovation champions in the digital age, as this dissertation argues in the following.

First, the availability of digital technologies (e.g., digital platforms) may influence innovation champions' way of working, as it may offer alternative resource acquisition strategies or enable them to drive innovation success more effectively. Considering this perspective within the innovation champion model proposed by Jenssen and Jørgensen (2004), digital technology may form another enabler (or barrier) for innovation champions. This is illustrated in the schematic representation in Figure 4.

Second, digital innovation and transformation form the context in which innovation champions promote innovation. As such, digital innovation and transformation may reshape innovation champions' individual characteristics, resource acquisition strategy, impact on organizational performance, and organizational and environmental characteristics influencing them. Thus, the challenges of managing varying task-expertise units and addressing prevailing paradoxes of digital innovation may call for different competencies and behavioral strategies among innovation champions. Moreover, the changing organizational and industrial environment created through waves of digital innovation may influence innovation champions' endeavors to promote innovation in unexpected ways. Accordingly, the digital age may challenge the current understanding of innovation champions, as illustrated in the schematic representation of the adapted champion model by Jenssen and Jørgensen (2004) in Figure 5.

In the literature review presented in the following two sections, the extended champion model depicted in Figures[8] 4 and 5 is used as an organizing lens to classify the studies' research foci.

[7]The literature review provided in the following sections is an updated excerpt of the essential studies analyzing champions in the digital age, which are also covered in more detail in the literature reviews on innovation champions (Part I). A detailed description of the literature reviews' methodological approach can be found in Section 3.1.1.

[8]The figures display adapted versions of the champion model by Jenssen and Jørgensen (2004).

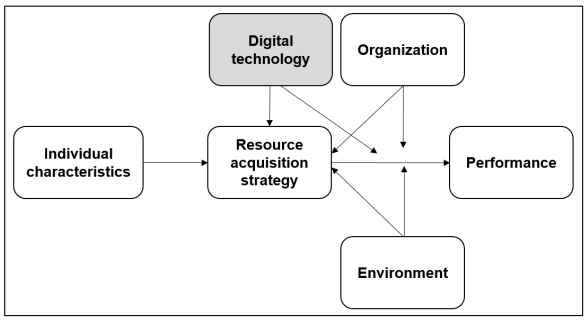


Figure 4: Digital technology as an enabler of innovation champions

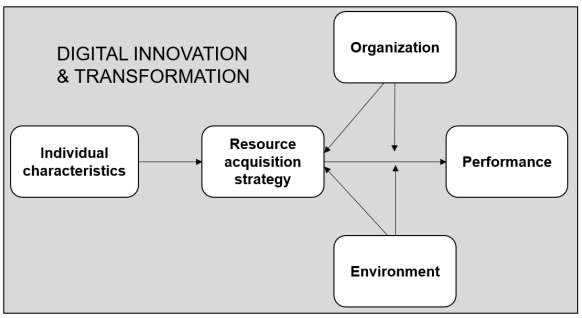
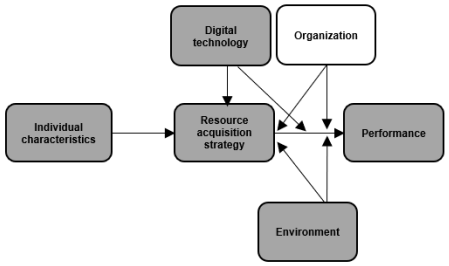
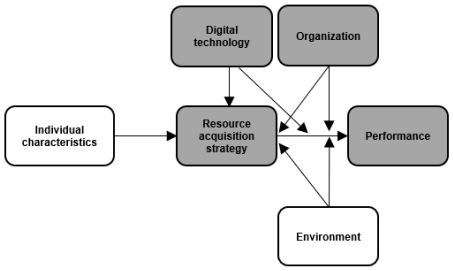


Figure 5: Innovation champions of digital innovation

2.3.2 Related Literature - Digital Technology as an Enabler of Innovation Champions

Table 1 summarizes extant literature studying digital technology as an enabler of innovation champions. Research has predominantly focused on studying innovation champions contributing to innovation in a company but situated outside the respective company (Gupta et al., 2006; Mahr & Lievens, 2012). Thus, Gupta et al. (2006) conceptualize and analyze the role of network champions, a type of champion situated outside the company and orchestrating a network of supplier and buyer companies in e-commerce. The study shows how these network champions, in collaboration with other types of champions, influence innovation and the composition of the overall network of companies and their strategic direction.

Research focus	Study	Study's description	Method
	Mahr and Lievens (2012)	Analysis of lead users, as innovation champions in user communities, and the influence of their individual characteristics on creation of knowledge and innovation; derivation of design suggestions for user community	Netnography & consensual agreement technique
	Benbya and Leidner (2018)	Study of idea platform and identification of formally assigned (executive) champions' role in orchestrating and enabling idea generation by employees	Case study
	Gupta et al. (2006)	Conceptualization and analysis of external network champions orchestrating network of companies and their relationship with other champions	Case study

Note: In the figures (adapted from Jenssen and Jørgensen (2004)), the main focus of the respective studies is colored entirely in light or dark grey. Components depicted in white are not the focus of the respective studies.

Table 1: Research studying digital technology as an enabler of innovation champions

Also focusing on innovation champions situated outside the company, Mahr and Lievens (2012) take a different perspective by studying lead users, who contribute and champion knowledge creation and product innovation within virtual user communities. Based on their analysis of individual characteristics of lead users, Mahr and Lievens (2012) derive design recommendations for user communities. This research is embedded in the broader stream of literature studying innovation communities' contribution to companies' innovation outcomes (e.g., Colazo, 2014; Fichter, 2009; Parmentier & Mangematin, 2014)[9]. Given the distinctive dynamics within and outside a company the literature stream's findings must be applied cautiously.

Benbya and Leidner (2018) form an exception to the predominant focus on the facilitating role of digital technology for champions outside a company. Studying the creation of an idea management platform at Allianz, the authors emphasize the importance of formally assigned innovation champions within companies in supporting and managing the digital idea management platform. While this study delivers valuable insights into the relationship between digital technology and innovation champions in the digital age, due to its orientation towards practitioners it lacks a theoretical grounding possibly limiting its generalizability.

2.3.3 Related Literature - Champions of Digital Innovation

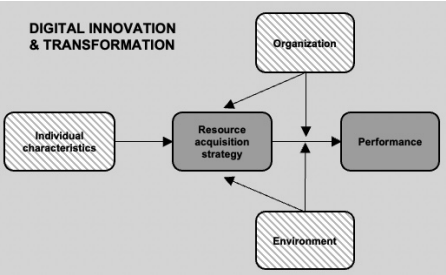
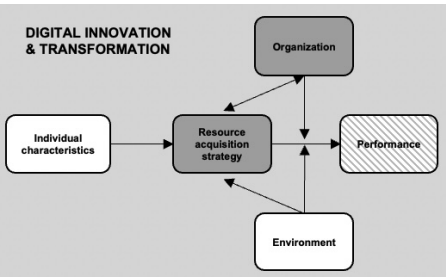
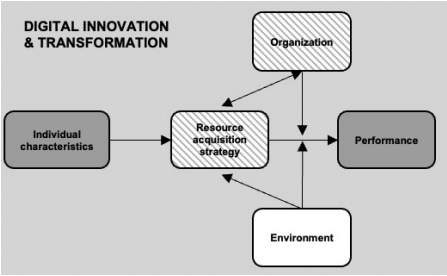
Table 2 summarizes the research foci of the most critical studies exploring champions of digital innovation. It illustrates that most studies have concentrated on exploring and identifying the resource acquisition strategies used by innovation champions (e.g., Abetti, 1997; Tumbas et al., 2018). Six of the reviewed studies explore successful strategies for innovation success (e.g., Abetti, 1997; van Laere & Aggestam, 2016) or study the interaction of resource acquisition strategies with organizational characteristics (Tumbas et al., 2018; Watts & Henderson, 2006).

Within the first group of studies, especially the distributed nature of champions of digital innovation and the interaction between champions and other key stakeholders of digital innovation have been emphasized (e.g., Abetti, 1997; Arvidsson & Mønsted, 2018). Abetti (1997) traces the evolution of an 'under-the-table' development project for computers at Toshiba and identifies the strategies used by the collaborating product champion, marketing champion, and executive champion. Focusing on the cooperation between different innovation champions, van Laere and Aggestam (2016) conceptualize how champions interact and collaborate by taking over complementary roles to promote digital innovation.

Arvidsson and Mønsted (2018) also identify different types of innovation champions when studying corporate entrepreneurship. They derive a framework to describe the four main tactics used by corporate entrepreneurs, including innovation champions, to exploit the innovation potential of the case organization, after a digital innovation project failed. Along similar lines, Zhang and Faerman (2007) study the leadership dynamics and distribution of leadership between champions, project leaders, and upper management in developing a knowledge-sharing system. All four studies rely on a single case study and the focus is on understanding champions' resource acquisition strategies.

The second group of studies studying champions of digital innovation explores how executive innovation champions (i.e., CIOs or CDOs) use different strategies to influence organizational

[9]This literature stream is not covered in this literature review, as it either does not study the role of digital technology for innovation champions or focuses on users in virtual communities overall. The study by Mahr and Lievens (2012) forms an exception, since the characterization of the lead user chosen by the authors matches the definition of innovation champions adopted in this dissertation.

Research focus	Study	Study's description	Method
	Abetti (1997)	Analysis of championing process in 'under-the-table' digital innovation development; Identification of strategies applied by triad of champions	Single case study
	van Laere and Aggestam (2016)	Conceptualization of cooperation and interaction behaviors among group of champions in digital innovation project	Single case study
	Arvidsson and Mønsted (2018)	Derivation of framework describing tactics corporate entrepreneurs, including champions, use to generate value after failed digital innovation projects	Single case study
	Zhang and Faerman (2007)	Analysis of leadership dynamics and distributed leadership roles among executives and champions in digital innovation development	Single case study
	Tumbas et al. (2018)	Identification of CDOs' strategies and approaches for establishing a jurisdictional claim towards digital innovation	Interview study
	Watts and Henderson (2006)	Analysis of CIOs' practices in creating innovative climate	Interview study
	Young et al. (2016)	Identification of inconsistencies and incongruencies in executive champions' technological frames; Analysis of their influence on the evolution and outcome of digital innovation	Action study

Note: In the figures (adapted from Jenssen and Jørgensen (2004)), the main focus of the respective studies is colored entirely in light or dark grey, while peripherally studied components in the innovation champions model are shaded in a striped pattern. Components depicted in white are not the focus of the respective studies.

Table 2: Research on champions of digital innovation

characteristics. Thus, Watts and Henderson (2006) outline the distinct practices used by CIOs to create an innovation climate when collaborating with others and developing new business processes. Additionally, Tumbas et al. (2018) identify three strategies that CDOs use to establish a digital logic of action within companies to create legitimacy for their claim on innovation. This aligns with other studies that have emphasized the new role of CDOs in governing and pioneering digital innovation and transformation (Singh & Hess, 2017; Tumbas et al., 2017).

Within research on champions of digital innovation, the study by Young et al. (2016) stands out, since it explores the influence of executive champions' individual characteristics on digital

innovation outcomes. Thus, the authors identify inconsistencies and incongruencies of innovation champions' technological frames, which characterizes the assumptions, expectations, and knowledge used by executive champions to understand an organization's technology. Young et al. (2016) then also trace how champions' perceptions impact the evolution and outcomes of a digital innovation project.

This review of extant literature on champions of digital innovation illustrates shortcomings in prior research on champions of digital innovation. While some studies explore the relationship between innovation champions and performance, such as innovation success (e.g., Abetti, 1997; van Laere & Aggestam, 2016), they do so only within the specific context of the studied single case organization. Thus, the generalizability of these findings to other companies and organizational circumstances is unclear. Moreover, the literature review illustrates the scarcity of research that accounts for the influence of champions' individual characteristics as well as organizational and environmental characteristics on innovation outcomes or performance. Only Young et al. (2016) account for these characteristics when studying champions' technological frames.

2.4 Research Questions

This section identifies existing gaps in the literature on innovation champions in the digital age and derives detailed research questions guiding this dissertation, based on the presented literature review. The five derived questions enable a multifaceted response to the overarching research question: *What makes innovation champions successful in the digital age?* by focusing on different components of the extended innovation champion model. Table 3 (at the end of this section) summarizes the various components addressed across the five research questions.

As outlined in the previous sections, the literature points to changes in innovation's nature and agency (Nambisan et al., 2017; Yoo et al., 2010) that may have implications for innovation champions. Before taking a closer look at these implications, however, it is promising to take a step back to gain a comprehensive understanding of existing literature on innovation champions as a whole, whose extensive body of research studies spans more than half a century and reaches across multiple disciplines. Existing literature reviews have overwhelmingly only considered the perspective of their respective discipline, such as Innovation Management (e.g., Jenssen & Jørgensen, 2004), or studied a particular group of champions, such as champions of IT implementation (e.g., Renken & Heeks, 2019), rather than aiming to review existing research comprehensively. Moreover, reviews have predominantly been limited to innovation champions' individual characteristics or behaviors (e.g., Jenssen & Jørgensen, 2004; Renken & Heeks, 2019).

Thus, literature reviews have fallen short of exploring innovation champions from an multifaceted perspective by characterizing innovation champions' resource acquisition strategy and influence on organiaztional performance or considering innovation champions' organizational and individual enablers across disciplines. These topics are essential to understand because companies can only tap into innovation champions' potential, if they know how these actors promote innovation and which characteristics enable or hinder innovation champions' success (Howell & Higgins, 1990). It is significant for companies to recognize when and how they can empower champions through executive actions (Kelley & Lee, 2010) and how to select and hire innovation champions (Mansfeld et al., 2010). At the same time, a synthesis of this knowledge forms a valuable starting point to explore the changing nature of innovation champions in the digital age, since scholars have called for research to understand the actors' activities and the role of their organizational environment for digital innovation (Holmström, 2018). Thus, the first research question in this dissertation is:

Research question 1 (RQ1): What do we know about innovation champions' individual characteristics, resource acquisition strategy, and performance, as well as organizational enablers, based on extant literature?

The review in Section 2.2.2 illustrates the changing nature of digital innovation, innovation processes, and the organizational environment. These changes in the digital age have several implications for innovation champions. The generativity of digital technology means that innovation is subject to constant change (Yoo et al., 2010; Zittrain, 2006). This ever-changing nature of innovation will likely increase the need for innovation champions. As orchestrators of the digital innovation process, innovation champions can keep track of the technological developments through their broad network of contacts and influences or set the future direction of an organization's innovation efforts by selecting and championing promising ideas. This is also reflected in prior research on champions of digital innovation, which has explored the champions' different resource acquisition strategies in-depth (e.g., Tumbas et al., 2018; van Laere & Aggestam, 2016). Additionally, recent literature has emphasized the importance of executive innovation champions, such as CDOs, who govern digital innovation and the organizational environment enabling digital innovation (Tumbas et al., 2018; Watts & Henderson, 2006).

The changing nature of digital innovation's agency towards more distributed, heterogeneous, and frequently changing groups of actors (Nambisan et al., 2017; Yoo et al., 2012) gives reason to assume that innovation champions' nature has been subject to changes in the digital age. Innovation champions may need to develop new skills, acquire different knowledge, establish new relationships in their social network, and rely on novel strategies to manage the fluidly changing 'task-expertise-people units' in the development process of digital innovation. Yet, the individual characteristics that enable innovation champions in the digital age to promote a company's innovation success and contribute to overall company performance are not well explored in extant research. Moreover, with the emphasis on exploratory, qualitative research methods in extant research on champions of digital innovation (see Section 2.3), no conclusions about the causal link between innovation champions' presence and organizational performance can be drawn on a general level. To address these questions surrounding individual characteristics of innovation champions and their impact on organizational performance in the digital age, the second research question is:

Research question 2 (RQ2): What characterizes innovation champions who contribute to companies' success in the digital age?

As outlined in Section 2.2.3, the phenomenon of digital innovation leads to changes in organizational characteristics, such as structure, culture, and strategy (e.g., Bharadwaj et al., 2013; Lokuge et al., 2019; Nylén & Holmström, 2015) and is deeply intertwined with digital transformation in incumbent companies (Vial, 2019). The implications for innovation champion and their way of working with these changes in companies are unclear. At the same time, further organizational change may be needed to address the paradoxes of control and change inherent in digital innovation (Tilson et al., 2010). Even though existing studies on champions of digital innovation do not focus on organizational characteristics in depth, these case studies also point to the importance of organizational enablers, such as the possibility to divert funding within a company (Abetti, 1997) or a hiring strategy that favors complementary skills (van Laere & Aggestam, 2016), for champions of digital innovation. Due to the importance of generating knowledge on organizational characteristics enabling or hindering innovation champions in the digital age, the third research question is:

Research question 3 (RQ3): Which organizational characteristics enable or hinder innovation champions in promoting innovation and contributing to companies' success in the digital age?

With the ubiquity of digital technology, new perspectives on innovation processes have emerged (see Sections 2.2.1 and 2.3). Thus, open and user-driven innovation (e.g., Chesbrough, 2003; Mahr & Lievens, 2012), as well as employee-driven innovation and intrapreneurship (Benbya & Leidner, 2018; Birkinshaw & Duke, 2013) have increasingly gained popularity. While research on idea and innovation generation via virtual user communities outside an organization is quite established (Klerkx & Aarts, 2013; Mahr & Lievens, 2012), the potential of employees to champion innovation using digital technology has been less explored. As Benbya and Leidner (2018) exemplify in their practitioner-oriented case study, using collaboration tools offered by digital platforms and a formalized role for innovation champions can enhance idea generation among employees.

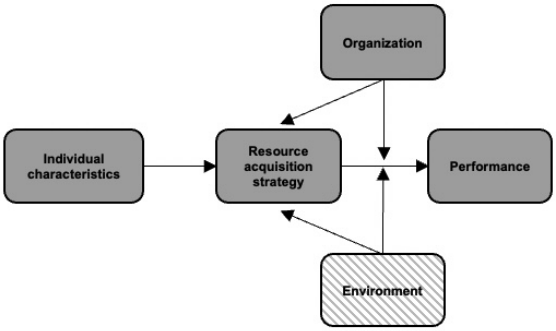
Digital technologies may enable companies to promote innovation and championing among employees systematically by establishing work models, which combine digital platforms and technologies with organizational measures, such as dedicated time for idea generation. An understanding of organizational determinants of work models' success is vital, since the innovation generated by employees can yield significant financial savings or new revenue streams in companies (Benbya & Leidner, 2018). Additionally, the design of digital platforms that use digital technologies to catalyze idea generation (and possibly) championing behavior among employees, presents challenges, such as fitting incentivization, constant momentum for innovation development, and a suitable mechanism for evaluating ideas (de Reuver et al., 2018). Accordingly, the fourth research question is:

Research question 4 (RQ4): How can digital technology enable championing behavior within companies?

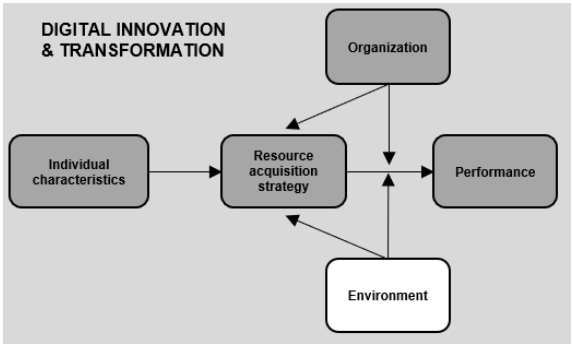
The main research focus of this dissertation is innovation champions in the digital age. However, the context in which innovation champions operate, characterized by the reasonably new phenomena of digital innovation and transformation, is rapidly changing. For instance, the organizational environment is constantly shifting, as digital innovation has been proposed to blur the boundaries of industries (Porter & Heppelmann, 2014; Seo, 2017). These changes are rooted in an increasing focus on products that integrate heterogeneous knowledge from different areas and the layered modular architecture of digital technology, which allows a rapid transfer or adjustment of individual layers to different industrial contexts (Yoo et al., 2012; Yoo et al., 2010). These developments fundamentally change the playing field in which innovation champions decide which innovative ideas to promote and which to neglect.

At the same time, extant research has illustrated the vital role that companies' environment (e.g., Greene et al., 1999; Shane et al., 1995) can play for innovation champions' emergence and success. This calls for future research, especially against the backdrop that scholars have pointed to the possibility that the digital age may have fundamentally challenged the existing assumption of innovation (Benner & Tushman, 2015). Moreover, calls for future research on digital innovation and transformation and the connection between both phenomena have been reinforced recently (Hund et al., 2021; Vial, 2019). Against this backdrop, the fifth research question targets the context in which innovation champions promote innovation in the digital age by asking:

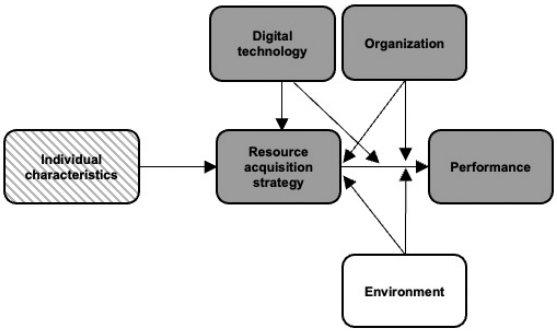
Research question 5 (RQ5): What characterizes digital innovation and transformation?



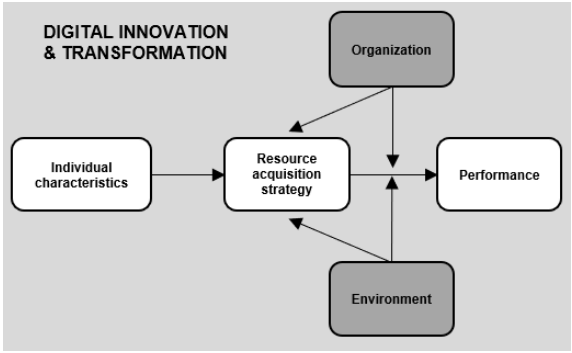
RQ 1: What do we know about innovation champions' individual characteristics, resource acquisition strategy, and performance, as well as organizational enablers, based on extant literature?



RQ 2: What characterizes innovation champions who contribute to companies' success in the digital age?
RQ 3: Which organizational characteristics enable or hinder innovation champions in promoting innovation and contributing to companies' success in the digital age?



RQ 4: How can digital technology enable championing behavior within companies?



RQ 5: What characterizes digital innovation and transformation?

Note: In the figures (adapted from Jenssen and Jørgensen (2004)), the main focus of the respective research question is colored entirely in light or dark grey, while peripherally studied components in the innovation champions model are shaded in a striped pattern. Components depicted in white are not the focus of the respective research question.

Table 3: Overview - Research questions (RQs)

2.5 Theoretical Lenses[10]

This thesis aims to understand what makes innovation champions successful in the digital age. Doing so is grounded in different theories and research streams of IS, Organization and Leadership research. In the following, the three main literature streams and theoretical lenses that this thesis relies on are introduced: social network research (Section 2.5.1), STS theory (Section 2.5.2), and managerial power theory (Section 2.5.3). As each section outlines, all three lenses augment our understanding of innovation champions.

2.5.1 Social Network Research

Innovation arises from forming new conections and exchanging ideas, resources, and knowledge among actors (e.g., Ahuja, 2000; Kogut & Zander, 1992; Wang et al., 2014). Consequently, researchers have emphasized the essential role of social networks in creating innovation (Burt,

[10] Please note that this section contains text passages from Paper IV (Drechsler et al., 2022a) and Paper VI (Drechsler et al., 2022b).

2004; Obstfeld, 2005; Tsai, 2001) since they enable information exchange, interaction, and collaboration of actors (Granovetter, 1985). Social network research has a rich and diverse tradition in the social sciences and consists of different streams, including Burt's theory of structural holes (1992) and Granovetter's strength of weak ties theory (1973). Before outlining some of the most important theoretical concepts used in this dissertation, the basic terminology in social networks is introduced.

A social network consists of multiple nodes, each representing one actor. Depending on the level of analysis, actors can be individuals, teams, or organizations. Ties between actors indicate the social relationships among the actors. The pattern of ties results in a network structure wherein each actor occupies a specific position (Borgatti & Foster, 2003; Borgatti & Halgin, 2011). Figure 6 exemplifies these network characteristics by depicting a snapshot of two actors' social networks. Actors A and B, represented by two nodes, form a social tie. Actor A takes a relatively central position in the social network, as he or she possesses six other social ties, while actor B only forms a tie with one other actor.

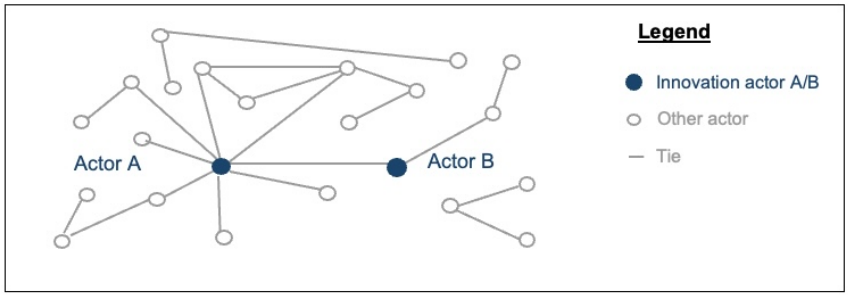


Figure 6: Actors' social network (Drechsler et al., 2022a, p.7)

Besides the network structure, the concept of embeddedness is essential to consider, as it describes how economic exchanges are shaped by social relationships (Uzzi, 1996). This concept was first introduced by Granovetter (1985) and allowed researchers to move beyond explaining economic exchanges as interactions between purely rational actors. Embedded ties in the social network, characterized by long-term cooperation, have been shown to provide a performance benefit up to a certain point, as actors can benefit from information exchange, learning, and risk-sharing from closer relationships with other actors (Uzzi, 1996).

According to the typology of network research by Borgatti and Foster (2003), research on the consequences of networks can be distinguished based on the explanatory goals and explanatory mechanisms. This dissertation focuses on explanatory goals by taking a social capital perspective, which aims to explain the relationship between individual and organizational performance variations and characteristics of social network ties (e.g., Burt, 1992). Concerning explanatory mechanisms, Borgatti and Foster (2003) differentiate between two strands in the literature: structuralist and connectionist perspectives, which treat ties in a social network differently.

The **structuralist** stream of literature explores the topology of a social network by focusing on the structure and configuration of social ties in a network (Burt, 1992; Coleman, 1990). Literature in this stream builds on the idea that two actors with similar central positions in a social network or structures of their ego-network will achieve similar results (Burt et al., 2000; Powell et al., 1996). Yet, the optimal structure of an actor's network has been debated. Coleman (1990) argues that a dense ego-network will give actors an advantage since they may be able to better coordinate with other actors. In contrast, Burt (1992) outlines the benefits of structural holes that allow an actor to exploit the lack of a social connection between its alters by acting as a broker. In contrast

to this perspective, the **connectionist** research stream has focused on analyzing the flow of information and knowledge in the network and considering the quality of ties (Lin, 2001). This literature relates actor's success to his or her access to resources and knowledge and resources available through his or her existing social ties.

Granovetter (1992) also reflects this distinction between structuralist and connectionist streams of research by differentiating between structural and relational embeddedness when studying networks. Structural embeddedness is "the impersonal configuration of linkages between people or units" (Nahapiet & Ghoshal, 1998, p.244) and describes the structure of actors' network ties. Relational embeddedness denotes "personal relationships people have developed with each other through a history of interactions" (Nahapiet & Ghoshal, 1998, p.244). It describes the character of ties in the social network.

Innovation champions derive influence from their social network by using it to exchange information and resources (e.g., Chakrabarti & Hauschildt, 1989; Maidique, 1980). Thus, innovation champions often transfer information and knowledge (e.g., Chakrabarti & Hauschildt, 1989; Howell & Shea, 2006) or connect with others and build networks (e.g., Howell & Shea, 2006; Kessler & Chakrabarti, 1999). Despite the critical role of innovation champions' social networks in enabling interactions and collaboration for the development of digital innovation, our knowledge thereof in the digital age is scattered. To build a comprehensive understanding of the role of innovation champions' social networks in promoting innovation projects in the digital age, this dissertation relies on social network theory as a theoretical lens for a structured literature review in Paper IV and, to a lesser extent, in Paper I. By exploring the distinct elements of champions' social networks, an understanding of how innovation champions use their social networks to promote innovation in the digital age and which network characteristics enable the success of digital innovation projects can be developed.

Paper IV develops and uses a framework based on current knowledge in social network research, specifically the typology of social network research by Borgatti and Foster (2003), to analyze innovation champions' social networks. Table 4 depicts the research framework that guides the research on innovation champions in the digital age. Following the distinction between structuralist and connectionist research streams, the analysis of innovation champions' social networks encompasses two dimensions: network topology (structuralist) and network flows (connectionist). Moreover, the direction of causality in innovation champions' interaction with the social network is considered by differentiating between actor-network and network-actor perspectives (Borgatti & Foster, 2003). The actor-network perspective is used to analyze the activities of innovation champions in their social network to understand the means champions use to promote innovation. Complementing this analysis, the network-actor perspective examines the impact of social network characteristics on innovation champions.

When taking an actor-network perspective to study innovation champions' activities in the social network, the topology and flows of innovation champions' social network are considered by analyzing the activities that champions take to create and use social ties in their network. Thus, innovation champions perform different activities in the network to create social ties and change their social network's structure (e.g., Hayton & Kelley, 2006; Howell & Shea, 2001). From a network-actor perspective, innovation champions' embeddedness in the social network can be characterized by their network position and the quantity and quality of their relationships with other actors (e.g., Dougherty & Bowman, 1995; Jenssen & Nybakk, 2009). Following Granovetter (1992), the framework differentiates between structural and relational embeddedness to consider the network structure and quality of relationships enabling champions to promote innovation.

	Actor-network: Activities in network	Network-actor: Network characteristics
Network topology (structuralist)	**Creating social ties**	**Structural embeddedness**
Network flows (connectionist)	**Using social ties**	**Relational embeddedness**

Table 4: Research framework to analyze innovation champions' social networks (Drechsler et al., 2022a, p.12)

2.5.2 Socio-Technical Systems Theory

The socio-technical systems (STS) theory based on Leavitt's diamond (Leavitt, 1964) describes organizational and technological change by considering the complex relationships between actors, technology, task, and structure. The different components are characterized in the literature (Leavitt, 1964; Lyytinen et al., 1998) as follows: Actors refers to all stakeholders, such as managers and employees, involved in the organizational or technological change and accompanying processes. Technology denotes the software, hardware, and development tools that enable organizational or technological change. Task covers the objective, goals, processes, and deliverables of the organizational or technological change. Structure characterizes the organizational systems of communication, authority, and workflow. Additionally, Kwon and Zmud (1987) extended the original model to include the environment, which accounts for all external factors influencing organizational or technological change.

The STS theory has been widely applied in IS research to understand organizational change (e.g., Kwon & Zmud, 1987; Lyytinen et al., 1998; Lyytinen & Newman, 2008; Mumford, 1983). The underlying idea is that organizational change can only succeed if social and technical elements are considered simultaneously, as interconnected parts of a complex system that need to be brought into alignment (Leavitt, 1964). Thus, a lack of alignment between components may cause dysfunction in the overall STS (Mumford, 1983). At the same time, the STS is subject to constant change since it is impacted by the environment, making it a vital task for management to constantly react to such change (Kwon & Zmud, 1987). Figure 7 illustrates this strong interdependence between components forming the diamond shape created by Leavitt (1964).

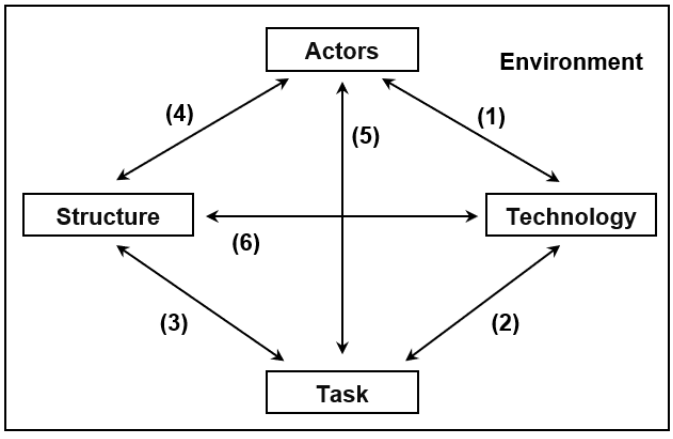


Figure 7: Socio-technical system model (Reibenspiess et al. (2019, p.6), based on Leavitt (1964) and Lyytinen et al. (1998))

An analysis of the interdependences between the different components, in addition to studying components in isolation, helps to understand the complex relationships between all components. Lyytinen et al. (1998) characterize the interdependences as follows: Technology-actors interdependence (1) depicts risks and benefits of actors' use of technology. Technology-task interdependence (2) outlines the fit or misfit between technology and tasks. Structure-task interdependence (3) focuses on the alignment between the organizational structure and task and captures possible problems in carrying out a task in an organization. Actors-structure independence (4) deals with the congruence of actors' behavior and the organizational structure (e.g., values, incentives). Actors-task interdependence (5) focuses on the actors' ability to perform a task to achieve the targeted goal. Finally, technology-structure interdependence (6) characterizes the impact of a technological change on the system of workflows, authority, and communication, and vice versa.

In this dissertation, the STS theory is used as a guiding lens to analyze the drivers and barriers to introducing a new work model that promotes championing among employees (Paper VII) and designing a digital intrapreneurship platform (Paper IX). The work model and the digital intrapreneurship platform can both be categorized as instantiations of complex work systems (Alter, 2013). Both are shaped by the activities of a group of individuals who create and champion innovation using digital technologies, such as specialist tools and social media, while embedded in an organizational structure and environment (see Paper IX for details). Consequently, the STS theory provides a fitting theoretical lens to study and design these systems, since work systems have been shown to comprise complex relationships between actors, technology, task, structure, and environment (e.g., Lyytinen & Newman, 2008; Mumford, 2006). In Paper VII, all components of a STS are matched with the corresponding elements of the system to understand the relationship between these elements as well as barriers and drivers of the organizational change process. In Paper IX, the STS theory builds the theoretical foundation to successfully design a digital intrapreneurship platform, which aligns all components of the STS.

2.5.3 Managerial Power Theory

Managerial power is "the capacity of individuals to exert their will" (Finkelstein, 1992, p.506). Managerial power (in the following, also referred to as power) is attained by top managers who can deal with internal and external uncertainty, both due to their ability and position (Finkelstein, 1992; Thompson, 1967). Power enables managers to gain strategic decision-making authority and influence the fate of a company (Child, 1972; Finkelstein, 1992). Three types of managerial power can be differentiated (Finkelstein, 1992): structural, prestige, and expert power.

Structural power is defined as executives' authority derived from the position within the company's formal structure. This hierarchical authority allows executives to control their subordinates' actions (Finkelstein, 1992; Hambrick, 1981). Prestige power is the influence that results from an executive's prestige or status. Stakeholders perceive executives with high standing or personal relationships with influential people as having a higher ability to manage uncertainty, because they can, for example, use their influential network to obtain relevant information about environmental contingencies early on (Finkelstein, 1992). Expert power is defined as executives' ability to cope with environmental contingencies by drawing on their relevant knowledge and experience (Finkelstein, 1992; Hambrick, 1981).

The managerial power theory was developed by Finkelstein (1992) with a focus on the Chief Executive Officer (CEO), which also dominated later studies (e.g., Adams et al., 2005; Daily & Johnson, 1997). In recent years, increasingly research on functional top managers (e.g., CIO, Chief Technology Officer) has considered managerial power theory (e.g., Bradley et al., 2012; Feng et al.,

2015). The underlying idea is that the position of a functional top manager can be linked to a company's commitment to the manager's function (e.g., Garms & Engelen, 2019). Research on functional top managers has predominantly identified a positive relationship between a top manager's level of structural power and company performance (e.g., Feng et al., 2015; Taylor & Vithayathil, 2018). In information research, CIOs' level of structural power has also been linked to the quality of IT governance (Bradley et al., 2012), the level of sophistication of electronic medical records (Smith et al., 2013), or demand-side leadership (Chen et al., 2010).

Despite this increasing interest in studying functional top managers with power theoretical arguments, some shortcomings in extant research exist. Thus, existing studies have frequently taken a non-specific conceptual and measurement perspective on power and have not differentiated among different dimensions (e.g., Baker et al., 2019; Feng et al., 2015) or focused on structural power only (e.g., Chen et al., 2010; Taylor & Vithayathil, 2018). As a rare exception, Lim et al. (2013) study both structural and expert power and find that a CIO's structural power and IT-related expert power is positively associated with public recognition of the company's IT capability. Another differentiated perspective on managerial power from Innovation Management research finds that a Chief Technology Officer's structural power is positively related to the TMT's commitment to innovation, but a negative relationship exists between a Chief Technology Officer's expert power and multi-function power, a measure of power breadth, and the TMT's commitment to innovation (Garms & Engelen, 2019).

This dissertation uses the theoretical lens of managerial power to comprehensively study the power profile of the CDO, an executive champion of digital innovation, as depicted in Figure 8. Executive champions in promote innovation projects by relying on their influence and power. Thus, they provide endorsement, legitimacy, and the necessary resources for innovation projects (Howell & Higgins, 1990; Maidique, 1980; Tushman & Nadler, 1986). The theory of managerial power can enable a better understanding of executive champions in the digital age by opening up the opportunity to explore the enablers of champions' influence.

Accordingly, this dissertation explores in Paper VI which combination of structural, expert, and prestige power of champions is positively linked to a company's stock market reaction following CDO appointments. In the case of the CDO, prestige, and expert power may play an essential role, in addition to structural power, since the CDO takes up a wide range of different responsibilities (Singh & Hess, 2017; Tumbas et al., 2018). Thus, CDOs' role has been described to include diverse tasks, ranging from orchestrating digital initiatives across business units to developing digital technologies (Singh & Hess, 2017; Tumbas et al., 2018). With such a profile, a broad power foundation may be advantageous. The hypothesized relationships based on Finkelstein (1992) and literature on IT-related leadership are depicted in Figure 8.

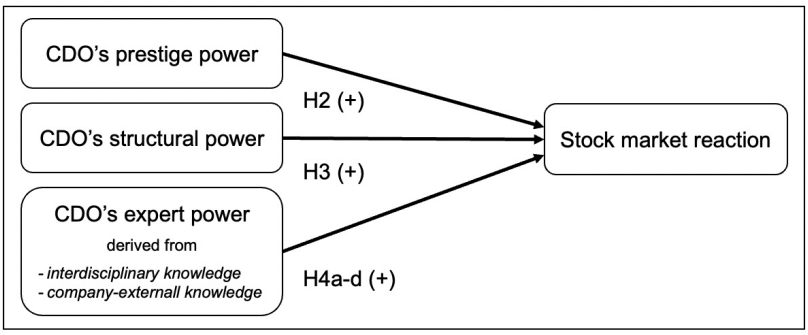


Figure 8: Nomological network of CDO's power profile (Drechsler et al., 2022b, p.11)

3 Research Methodology

This dissertation relies on a multi-method approach. Figure 9 illustrates the different research approaches and methods used in the twelve research papers in this dissertation to answer the identified research questions. The dissertation relies on a combination of non-empricial and empirical research approaches and uses seven different research methods. The combination of different research approaches and methods with their complementary strength and boundary conditions was chosen to explore innovation champions from a multifaceted perspective following the recommendations in existing literature (Hassan & Mingers, 2018; Mingers, 2001; Venkatesh et al., 2013). This mixture of research methods originating from different disciplines (e.g., Finance, Management, IS) allows for developing a complex and rich understanding of innovation champions in the digital age (see Section 2.4). Before outlining the different research approaches and methods in the subsequent sections, the underlying assumptions and research perspectives are discussed.

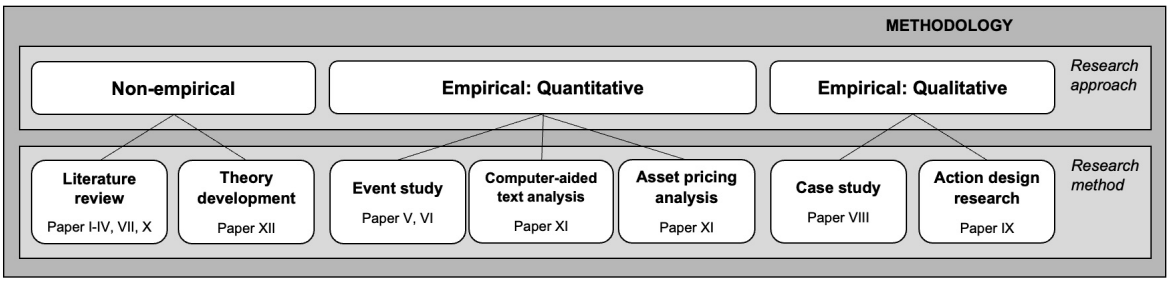


Figure 9: Overview of the research approaches and methods used in this dissertation

The different research approaches and methods are characterized by diverging underlying research perspectives or paradigms, sets of philosophical assumptions about, for instance, ontology (the nature of reality), epistemology (the nature of knowledge) and methodology (Iivari et al., 1998; Mingers, 2001). In the IS discipline two research perspectives prevail: the **behavioral science perspective** and the **design science perspective** (Hevner et al., 2004). Research following the behavioral science perspective aims to develop and verify theories that explain or predict the interaction of people, organizations and technology. In contrast, research relying on the design science perspective builds and evaluates innovative artifacts that provide utility by extending human and organizational capabilities (Hevner et al., 2004).

Concerning research following the behavioral science paradigm, researchers further differentiate between two paradigms: **positivism** and **interpretivism** (e.g., Chen & Hirschheim, 2004; Orlikowski & Baroudi, 1991). With respect to epistemology, for instance, positivism sees the role of the researcher as a detached observer of causal relationships. Positivist studies focus on testing theories to derive generalizable findings and make predictions about a phenomenon (Orlikowski & Baroudi, 1991). In contrast, interpretivism argues that knowledge emerges from understanding human and social interactions and by exploring the meaning humans assign to the studied phenomenon (Walsham, 1995). Regarding methodology, positivist research takes an objective and value-free position when conducting research, frequently using quantitative methods (Chen & Hirschheim, 2004; Orlikowski & Baroudi, 1991). Interpretive research asserts the importance of using a participatory research method, where researchers study the deeper structure of a phenomenon by actively engaging with research participants in the natural setting and using qualitative methods (Chen & Hirschheim, 2004; Orlikowski & Baroudi, 1991).

This dissertation predominantly builds on the behavioral-science research perspective and the positivist research paradigm (Paper I-VII, X-XII). This is complemented by single research papers that embrace a design science perspective (Paper IX) and the interpretive research paradigm (Paper VIII). By following such a multi-perspective approach, the research questions can be answered from different angles, which enables a richer understanding of the research topic (Mingers, 2001; Venkatesh et al., 2013). In this dissertation, the chosen combination of research approaches and methods facilitates the derivation of generalizable findings through positivist, quantitative research, while also allowing for the exploratory generation of novel and complex insights on innovation champions in the digital age through qualitative research approaches and theory generation based on non-empirical research. Moreover, complementing the prevalently used behavioral science research perspective with a design science perspective allows this dissertation to account for the inseparability of behavior and technology in information systems and, as a result, to strengthen practical and theoretical relevance (Hevner et al., 2004). This combination of different perspectives also allows this dissertation to make varying types of theoretical contributions to extant research (Gregor, 2006).

Based on the overview and structure given in Figure 9, the different research approaches and methods used in this dissertation are described in the following. Section 3.1 outlines non-empirical research methods, Section 3.2 summarizes quantitative research methods, and Section 3.3 elaborates on qualitative research methods used in this dissertation.

3.1 Non-Empirical Research

Non-empirical research focuses on ideas and concepts to advance new theories or conceptual frameworks (Chen & Hirschheim, 2004). In order to build a theoretically grounded understanding of innovation champions in the digital age, the dissertation uses two research methods that rely on a non-empirical research approach. Several structured literature reviews (Section 3.1.1) form the groundwork of this dissertation and serve to gain a broad understanding of existing knowledge on innovation champions. Building on identified gaps in our understanding of the research topic and developing a more thorough understanding of innovation champions' context, theory development (Section 3.1.2) forms the second non-empirical research approach in this dissertation.

3.1.1 Literature Review

Literature reviews enable researchers to gain an overview of existing knowledge regarding a specific research topic or phenomenon. As such, literature reviews form a prerequisite for any research study to situate the studies within the existing literature streams and present its methodological and theoretical foundation (Paré et al., 2015). This Introductory Paper and Paper V, VI, VIII, IX, XI, and XII include a literature review to summarize prior research and establish the existing knowledge gap the research papers aim to address. The literature review can also serve as a stand-alone method to synthesize literature in a field, develop a new theoretical framework or model, or propose an agenda for future research without relying on primary data (Paré et al., 2015; Rowe, 2014). In this dissertation, Paper I-IV, VII, and X undertake different types of such standalone literature reviews to synthesize extant literature on innovation champions.

In the following, Section 3.1.1.1 outline the different types of literature reviews present in this dissertation. Subsequently, the literature reviews' research design (Section 3.1.1.2) and data analysis (Section 3.1.1.3) are summarized.

3.1.1.1 Types of Literature Reviews

The standalone literature reviews in this dissertation can be differentiated based on their review focus and research objective, as shown in Figure 10, following the polylithic framework by Leidner (2018). Review articles' objective spans from literature synthesis to theorizing the literature. Review articles' focus ranges from describing the literature to identifying trends and gaps (Leidner, 2018). Based on these two spectra, Leidner (2018) proposes four different types of literature reviews: broad theorizing review, specific theorizing review, organizing review, and assessing review, with gradual boundaries between the different types.

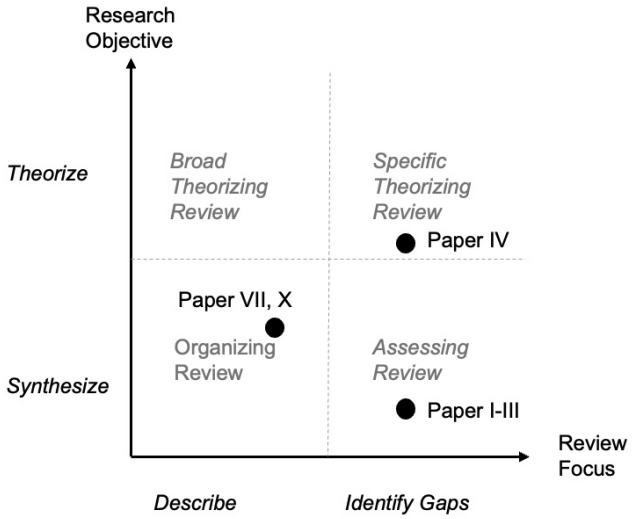


Figure 10: Classification of dissertation's literature reviews based on Leidner (2018)

In this dissertation, Paper I to III form **assessing reviews**. Since the concept of the innovation champion goes back to the 1960s, an extensive literature has accumulated over the last decade. Paper I to III serve as the informed entrance into this dissertation by synthesizing existing knowledge on innovation champions' roles, activities, enablers, barriers, and influences. These assessing reviews aim to identify themes and reveal gaps in prior research that inform the research questions of the latter papers forming this dissertation.

In comparison, Paper IV not only focuses on identifying gaps in extant research regarding the characteristics of innovation champions' social networks based on a summary of the state-of-art knowledge, but also theorizes by developing a conceptual framework. The framework is derived from social network theory and innovation champion research. It enables a more profound understanding of the impact of digital technologies' pervasiveness and the increasing significance of digital innovation for innovation champions' social networks. Accordingly, Paper IV constitutes a **specific theorizing review** that seeks to fill a particular gap in the literature through theorizing (Leidner, 2018).

In contrast, Paper VII and X form **organizing reviews** focused on describing the current knowledge with the objective of synthesizing findings in the respective stream of literature (Leidner, 2018). Paper VII reviews research on executives responsible for information systems (e.g., CIOs) to connect with prior research in IS and to understand and delineate the research context of Part III of this dissertation, which focuses on champions at the C-Level, and especially the CDO. Paper X explores and describes research on the novel phenomenon of digital innovation to apprehend the distinct characteristics and gain insights into innovation champions' context in

the digital age. The three reviews, therefore, strive for a broad and informative, but not necessarily comprehensive, synthesis of the literature.

3.1.1.2 Research Design

All standalone literature reviews in this dissertation follow systematic approaches based on established guidelines (Bandara et al., 2015; Paré et al., 2016; Rowe, 2014; Webster & Watson, 2002). Thus, the literature reviews emphasize systematicity and transparency to reduce the risks of errors or biases and ensure reproducibility. In doing so, a high level of validity and reliability of the conducted literature reviews can be achieved (Paré et al., 2016; Webster & Watson, 2002). Due to the different thematic foci and types of reviews, the parameters chosen in the structured approach vary across the literature reviews in this dissertation, as summarized in Table 5.

Paper	Thematic focus of review	Sources	Screening criteria	Coverage final sample
I	Innovation champions' activities and influence on organizational and network characteristics	139 publication outlets ranked A+, A, B in VHB-JOURQUAL3 across IS, TIE, BA, O&HR disciplines	(1) Detailed description of research method, (2) focus on innovation process and innovation champion (I & II) or actor championing innovation (III & IV), (3) individual or organizational (I-III), or social network (IV) perspective	Publications 1995-2018: 92
II	Individual and organizational enablers of innovation champions			Publications 1995-2016: 85
III	Innovation actors' roles and organizational enablers for championing in digital vs. non-digital context			Publications 1995-2018: 110
IV	Characteristics of innovation champions' social network in the digital age			Publications 1995-2020: 61
VII	Inputs, mediators and outcomes of executives responsible for IS	AIS Senior Scholars' Basket of 8, additionally MISQE & ICIS	(1) Detailed description of research method, (2) focus on leadership of individual executive, (3) executive with responsibility for IS- or IT-related tasks	Publications until July 2019: 47
X	Digital innovation: Nature and process, and individual, organizational, and environmental determinants	46 publication outlets ranked A+, A in VHB-JOURQUAL3 across IS, TIE, BA, O&HR disciplines	(1) Detailed description of research method, (2) focus on digital innovation, (3) analysis of nature or determinants of digital innovation	Publications until May 2018: 26

Abbreviations: IS = Information Systems, TIE = Technology, Innovation and Entrepreneurship, BA = Business Administration, O&HR = Organization and Human Resources, MISQE = MIS Quarterly Executive, ICIS = Proceedings of International Conference on Information Systems

Table 5: Research focus and parameters of literature reviews in this dissertation

All literature reviews started with the formulation of the research focus and question. Next, the sources for the literature review were chosen based on the review's focus. A broad selection of publication outlets was incorporated in the assessing and specific theorizing reviews (Paper I-IV) to allow for comprehensive coverage of research on innovation champions. Thus, 139 journals and conference proceedings across disciplines were selected. In addition to Innovation Management

(also referred to as TIE), where the innovation champion concept originated, and IS - the field in which this dissertation is anchored - high-quality journals from Organization, Human Resources, and Business Administration research were considered to enable a comprehensive coverage of the literature. The initial journal selection was based on the German VHB-JOURQUAL3 ranking (Hennig-Thurau et al., 2015), which was then evaluated and extended to ensure international comparability using the Journal Quality List meta-ranking (Harzing, 2018). As a starting point for the literature search, the year 1995 was selected in Paper I to IV since the year marks the beginning of the commercialization of the Internet (Harris & Gerich, 1996) and the base for digital technologies, and may therefore be considered to mark the onset of the digital age.

The source selection was less extensive for the organizing reviews (Paper VII & X), since these literature reviews emphasize representativity over comprehensiveness. Thus, Paper VII relied on the journals in the Senior Scholars' Basket due to their significance in the IS field (Lowry et al., 2013) and two additional outlets based on their relevance for the research theme (MIS Quarterly Executive) and tendency to publish cutting-edge research (Proceedings of International Conference on Information Systems). The source selection for Paper X proceeded similarly to Paper I-IV, but only relied on top-quality publication outlets ranked as A+ or A in the VHB-JOURQUAL3 ranking. In Paper VII and X the the search period was not restricted.

Following the source selection, the search terms were selected based on the papers' research questions. After the initial search, which covered a wide variety of databases, a backward and forward search was conducted to identify additional research articles that had quoted or were quoted by the relevant research article, following the recommendation by Webster and Watson (2002). All search results were screened based on methodological and content-based criteria to ensure the high quality and relevance of the selected publications, as summarized in Table 5. The screening was done in two rounds by first reviewing the title and abstract and then applying the screening criteria to the full text.

3.1.1.3 Data Analysis

The subsequent analysis relied on a concept-centric approach to synthesize currentknowledge (Webster & Watson, 2002). The findings of all articles included in the review were coded using a mixed approach, combining inductive and deductive coding, and following established guidelines (Bandara et al., 2015). Inductive coding allows for an analysis of literature's findings without pre-defined themes and, consequently, the emergence of new insights. In contrast, deductive coding relies on an organizing framework or theory derived from existing literature that enables a strong alignment of research question and analysis and testing of hypothesized relationships. Here, the literature's findings are coded based on the organizing framework's components and their definition.

A mixed approach combines the advantages of inductive and deductive coding by enabling the identification of novel insights while applying an established theoretical framework to the literature (Bandara et al., 2015). To achieve high reliability and consistency, the coding process was, except for the single-authored Paper VII, always conducted by two researchers to avoid discrepancies (Paré et al., 2016). Finally, the findings of all research articles were synthesized in each literature review by relying on frequency and content analysis.

3.1.2 Theory Development

Theory development constitutes an essential part of research, and the accumulated knowledge in a discipline is represented by its theories (Recker, 2013). The interaction of research with theory

is manifold, as researchers may create new theories, evaluate the validity of existing theories, or modify and extend existing theories. Each paper in this dissertation interacts with theory in one of these ways and the concepts outlined in this section apply to all research papers in this dissertation. However, this section focuses especially on theory building and development as the primary research method, used in Paper XI in this dissertation. In contrast to other research methods, theory development relies on logic instead of empirical data (Bacharach, 1989). In contrast to literature reviews, theory development does not rely on a systematic synthesis of earlier literature but may only use selected research to substantiate its argumentation.

Theory is "a statement of relations among concepts within a set of boundary assumptions and constraints" (Bacharach, 1989, p.496). The goal of theory is to organize and articulate complex phenomena and understand the questions of how, when, and why (Bacharach, 1989). Theory consists of four components (Recker, 2013; Whetten, 1989): constructs (what), relationships (how), justifications (why), and boundary conditions (who, when, where). While constructs represent properties of tangible and intangible things in the real world, relationships denote the association between different constructs (Recker, 2013). Nomological networks are representations of constructs and the proposed relationships between constructs. They are frequently used to depict developed theories graphically.

Theory development occurs at the boundaries of existing knowledge, and the creation of new knowledge needs to be underpinned with convincing and logical justifications (Whetten, 1989). Accordingly, justifications form essential elements of research in explaining the dynamics underlying the proposed constructs and the relationships between constructs (Whetten, 1989). Boundary conditions complement a theory by describing the contextual and temporal conditions under which the proposed theoretical model or theory is valid (Whetten, 1989). A contribution to theory can be made by creating and adding new components (constructs, relationships, justifications, or boundary conditions) or by eliminating or refining existing components (Recker, 2013).

Theorizing forms an iterative and cyclic process, as Recker (2013) outlines. Based on extant literature and assumptions derived from extant literature, tentative propositions or conjectures are derived (Recker, 2013). After validating these conjectures, possibly but not necessarily through the analysis of empirical data, the theory is fully developed or revised to align with the validation results (Recker, 2013). In doing so, new assumptions and knowledge may be derived, which could form the starting point for a new theorizing cycle (Recker, 2013). Paper IX follows this iterative process. Existing knowledge is used to derive and develop a theoretical framework for digital innovation and digital transformation in incumbent companies. The theoretical framework is then revised and refined by validating this model against data collected during a workshop.

Paper IX theorizes the relationship between existing constructs, such as digital innovation, digital transformation, and IT consumerization, and derives a theoretical model illustrating these relationships. In doing so, Paper IX proposes justifications for these relationships and reconsiders boundary conditions proposed in earlier literature. Paper IX provides a theory of explaining (Gregor, 2006), since it focuses on explaining the relationships between digital innovation and transformation, but provides no testable propositions.

3.2 Quantitative Research

As part of the multi-method approach used in this dissertation, empirical research approaches based on observed and measured phenomena complement the methodology of this dissertation. Thus, both quantitative research (this section) and qualitative research approaches (Section 3.3),

where empirical data is collected and analyzed to derive new insights and test theories (Chen & Hirschheim, 2004), are used to derive a multifaceted understanding of innovation champions.

Quantitative research relies on numerical analyses to identify the relationship between different variables, test theory, and propose extensions to existing theory, such as identifying new mechanisms or boundaries (Chen & Hirschheim, 2004; Edmondson & McManus, 2007). It is especially well suited to evaluate and refine mature theories, which are theories with an extensive body of research and a detailed understanding of the different aspects of the theory or model (Edmondson & McManus, 2007). Testing hypotheses of mature theories quantitative research predominantly focuses on variables and the relationship between these variables using statistical methods, such as regression analysis (Edmondson & McManus, 2007).

This dissertation uses quantitative research methods in Paper V, VI, and XI to test hypotheses regarding innovation champions and digital innovation. Papers V and VI focus on the CDO as an executive champion of digital innovation. Since the CIO, another IS executive, and other functional top managers have been extensively researched, several mature theories regarding functional top managers exist (e.g., managerial power theory). Paper V and VI build on this theoretical knowledge in testing hypotheses concerning CDOs. Paper XI explores digital innovation from an asset pricing perspective. Asset pricing analysis has a long research tradition in Finance with established theories (Campbell et al., 1996). Accordingly, the quantitative approach is well suited in these papers to extend and refine extant theories regarding innovation champions and their context in the digital age.

In using quantitative methods, this dissertation relies on several methods, as illustrated in Figure 11. Paper V and VI use an event study method to analyze the the impact of CDO appointments on companies' stock market performance. Paper XI uses an asset pricing analysis, combined with computer-aided text analysis, to evaluate differences in companies' characteristics based on their level of engagement with digital innovation. The event study method and the asset pricing analysis are based on asset pricing models. Moreover, all three papers rely on hypothesis testing and regression analysis.

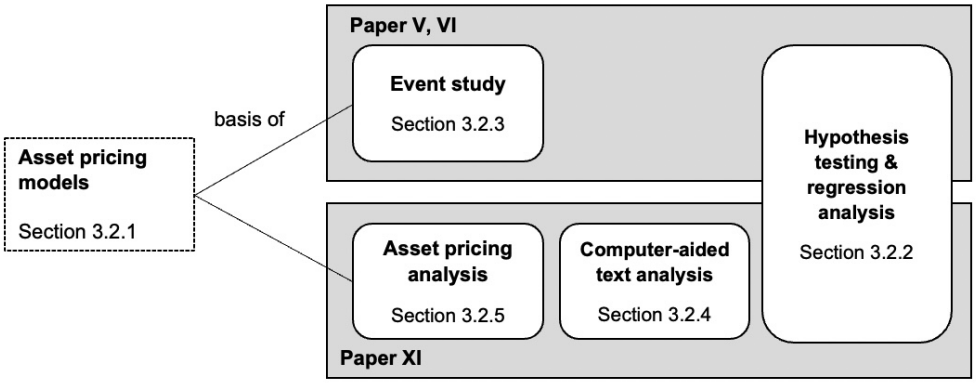


Figure 11: Overview of quantitative research methods used in this dissertation

In the following, the principles of asset pricing models (Section 3.2.1) are first outlined, followed by a summary of the general principles of hypothesis testing and regression analysis (Section 3.2.2). Subsequently, the event study method (Section 3.2.3), computer-aided text analysis (Section 3.2.4), and asset pricing analysis (Section 3.2.5) are discussed.

3.2.1 Asset Pricing Models

Asset pricing models focus on describing and explaining the pricing of assets and assets' returns on the financial markets. As such, asset pricing models form the foundation when evaluating companies' stock market performance in Paper V, VI, and XI. The Finance discipline differentiates two approaches in asset pricing: statistical and economic models. Statistical models solely rely on statistical assumptions about the behavior of asset prices and returns (MacKinlay, 1997). In contrast, economic models make assumptions about investors' behavior based on observable company or economic characteristics. These models integrate so-called 'factors' to explain asset pricing, in addition to statistical assumptions (MacKinlay, 1997). While economic models may be able to estimate the return of assets more precisely, they are also more restrictive due to the underlying assumptions, requiring an informed model selection in each research context.

In this dissertation, asset pricing models serve two purposes, which also influence the selection of the asset pricing model in each case. First, Paper V and VI rely on the market model, a statistical asset pricing model, to assess the impact of executive champions' appointment on companies' short-term financial performance using an event study method. The market model is the most commonly used asset pricing model in event studies (MacKinlay, 1997; McWilliams & Siegel, 1997). Even though the use of economic models over statistical models could theoretically lead to gains in the precision of the estimates, these gains are marginal for event studies, since the explanatory power of additional factors besides the market factor is negligible (Campbell et al., 1996). Section 3.2.3.3 outlines the use of the market model in event studies and the estimation of abnormal returns.

Second, Paper XI uses an economic asset pricing model to identify systematic differences in companies' characteristics and financial performance based on companies' level of engagement with digital innovation. The paper aims to understand asset pricing for intangible assets in the digital age. For intangible assets, such as digital innovation, even sophisticated multi-factor asset pricing models are challenged and cannot fully explain asset pricing (Daniel & Titman, 2006). Paper IX addresses this shortcoming by building on extant research of asset pricing, which uses multi-factor economic asset pricing models (Hou et al., 2020), to identify a new asset pricing factor of digital innovation. Section 3.2.5.1 illustrates the multi-factor asset pricing model used in Paper XI in more detail.

3.2.2 Hypothesis Testing and Regression Analysis

In this dissertation two methods of statistical data analysis are used: hypothesis testing and regression analysis. Hypothesis testing identifies and tests the existence of significant effects and differences between populations. Complementing these analyses, regression analyses allow for identifying relationships between variables. In the following sections, both types of data analysis are briefly outlined. Finally, evaluation criteria for both hypothesis testing and regression analysis are introduced.

3.2.2.1 Hypothesis Testing

This dissertation conducts two types of hypothesis tests: (1) hypothesis tests concerning the population mean and (2) hypothesis tests concerning the difference between two population means. Hypothesis testing allows to determine whether a statically identified effect is likely to depict an existing effect or only arises due to chance (Stock & Watson, 2012). To conduct hypothesis testing, the **null and alternative hypothesis** need to be specified (Stock & Watson, 2012). In this dissertation, only two-sided hypothesis tests are conducted. For two-sided hypothesis tests

concerning the population mean, the null hypothesis H_o states that the analyzed effect in the population mean $E(Y)$ is 0 ($H_o : E(Y) = 0$). In two-sided hypothesis tests concerning the difference between population means, the null hypothesis H_o formulates that the difference between the mean of the first population μ_1 and the mean of the second population μ_2 is 0 ($H_o : \mu_1 - \mu_2 = 0$). The test statistic and p-value are then calculated to conclude whether the null hypothesis is rejected or fails to be rejected. The p-value denotes the probability of drawing a test result at least as extreme as the test result computed, assuming the null hypothesis is correct (Stock & Watson, 2012).

The **choice of test statistic** depends on several factors. In this dissertation, all studied dependent variables are interval scaled, justifying the selection of a student's t-test (Rasch et al., 2014). The student's t-test is a commonly used test statistic for hypothesis testing of the sample average. At the same time, the student's t-test can only be applied if the sample is sufficiently large to warrant the assumption of a normal distribution (number of observations larger than 30). If the sample is not sufficiently large or the normal distribution assumption could be violated, a non-parametric test, such as the generalized sign test must be used (McWilliams & Siegel, 1997).

When using the student's t-test, different cases need to be differentiated. Hypothesis testing concerning the population mean relies on a one-sample t-test (Rasch et al., 2014). This is the most commonly known and widely applied form of the t-test, also used in most regression analyses. Hypothesis testing concerning the difference between two population means relies on a two-sample t-test (Rasch et al., 2014). Depending on the nature of the two populations compared, an independent or dependent two-sample t-test is applied. A two-sample independent t-test is used, if the values of one population do not affect the other population and the variance of both populations is homogeneous. In contrast, for applying a dependent two-sample t-test, the values of both populations are assumed to be related (Rasch et al., 2014).

Paper V and VI conduct hypothesis testing concerning the population mean based on the overall sample and subsamples. Paper XI relies on hypothesis testing concerning the population mean, and the difference between population means. Companies with high and low engagement with digital innovation were compared with respect to a wide range of company characteristics. The two samples of companies were independent of each other, leading to the application of a two-sample t-test for independent samples.

3.2.2.2 Regression Analysis

Multivariate regression analysis enables the analysis of relationships between multiple independent variables and one dependent variable. Thus, regression analysis can be used to identify correlations and causal associations between variables (Stock & Watson, 2012). The coefficient denotes the strength of a relationship between independent and dependent variables. Its significance can be evaluated following the procedure described above for hypothesis testing concerning the population mean.

Commonly ordinary least square estimator (OLS) is used if all variables are either interval scaled or coded as dummy variables. Generally, the **Gauss-Markov assumptions** need to be fulfilled to conduct a multivariate regression analysis using OLS (Stock & Watson, 2012): (1) A linear relationship between the independent and dependent variable needs to exist, (2) the analysis needs to be based on a random sample of the population, (3) the independent variables cannot be perfectly correlated with each other, (4) the independent variables need to be exogenous, that is uncorrelated with the error term, and (5) the variance of the error term is constant or homoscedastic. Except for assumption (2), which depends on the research design, these

assumptions can be examined using descriptive or visual analysis. Since not all assumptions are usually met, statistical methods have been developed over time to counteract or account for violations of these assumptions (Stock & Watson, 2012).

When examining the validity of the Gauss Markov assumptions in Paper VI and X, the analysis showed that assumption (5) might be violated, as the variance of the regressions' error terms varied. Accordingly, alternative formulas to derive standard errors were used in this dissertation. Paper VI relies on heteroskedasticity-robust standard errors. Paper XI uses Newey-West standard error to adjust for auto-correlation across time periods (Newey & West, 1994).

3.2.2.3 Assessing Hypothesis Testing and Regression Analysis

Several criteria exist to evaluate the results of hypothesis testing and regression analysis. This section outlines the significance level and statistical power as measures of two possible errors in hypothesis testing and regression analysis. Subsequently, R-squared, which constitutes a measure of the goodness of fit for regression analysis, is discussed.

Hypothesis testing and regression analysis can be subject to two possible errors: type I and type II error. **Type I error** (usually denoted as α) occurs if the null hypothesis is rejected, even though it is true (Stock & Watson, 2012). The significance level of a test denotes the predetermined threshold of a type I error (Stock & Watson, 2012), usually using the 10%-, 5%-, and 1%- levels. Critical values for the significance levels of 10%, 5%, and 1% for two-sided student's t-test are 1.64, 1.96, and 2.58, respectively. A relationship is statistically significant if the t-test is greater than the critical value. Then it can be concluded with a high degree of probability that an effect was not measured due to chance but because the relationship exists.

Type II error (usually denoted as β) occurs if the null hypothesis is not rejected, but is not true (Stock & Watson, 2012). To ensure a low type II error, the power of a test $(1 - \beta)$, denoting the probability that a test correctly rejects the null hypothesis given that the alternative hypothesis is true, can be computed based on the effect size, sample size, significance level and variance of the population mean (Ellis, 2010). In this dissertation, the power was computed (but not reported) when testing hypotheses and estimating regressions to ensure that the sampled population sufficed to reach a power of at least 65%, but better 80%, which are two generally accepted thresholds for statistical power (Ellis, 2010). Both type I and type II error form a trade-off. If type I decreases, type II error increases, and vice versa (Ellis, 2010).

To measure the **goodness of fit** of a regression model, R-squared (R^2) is computed, as it measures the proportion of the sample variance of the dependent variable that is explained by all independent variables in the regression (Stock & Watson, 2012). Since R^2 automatically increases when a new variable is added to the regression, commonly adjusted R^2 is used to evaluate the fit of the regression, as it accounts for this effect (Stock & Watson, 2012). The value ranges between 0 and 1. The widely accepted level of fit for a regression model will vary depending on the context and type of data in which regression analysis is applied. In this dissertation, regression analysis is used to analyze stock market data. Since numerous factors influence the movement and price formation of the stock market, generally, low values of R^2 have been presented in past studies using stock market data (e.g., Chatterjee et al., 2001; Yang et al., 2012).

3.2.3 Event Study

Paper V and VI in this dissertation rely on an event study method. The event study method is established and has been widely used in Finance research in the last half a century (Binder, 1998;

MacKinlay, 1997), since its introduction by Ball and Brown (1968) and Fama et al. (1969). In IS, the event study method has been frequently applied to study the effect of events, such as the appointment of the CIO (e.g., Chatterjee et al., 2001), IT investment (e.g., Dehning et al., 2003; Yang et al., 2012), or identity theft countermeasures (e.g., Bose & Leung, 2019), on the expected business value. This method makes it possible to isolate the reaction to an unexpected event on the stock market and consequently estimate its causal effect on a company's short-term financial performance (Fama, 1970; McWilliams & Siegel, 1997). Figure 12 illustrates the basic notion of the event study method: the calculation of the abnormal return of a stock based on the difference between the observed stock market return surrounding the unexpected event (event window) with the normal stock market return without the event (estimation window). The normal stock market return characterizes the estimated return for a hypothetical scenario where no event occurred during the event window (Brown & Warner, 1985; MacKinlay, 1997).

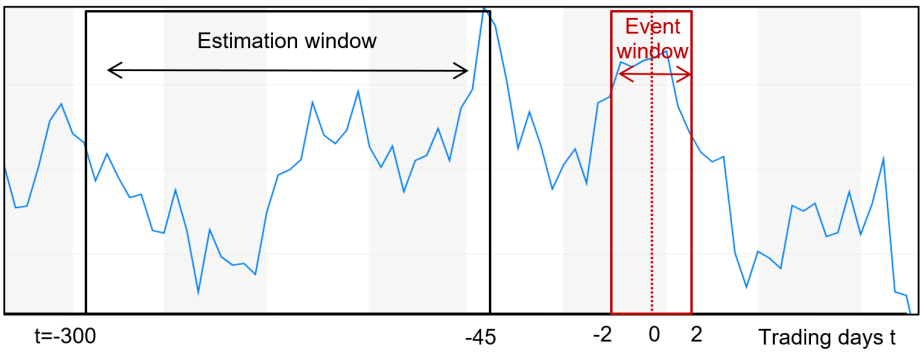


Figure 12: Illustration of event and estimation window (Drechsler et al., 2019b, p.8)

The subsequent sections are organized as follows. First, signaling theory as the theoretical foundation of event studies is outlined. Second, critical assumptions of event studies and the overall research design are summarized. Third, the construction of the market model and the estimation of abnormal returns are presented. Finally, the methods of data analysis used in the event studies are described.

3.2.3.1 Signaling Theory and Event Studies

The event study method is grounded in signaling theory, which argues that companies can use signals to diminish existing information asymmetries between two stakeholders (Spence, 1973, 2002). Originally derived from analyzing the labor market (Spence, 1973), signaling theory has been applied to the organizational context (e.g., Zmud et al., 2010). Companies send strategic signals by communicating previously unknown information to external stakeholders. Information, which changes the perception of a company's future prospects among external stakeholders, such as investors, leads to imminent reactions (Herbig & Milewicz, 1996; Moore & Chapman, 1992). In efficient financial markets, such as the stock market, investors respond to new information about a company by selling or buying shares in the company, depending on whether the new information elevates or lowers investors' expectations about the company's future (Fama, 1970; Herbig & Milewicz, 1996). The aggregate of investors' reactions to a company's announcement of new information influence the value of a company on the stock market. Event studies exploit this mechanisms by observing the aggregate reaction of investors to a specific type of new information, for instance, the appointment of a new executive.

The impact of innovation champions on organizational performance is generally hard to isolate due to numerous other organizational and environmental factors that may impact this relationship. Applying an event study to measure the link between executive champions' appointment and the financial market can circumvent such problems. Accordingly, Paper V and VI use an event study method to measure the effect of companies' announcements of CDO appointments on stock market reactions. Releasing information about a CDO appointment can be a strategic signal, if investors perceive the information to change their assessment of the company's prospects. Thus, a reassessment could, for instance, occur due to the perception that the CDO is going to play a significant role in driving digital innovation and transformation. This may lead to higher than usual stock returns (i.e., positive abnormal returns) for the appointing company.

3.2.3.2 Research Design

Several critical questions need to be considered when designing and executing an event study to ensure its validity and reliability, as outlined by McWilliams and Siegel (1997). Table 6 summarizes the underlying assumptions and research design choices made in Paper V and VI to circumvent possible issues arising from a violation of these assumptions, following earlier literature (e.g., Bose & Leung, 2019; Yang et al., 2012). Suppose the event study is designed and executed by complying with these assumptions. In that case, the event study method can estimate the event's effect on company performance, while minimizing possible problems of endogeneity and reverse causality (McWilliams & Siegel, 1997). Moreover, due to the use of stock market returns as a dependent variable, the event study also offers the advantage of a highly objective measure, which is harder to manipulate than accounting-based measures of company performance. Additionally, Paper VII and VIII rely on two independent sources of secondary data, press releases and stock price data, which eliminates the problem of common method bias.

Underlying assumptions in event studies (McWilliams & Siegel, 1997)	**Research design choices in Paper V and VI**
Market efficiency: Relevant information is priced into the share price directly after its release	Use of a short event window with a maximum of five days surrounding CDO appointments & estimation using only stocks with high trading volume in liquid stock markets (McWilliams & Siegel, 1997)
Unanticipated event: Announcement provides investors with new information not previously known or anticipated	The event window includes two days preceding the event to account for the possibility of leaked information about CDO appointments (e.g., Chatterjee et al., 2001; McWilliams & Siegel, 1997)
No confounding events: No simultaneously occurring events bias the estimated impact of the studied event on stock market prices	Exclusion of CDO appointments that coincided with other events which could affect investors' perception of a company's future prospects (e.g., the declaration of dividends, unexpected earnings, or lawsuits) within a five-day window around the event (e.g., Bose & Leung, 2019; Yang et al., 2012)
Normality assumption: Parametric test statistics assume normality distribution, which is only satisfied for large samples	Additional use of non-parametric tests, since they do not make assumptions about the underlying distribution of the sample (MacKinlay, 1997; McWilliams & Siegel, 1997)
No outliers: Estimates are not influenced by extreme values	Additional use of non-parametric tests to circumvent that results are driven by outliers (MacKinlay, 1997; McWilliams & Siegel, 1997) & winsorization of stock price data to eliminate outliers, e.g., by setting stock prices in the top and bottom one percentile to the values of the 1st and 99th percentile, respectively (Dewan et al., 2007)

Table 6: Assumptions in event studies and research design in this dissertation

The methodological approach in Paper V and VI adheres closely to established guidelines for undertaking event studies (MacKinlay, 1997; McWilliams & Siegel, 1997) and mirrors the approach of earlier event studies in IS (e.g., Bose & Leung, 2019; Chatterjee et al., 2001; Yang et al., 2012). The event studies follow seven steps: collecting the events' announcements, screening announcements, coding announcements to retrieve explanatory and control variables, collecting stock prices and company/ industry data, constructing the abnormal return model, estimating abnormal returns, and conducting regression or subsampling analyses.

The press releases were collected from Lexis-Nexis, an electronic database with comprehensive coverage of daily newspaper articles and press announcements, using a keyword search. The press releases were then screened by excluding irrelevant and duplicate announcements and announcements referring to subsidiaries, local branches, or non-listed companies. The remaining announcements were then matched with daily stock price data of the respective company and market indices retrieved from Refinitv (previously Thomson Reuters) Eikon and Datastream. Paper V relies on data of 101 CDO appointments for the period 2002 to 2018 in Europe and North America. Paper VI uses data on 307 CDO appointments for the period 2009 to 2020 globally. Additionally, samples of 110 and 276 CIO appointments in the US during the period 1987-1998 and 2011-2020, respectively, formed part of the dataset for the analysis in Paper VI.

Next, the market model was constructed using these datasets, and abnormal returns were estimated based on the market model (see Section 3.2.3.3). Subsequently, statistical hypothesis tests and/or regression analyses were performed to test the hypothesis regarding the stock market reaction to CDO appointments (see Section 3.2.3.4).

3.2.3.3 The Market Model and Abnormal Returns

The market model relates an asset's daily return to the market portfolio's return (MacKinlay, 1997; McWilliams & Siegel, 1997). In Paper V and VI, formula (1) is used to relate the company's daily stock market return (i.e., day-to-day changes in a company's stock price) to the daily return of the market index (i.e., day-to-day changes in the price of the market portfolio, which contains all stocks traded on a stock market) for a period preceding the CDO appointment:

$$R_{i,\tau} = \alpha_i + \beta_i * R_{m,\tau} + \epsilon_{it} \quad (1)$$

$R_{i,\tau}$ is the return of stock i on day τ, $R_{m,\tau}$ is the return of the market portfolio m on day τ, α_i is the intercept, β_i is the systematic risk of stock i, and ϵ_{it} is the error term. To estimate the coefficients, stock price data for an estimation windows (e.g., t = [-300;-45]) prior to the event (t = 0) is used, as illustrated in Figure 12. To account for heterogeneity in the global samples used in Paper V and VI, both papers match a company's stock prices to country-specific market indices and then select the market index with the highest explanatory power (measured by R^2) for each stock, following Bose and Leung (2019).

Subsequently, the daily abnormal return $AR_{i,\tau}$ for stock i on day τ is then derived for an event window, for instance, encompassing the announcement day, the two days before, and two days after (t = [-2; 2]). Here formula (2) is applied, where $\hat{\alpha}_i$ and $\hat{\beta}_i$ are the estimates of a regression of $R_{i,\tau}$ on $R_{m,\tau}$ over the estimation window:

$$AR_{i,\tau} = R_{i,\tau} - (\hat{\alpha}_i + \hat{\beta}_i * R_{m,\tau}) \quad (2)$$

Thus, the daily abnormal return characterizes the deviation of the stock's observed market return on an event day from the stock's average return during the estimation window (i.e., the

expected stock return without the event). The next step is to compute the cumulative abnormal return of CDO appointments by averaging the abnormal returns of all *i* stocks in the sample and aggregating the daily abnormal returns over the entire event window.

3.2.3.4 Data Analysis

This section builds on the principles of hypothesis testing and regression analysis described in Section 3.2.2 and describes several commonly applied approaches of data analysis in event studies. First, different tests to analyze overall (cumulative) abnormal returns are outlined. Next, techniques of cross-sectional analysis in event studies to identify the influence of explanatory variables on abnormal returns are summarized.

Analyzing Abnormal Return. In event studies, the overall stock market effect of the studied event is commonly evaluated using hypothesis testing concerning the population mean. These hypothesis tests examine the validity of the null hypothesis that abnormal returns have a value of zero and determine the corresponding significance level. Event studies should rely on both parametric and non-parametric tests to increase the results' reliability (McWilliams & Siegel, 1997). Whereas parametric tests rely on normality assumptions and are sensitive to outliers, non-parametric tests are not based on such restrictive assumptions. Therefore, non-parametric tests provide a robustness check to parametric test statistics (MacKinlay, 1997). Two commonly used tests are the Patell test (Patell, 1976), a parametric test, and the generalized sign test (Cowan, 1992), a non-parametric test. Paper V and VI measure the overall stock market reaction following CDO appointments based on the Patell and generalized sign test and following existing event studies in IS research (e.g., Bose & Leung, 2019; Chatterjee et al., 2001).

The **Patell t-test** is computed by calculating the t-statistic (also called: z-score) for each event day, aggregating these t-statistic, and dividing the sum by the square root of the sample size (Corrado, 2011; Patell, 1976). The resulting test statistic follows the normal distribution. It is commonly used in event studies, since it is more powerful than other parametric test statistics (Brown & Warner, 1985). The **generalized sign test** is based on the idea that the proportion of positive abnormal returns during the event window should not deviate from the proportion of positive abnormal returns during the estimation window (Cowan, 1992; MacKinlay, 1997). The null hypothesis is rejected if a significant difference between these two proportions exists. Thus, the generalized sign test accounts for an asymmetric distribution of abnormal returns during the estimation window. Cowan (1992) shows that the generalized sign test can be more powerful than parametric tests, especially if extreme abnormal returns occur during event windows.

Cross-Sectional Analysis. To evaluate the influence of explanatory variables on abnormal return, two data analysis approaches are used in event studies in IS research (Bose & Leung, 2019; Chatterjee et al., 2001; Yang et al., 2012): subsampling analysis and regression analysis. While the regression analysis allows the modeling and estimation of complex relationships, the subsampling analysis can also be used for small samples (as in Paper V), where regression analysis cannot consistently estimate the effect of explanatory variables on the dependent variable. Whereas Paper V uses subsampling analysis, Paper VI relies on regression analysis.

In a **subsampling analysis**, the sample is split into two groups based on the value of one explanatory variable. Then, hypothesis testing relying on the Patell or generalized sign test is used to evaluate whether the abnormal stock returns differ significantly from zero for both groups. The **regression analysis** allows for studying the combined effect of explanatory variables on an event's abnormal returns. For hypotheses testing, the cumulative abnormal return over

the event window is regressed against explanatory variables using a multivariate OLS regression, following earlier IS studies (Bose & Leung, 2019; Chatterjee et al., 2001). In addition to regression analysis studying the hypothesized relationships, robustness checks, including control variables as well as alternative event and estimation windows, can be conducted to demonstrate the reliability of the presented results.

3.2.4 Computer-Aided Text Analysis

Computer-aided text analysis (CATA) allows for the content analysis of standardized reports across time to derive quantitative measures of constructs (Short et al., 2010). Using a word list, a given text is parsed, and a vector containing each word and its frequency in the text is derived, which is then aggregated to calculate an overall measure of the desired construct. CATA offers several advantages compared to manual coding since it permits the analysis of large amounts of data, while ensuring a high level of reliability, replicability, and comparability across studies (King & Lowe, 2003; Loughran & McDonald, 2016; Short et al., 2010). CATA has frequently been applied to quantify strategic orientation in Organization research (e.g., Short et al., 2010; Zachary et al., 2011) or positive and negative sentiment in Finance (e.g., Hillert et al., 2014; Loughran & McDonald, 2011), because it allows the measurement of constructs that are difficult to quantify in other ways.

In Paper XI, CATA measures the extent to which companies develop and rely on digital innovation. The methodological approach is very suitable for this paper, since a company's level of digital innovation is otherwise hard to measure. CATA facilitates the derivation of a longitudinal, objective measure for an extensive range of companies. Using the word list developed and validated by Kindermann et al. (2021), a dictionary is constructed to measure companies' engagement with digital innovation. Based on the four loosely coupled layers composing digital innovation's layered architecture, four dimensions of the digital innovation measure are derived: device, network, service, and content layer (Yoo et al., 2010) (see Section 2.2.2 for detailed information on the layered architecture).

When using CATA, a rigorous construct validation is recommended (McKenny et al., 2018; Short et al., 2010). Since the validity and the reliability of the deductively derived word list were extensively evaluated by Kindermann et al. (2021)[11] based on recommendations in the literature (MacKenzie et al., 2011; McKenny et al., 2018; Short et al., 2010), the wordlist is used without extensive evaluations. Only the dimensionality, the assignment of the different measurement dimensions to a single construct, is evaluated, because four new dimensions of the construct were derived. Since the four dimensions show a moderate correlation between 0.25 and 0.60, it is concluded that the dimensions are sufficiently correlated to be part of one construct but still form independent components, according to guidelines by Short et al. (2010).

In Paper XI, the derived dictionary is used to parse the management discussion and analysis (MD&A) section, a non-audited section of companies' annual reports that displays managers' assessment and understanding of a company (Loughran & McDonald, 2011). The level of engagement with digital innovation is measured for all US companies listed on the largest US stock exchanges (i.e., NYSE, AMEX, and NASDAQ) between 1996 and 2020. To derive a comparable measure of digital innovation across companies and time, the number of words counting digital

[11] Kindermann et al. (2021) used a step-wise approach in developing the wordlist to ensure its content validity. Moreover, they find the wordlist to fulfill external, concurrent, discriminant, and predictive validity based on standard evaluation criteria (Short et al., 2010). Moreover, Kindermann et al. (2021) ensure that a high inter-coder, parallel forms, and test-retest reliability is attained when developing the wordlist.

innovation was divided by the overall number of words in the MD&A section without stopwords (e.g., the, is, a, in), as suggested by Loughran and McDonald (2011). Additionally, an alternative measure of digital innovation, which accounts for the significance of a word within the overall sample, is calculated based on established weighting schemes (Loughran & McDonald, 2011).

3.2.5 Asset Pricing Analysis

In Finance, the relationship between an investment's risk and expected return is a key question. The capital asset pricing model (CAPM) by Sharpe (1964) and Lintner (1965) was the first model to respond to this question (Perold, 2004). According to CAPM, the expected return of an asset is linearly related to the the market portfolio's risk premium (i.e., the return of the market portfolio minus the return of a risk-free asset) (Campbell et al., 1996). The CAPM benefits from its simplicity enabling it to become one of most well-known asset pricing models. However, CAPM has also received frequent criticism due to its strong assumptions (Linton, 2019). Empirically, CAPM has frequently failed in comprehensively describing stock returns (e.g., Carhart, 1997; Fama & French, 1993). In the last two decades, numerous anomalies to CAPM have been identified. For instance, Hou et al. (2020) specify and test 452 anomalies identified in the literature. Among these anomalies, some have been found essential in pricing assets, leading to their incorporation in frequently used asset pricing models, such as the five-factor model (Fama & French, 2015) (see Section 3.2.5.1). However, existing multi-factor asset pricing models have largely failed to account for intangible assets in general and digital innovation in particular (Daniel & Titman, 2006).

Against this backdrop, Paper XI conducts an asset pricing analysis to understand differences in companies' characteristics based on their level engagement with digital innovation and to isolate a new asset pricing factor for digital innovation. Although the methodological traditions of Finance strongly shape the analysis, the general conclusions that can be drawn from an asset pricing analysis are far-reaching. By providing the means to explore and identify systematic differences in companies developing and using high versus low levels of engagement with digital innovation, asset pricing analysis offers implications for the IS disciplines. The suitability of asset pricing analysis to demonstrate the impact of digital innovation and its particular characteristics on financial markets and companies was therefore also key for the methodological choice in Paper XI. As a starting point for its analyses, Paper XI uses an asset pricing mode with established asset pricing factors that have been shown to address persistent anomalies (Carhart, 1997; Fama & French, 1993, 2015). The corresponding multi-factor asset pricing model is outlined in the next section, before a summary of the research design and data analysis of Paper XI is provided.[12]

3.2.5.1 A Multi-Factor Asset Pricing Model

Several multi-factor asset pricing models exist, which aim to explain asset pricing based on a limited number of company or economic risk factors. Examples include the three- and five-factor models by Fama and French (1993, 2015) and the four-factor model by Carhart (1997). Combining these models and following recent literature (e.g., Hillert et al., 2014; Hirshleifer et al., 2018; Müller, 2019), equation (3) depicts a multi-factor asset pricing model. In Paper XI, the model with six commonly used factors forms the baseline to examine the necessity for a new asset pricing factor for digital innovation. Here r_t describes the asset return, α is the intercept of the model, the βs

[12] Asset pricing analysis constitutes an extensive field of research in Finance with numerous broad research streams. The following sections, briefly introduce the research context and standard methods in the Finance discipline to explain the choices made in Paper XI and to illustrate their ability to answer one of the research questions of this dissertation.

form the coefficients of the respective asset pricing factors, and ϵ_t denotes the error term.

$$r_t = \alpha + \beta_{mktr} MKTR_t + \beta_{smb} SMB_t + \beta_{hml} HML_t + \beta_{rmw} RMW_t + \beta_{cma} CMA_t + \beta_{umd} UMD_t + \epsilon_t \quad (3)$$

$MKTR$ describes the market risk premium (i.e., the difference between the return of the market portfolio and a risk-free asset) as derived from CAPM (Lintner, 1965; Sharpe, 1964). SMB and HML denote the size and value risk factors derived by Fama and French (1993) to account for their observation that companies with small market capitalization and large book-to-market ratio[13] generate higher returns than companies with large market capitalization and small book-to-market ratio, respectively. RMW and CMA are profitability and investment factors based on Fama and French (2015). They account for higher returns among companies with high profitability[14] and conservative investment[15] compared to companies with low profitability and aggressive investment. UMD describes the momentum effect that Carhart (1997) identified to represent higher current returns by companies with higher returns in the previous period.

3.2.5.2 Research Design and Data Analysis

Studies analyzing asset pricing commonly apply a combination of two established approaches when identifying anomalies (Fama & French, 2008; Hillert et al., 2014; Hirshleifer et al., 2018): Fama-MacBeth regressions and portfolio sorting. In the following, the main principles of both approaches are outlined. In Paper XI, the analyses are performed using datasets combining digital innovation measures derived from CATA (see Section 3.2.4) and stock market data from CRSP and COMPUSTAT. The final sample constitutes 91.151 company-years with 24 periods and 10.367 unique companies, resulting in an outstanding 88% coverage of companies listed on the largest US stock exchanges.

Fama-MacBeth Regression. The Fama-Macbeth regression is an econometric two-step approach that allows for the estimation of consistent standard errors, even if cross-sectional correlation (across different stocks) exists (Fama & MacBeth, 1973), as is the case for longitudinal datasets of stock returns. While today more sophisticated procedures exist, due to its simplicity and historical significance, the Fama-MacBeth regression is still widely used in Finance (Cochrane, 2005). In the first step, cross-sectional regressions are run separately for every time period in the dataset. The second step aggregates the estimates across the time dimensions (Campbell et al., 1996; Cochrane, 2005).

Following Hillert et al. (2014), the Fama-MacBeth regression is used in Paper XI to examine the link between companies' characteristics and their engagement with digital innovation. Thus, the described two-step approach is conducted by regressing the measure of digital innovation against several company characteristics (e.g., company size, analyst coverage) as explanatory variables. The results indicate the explanatory power of the measure of digital innovation compared to other company characteristics. Using the results of the Fama-MacBeth regression, a residual measure of digital innovation can then be calculated following Hong et al. (2000) to remove strong dependencies between the raw measure of digital innovation and explanatory variables.

[13] The book-to-market ratio compares a company's current market value to its book value, measured as its assets minus liabilities (Greenwood & Hanson, 2012).

[14] Profitability is defined as annual revenues minus cost of goods sold, interest expense, and selling, general, and administrative expenses, all divided by book equity (Fama & French, 2015).

[15] Investment is defined as the total assets in one year divided by the total assets in the preceding year (Fama & French, 2015).

Portfolio Sorting. Portfolio sorting is a frequently applied procedure in empirical Finance research when analyzing the relationship between companies' stock returns and characteristics (e.g., Fama & French, 2008; Greenwood & Hanson, 2012; Müller, 2019). Stocks are sorted based on one particular characteristic, which forms the focus of the analysis, and then grouped into several portfolios, which are rebalanced every year. The average value concerning a broad range of company characteristics (e.g., book-to-market ratio, return on assets, sales growth) is computed for each portfolio. Finally, the average values of the top and bottom portfolios are calculated, and hypotheses tests are performed to evaluate whether these two portfolios have significantly different average values (see Section 3.2.3.4). In Paper XI, stocks are sorted based on the raw and residual measures of digital innovation and grouped into five portfolios, so-called quintile portfolios. Subsequently, systematic differences in companies' characteristics for companies with high and low levels of digital innovation are analyzed. Here hypothesis testing concerning the difference between two means from different populations (see Section 3.2.2) is applied.

This analysis is then taken further to explore systematic differences in stock returns between companies with high and low manifestations of a particular characteristic. Similar to the approach described above, stocks are grouped into quintile portfolios based on the level of their engagement with digital innovation. Then long-short portfolios are calculated based on the differences between the weighted top and bottom quintile, with a rebalanced portfolio calculated every twelve months. The long-short portfolio returns are then regressed against commonly used asset pricing factors (see Section 3.2.5.1) to identify the unexplained stock return of the new factor (i.e., the digital innovation factor in Paper XI). Thus, the estimated α in a regression analysis using equation (3) illustrates the return unexplained by established asset pricing factors. Paper XI performs additional portfolio sorting to verify the robustness of the identified new asset pricing factor of digital innovation and eliminate alternative explanations.

3.3 Qualitative Research

Qualitative research centers on the exploratory analysis of novel and emerging research topics with little extant knowledge (Recker, 2013). Thus, it is especially suited to explore issues with little theoretical understanding or nascent theories and to focus on the mechanisms underlying the phenomenon of interest (Edmondson & McManus, 2007). The literature reviews conducted in Paper I to IV revealed that research on innovation champions in the digital age is still nascent with respect to some aspects, such as the organizational enablers of innovation champions and coordination mechanisms for distributed championing. Paper VIII and IX apply qualitative research methods to address this gap in our understanding of innovation champions in the digital age, identify organizational enablers and mechanisms that facilitate the championing of innovation in the digital age, and derive theoretical explanations.

Due to a small body of extant knowledge on the studied phenomenon and the relevant concepts, qualitative research relies on rich and detailed data gained through open-ended inquiries, such as interviews, within the natural setting of the studied phenomenon (Recker, 2013). The design of qualitative studies is emergent, and the data collection and analysis may be adjusted iteratively as the first results emerge (Creswell, 2009). Accordingly, comprehensive documentation of the data collection and analysis is essential in qualitative studies (Yin, 2018). At the same time, the diverse and broad data collection and the large set of possibilities in data analysis offer the opportunity for complex and manifold knowledge contributions (Recker, 2013).

Qualitative research aims to develop a holistic account of the studied phenomenon (Creswell, 2009). In contrast to quantitative research, which predominantly focuses on whether a causal

effect exists, qualitative research centers around explaining the how and why of the studied phenomenon (Edmondson & McManus, 2007). Moreover, it is especially well suited to capture actors' perspectives and the studied phenomenon's influences and context factors (Edmondson & McManus, 2007). As in the case study in Paper VIII, a qualitative research paper may take an interpretive stance by striving to understand the meaning of events and processes for actors, whereby the researcher interprets their observations (Walsham, 1995). Alternatively, researchers may take actively participate in the research process, as in the action design research (ADR) study in Paper IX. Thus, the conclusions drawn cannot always be separated from the researchers' background, history, and context (Creswell, 2009). Accordingly, transparency regarding the researchers' role and prior experiences is essential in qualitative research (Creswell, 2009).

Section 3.3.1 outlines essential aspects of ensuring rigor in qualitative research. Subsequently, the two qualitative research methods used in this dissertation are outlined: case study (see Section 3.3.2) and ADR (see Section 3.3.3)[16].

3.3.1 Ensuring Rigor in Qualitative Research

Qualitative research depends on the activities of the individual researcher, giving rise to a certain level of subjectivity. Recker (2013) suggest four principles for qualitative research in IS to reduce subjectivity and ensure rigor: dependability, credibility, confirmability, and transferability. Table 7 summarizes the principles and general measures that were taken in Paper VIII and Paper IX following Yin (2018) and Recker (2013). These measures taken during data collection and data analysis are then described in detail.

Principle	Description	Measures taken
Dependability	Other researchers could reach similar conclusion when studying the same data	▸ Use of research project protocol to maintain chain of evidence ▸ Data collection and analysis always conducted by at least two researchers ▸ Discussion and reflection on findings among researchers
Credibility	Researchers provide sufficient and substantial evidence for the drawn conclusions	▸ Triangulation of research findings using diverse data sources ▸ Meticulous documentation of data collection and analysis ▸ Transparency about researchers' role and prior experiences
Confirmability	Research findings can be independently validated by members of the studied organization or case	▸ Informal conversations and reviews by key informants and stakeholders in the organization throughout the data collection and analysis
Transferability	Findings can be generalized to other settings, participants, organizations, or contexts	▸ Provision of rich and detailed descriptions of research context and case ▸ Use of theoretical lens in single research settings

Table 7: Ensuring rigor in Paper VIII and IX following Recker (2013) and Yin (2018)

[16] Please note that both research methods do not have to be strictly qualitative, but mixed methods combining quantitative and qualitative data are also possible. However, in this dissertation only qualitative data was used, which leads to the classification of case study and ADR as qualitative methods.

3.3.1.1 Ensuring Rigor in Data Collection

Traditionally, qualitative research methods involve various data collection methods to develop converging lines of inquiry and triangulate the findings by relating multiple data sources to each other (Eisenhardt, 1989; Walsham, 2006). This approach decreases the risk of methodological biases and paves the way for researchers to understand the studied phenomenon comprehensively (Recker, 2013). Accordingly, Paper VIII and Paper IX combine interviews, observations, and documentation. To maintain the chain of evidence, linking the research question to the collected data and the findings, the case study in Paper VIII and the ADR study in Paper IX documented each step of the data collection and subsequent analysis meticulously.

In Paper VIII and Paper IX interviews with key stakeholders form the core data source to assess key stakeholders' perceptions and opinions on the studied problem. Following an established approach in literature (Kumar et al., 1993), the selection of interview partners was based on the recommendations of key informants within the company. By selecting a high number of knowledgeable interview partners, the risk that individual interviewees' biased perspective drove the analysis was reduced (Eisenhardt & Grabner, 2007). Moreover, key stakeholders with diverse demographic profiles occupying various hierarchical and functional positions within the company were selected, as suggested in prior research (Eisenhardt & Grabner, 2007).

Both qualitative studies relied on semi-structured interviews that were conducted using open-ended questions and following guidelines in IS research (Myers & Newman, 2007) to derive insights from key stakeholders. Semi-structured questions follow a predefined interview protocol and offer the flexibility to adapt questions throughout the interview (Recker, 2013). As emphasized by Yin (2018), this research design allows for the collection of various perspectives across stakeholders and time, the comparability of these different perspectives, and the iterative exclusion of rival explanations for the studied phenomenon. To strengthen the dependability of the case study, each stakeholder was interviewed twice by at least two researchers (Eisenhardt, 1989; Yin, 2018).

In addition, observations of key stakeholders complemented the data collection in Paper VIII and IX. Observations offer the opportunity to observe stakeholders' behavior in a real-world setting and gain in-depth insights into the case context (Yin, 2018). At the same time, they are influenced by the observing researchers' interpretation, which may bias results. To increase the credibility of the observations, observations were meticulously documented, as suggested by Yin (2018). Additionally, documentation constituted the third data source. Documentation is not created as part of the case study and offers broad and objective information, for instance, regarding the organizational background and the social context (Yin, 2018). Table 8 provides an overview of the data different sources and their coverage and perspective in Paper VIII and IX.

3.3.1.2 Ensuring Rigor in Data Analysis

The data analysis in Paper VIII and Paper IX consisted of two steps performed in multiple cycles to ensure the dependability of the drawn conclusions, following the recommendations in extant literature. First, all data were coded openly and inductively to identify the frequently mentioned themes of the interviews. Thus, each phrase or sentence was assigned a descriptive label (Creswell, 2009). Second, the codes were assigned to categories mapping the theoretical lens applied in the studies (Walsham, 2006). If codes did not fit with the existing components of the chosen theoretical lens, a new category was created.

The coding processes of Paper VIII and Paper IX were iterative, and codes and categories were constantly discussed and revised among coding researchers. Two researchers analyzed the data

Data source	Coverage	Perspective
Interviews with key stakeholders	▸ Key stakeholders' perception and explanation of the studied problem ▸ Key stakeholders' knowledge about contextual factors ▸ Identification of other key stakeholders	Key stakeholders
Observations	▸ Collaboration and team dynamics among employees ▸ Information about organizational and social context	Researchers
Documentation (e.g., e-mails, project and technical descriptions)	▸ Background material on company ▸ Context information for interviews and observations ▸ Timeline of studied events ▸ Communication among key stakeholders	Written account of key stakeholders

Table 8: Qualitative research - Data sources and coverage in Paper VIII and Paper IX

simultaneously to increase the conclusions' dependability (Eisenhardt, 1989; Morse et al., 2002). Emerging themes and relationships were cross-checked with other data sources to control for alternative explanations (Eisenhardt, 1989). Findings were structured and condensed in concept matrices to illustrate constructs and relationships between constructs (Yin, 2018). Differences in coding and interpretation between the coding researchers were discussed with the other researchers until they could be resolved. These procedures were repeated in multiple cycles by reconsidering the research questions, data, findings, and drawn conclusions until coherent theoretical statements were reached (Yin, 2018).

3.3.2 Case Study

A case study "investigates a contemporary phenomenon ('the case') in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident". (Yin, 2018, p.15). Thus, case studies form a suitable research method when investigating a phenomenon's dynamics, and the researcher has limited control over the phenomenon (Yin, 2018). In investigating such a phenomenon, a case study is based on rich and diverse data sources, used to triangulate to reach a result (Yin, 2018). Depending on their research question and research objective, case studies can be descriptive, exploratory, or explanatory and take a positivist or interpretive perspective (Eisenhardt, 1989; Recker, 2013).

Paper VIII conducts an exploratory, interpretative case study to analyze a work models' organizational and technological drivers and barriers, which enable employees to champion innovation in companies. A case study forms a suitable research method, since the study focuses on understanding the dynamics underlying employees championing innovation. A case study's rich data collection and analysis are likely to offer significant insights. Moreover, since the studied phenomenon and the context are difficult to separate, an in-depth study with an interpretative perspective provides a fitting setting. Due to scarce knowledge on the role of work models in enabling championing behavior, the case study is exploratory.

Theory can play different roles in case studies, as it may be used as a guiding framework to collect and analyze data (Walsham, 1995) or as the study' outcome in the form of a newly formulated theory (Eisenhardt, 1989). Following the former approach based on Walsham (1995, 2006), a theory is used as a scaffold for data collection and analysis in Paper VIII. Thus, the implementation and launch of a work model enabling employees to champion innovation are studied using the STS theory (see Section 2.5.2). Undertaking a process called analytical generalization, the case study strives to draw theoretical insights, which can later be extended to other similar cases or a

population of cases, based on the analysis of a single case (or multiple cases) (Yin, 2018).

The following sections summarize the research design and data analysis of the case study in Paper VIII. In line with extant literature, the data collection and data analysis in Paper VIII were highly interwoven and iterative (Recker, 2013). Thus, data analysis took place in waves, where data collection alternated with data analysis.

3.3.2.1 Research Design

Generally, different types of case studies exist and can be differentiated along two dimensions: the number of cases (single vs. multiple) and units of analysis (single vs. multiple) (Yin, 2018). While the single case study fits best with the aim to discover novel insights across time using a representative and revelatory case, the multiple case studies and units of analysis are advantageous for building theory, as they allow for higher confidence in the results (Yin, 2018). For multiple cases or units, their selection relies on theoretical sampling, where cases or units are chosen for theoretical, and not statistical, reasons, that is, their ability to enable the researcher to gain new insights into the studied phenomenon (Eisenhardt, 1989; Glaser & Strauss, 1967). Regardless of the type of case study, an essential step in the research design is the definition and clear bounding of the case (or cases) analyzed (Yin, 2018).

For the case study in Paper VIII, an embedded single case study was chosen. Thus, the study focused on one case, a work model promoting championing behavior among employees in a public company. It also included multiple units of analysis. The key stakeholders were chosen through theoretical sampling. Key stakeholders were employees using the work model and experts responsible for the launch and implementation of the work model. The single case study setting fits well with the goal to explore the work model as a new and scarcely researched phenomenon at two points in time. Moreover, the studied case organization represents an instance of public companies in Germany since the structures and goals were typical. The multiple units of analysis allow for crosschecking stakeholders' perspectives with the account of others to gain richer insights and to identify converging findings.

As outlined in the previous section, the case study in Paper VIII relied on interviews, observations, and documentation. The core formed 54 interviews with 27 key stakeholders conducted at two different points in time to assess key stakeholders' perceptions and opinions on the implementation and launch of the work model. The interviews were conducted following the measures described in the previous section and complemented by observations of employees within the work model and documentation.

3.3.2.2 Data Analysis

Taking an interpretative perspective, the data analysis in Paper VIII aimed at identifying drivers and barriers of the work model in the case organization in line with and extending prior literature. All collected data, the transcribed interviews and other data sources, were analyzed using the STS theory as a theoretical lens (see Section 2.5.2). In doing so, the study considered whether this theoretical lens, which served as a scaffold (Walsham, 1995), might need to be expanded, revised or abandoned altogether during the data analysis.

The analysis followed the guidelines outlined in Section 3.3.1 and consisted of two steps. A round of open coding was followed by mapping the codes to the different components of the STS, following the procedure suggested by Walsham (2006). If codes did not fit with existing components of the STS, a new category was created. Overall this coding process in Paper VIII was iterative in nature and codes and categories were constantly discussed and revised among

the two simultaneously coding researchers until a consensus was achieved. The procedure was repeated in six cycles by reconsidering the initial research questions, the collected data, and the coding until coherent conclusions were reached.

3.3.3 Action Design Research

Action design research (ADR) is a relatively new research method introduced by Sein et al. (2011) which combines elements of design science research (DSR) and action research (AR). DSR aims to develop prescriptive knowledge by designing and evaluating an IT artifact or design theory to solve a real-life problem (Baskerville et al., 2018; Hevner et al., 2004). AR is a participatory research method, where researchers solve an identified organizational problem through interventions and study the effects of this intervention (Baskerville & Myers, 2004; Susman & Evered, 1978). AR can produce highly practical knowledge while contributing to scientific knowledge accumulation (Recker, 2013).

ADR is "a research method for generating prescriptive design knowledge through building and evaluating ensemble IT artifacts in an organizational setting" (Sein et al., 2011, p.40). As such, it combines the participatory nature in solving a practical problem within its organizational environment of AR with the structured process for IT artifact design and evaluation of DSR (Sein et al., 2011). Regardless of its novelty, ADR has already been widely applied in IS research (e.g., Gill & Chew, 2019; Mettler, 2018; Pan et al., 2020) and the original article by Sein et al. (2011) in MIS Quarterly is widely cited. The design science perspective taken in ADR follows a fundamentally different research approach, compared to the behavioral science perspective (see introduction to Section 3), by aiming to answer research questions through the creation and analysis of innovative artifacts (Hevner et al., 2004). Artifacts, a term used to express the artificial, constructed nature of the object (Simon, 1996), include constructs, models, methods, instantiations (e.g., prototypes), and design theories (March & Smith, 1995; Purao, 2013).

Using ADR, Paper IX studies the design of a digital intrapreneurship platform (i.e., the IT artifact), aimed at promoting intrapreneurial employees[17] to work collaboratively on innovation projects. The study was conducted in cooperation with a large IT service provider in the public sector. The company's project team participated actively in designing and implementing the IT artifact. Thus, the ADR team consisted of the project team, the team of researchers, and representatives of the department where the IT artifact was implemented. Overall, the ADR project lasted two and a half years and consisted of two cycles (alpha and beta cycle) until formalized design knowledge could be derived. In the alpha cycle, the ADR team conceptualized and evaluated the artifact's design. In the beta cycle, the artifact's design was refined based on the feedback in the alpha cycle. The artifact was also implemented and evaluated by employees.

ADR provides a fitting research method for Paper IX for several reasons. First, ADR considers the perspective and expertise of both researchers and users when designing an IT artifact (Sein et al., 2011). In the context of the intrapreneurship platform, this allows synthesizing the practical perspective and requirements of developers and users with the theoretical perspective and knowledge of researchers. Second, ADR aims to find solutions for real-world problems (Sein et al., 2011). In Paper IX, the designed digital intrapreneurship platform addresses the low acceptance and usage of the existing system used to enable employees to generate innovation, that is, a traditional suggestion box.

[17]With the goal of promoting intrapreneurial employees, the platform reaches beyond supporting innovation champions only, because intrapreneurship encompasses new venture creation and innovation as well as championing behavior. Section 2.1.2 discusses the concept of intrapreneurship and its relation to championing in more detail.

Third, the digital intrapreneurship platform, as an instantiation of a work system (see Section 2.5.2), needs to balance the requirements of all its components (actors, task, structure, and technology) (Leavitt, 1964). Therefore, the successful implementation of a work system relies on an understanding of social and technology components, which ADR explicitly addresses with its goal to design an innovative artifact embedded in an organizational setting (Sein et al., 2011). Moreover, using interventions that account for technological and social aspects of an organization, an essential part of ADR, is well aligned with the overall goal of the studied company to increase the company's innovativeness through socio-economic change initiatives. Finally, the platform aims to bring diverse actors with diverging goals and backgrounds together, a setting in which ADR has been suggested as a suitable research method (de Reuver et al., 2018).

The ADR process consists of four stages, according to Sein et al. (2011): (1) problem formulation, (2) building, intervention, and evaluation (BIE), (3) reflection and learning, and (4) formalization of learning. These different stages and the seven principles guiding these stages are illustrated in Figure 13 and outlined in the following sections. [18]

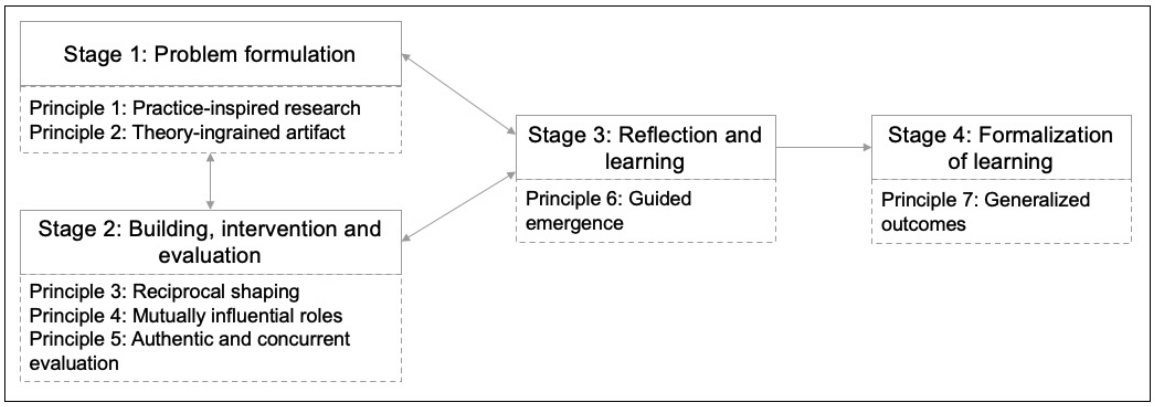


Figure 13: ADR process: Stages and principles (based on Sein et al. (2011))

3.3.3.1 Problem Formulation

During the first stage, the problem to be solved by the ADR team is identified, and the initial research question is derived. Sein et al. (2011) formulated two principles for this stage: (1) practice-inspired research and (2) theory-ingrained artifact. According to the first principle, researchers are directed to perceive a practical problem as an opportunity for new knowledge generation for a class of problems (Sein et al., 2011). The second principle proposes that the artifact should be designed and evaluated based on existing theories (Sein et al., 2011).

Following the principle of practice-inspired research, in Paper IX, the problems of the existing system, which aimed to facilitate intrapreneurship among employees (i.e., a traditional suggestion box), were assessed by conducting twelve exploratory interviews among employees, following the principles outlined in Section 3.3.1. Using additional sources (e.g., documentation), the findings were triangulated, and the boundary conditions of the planned ADR project were set. Based on the principle of a theory-ingrained artifact, the STS theory (see Section 2.5.2) was selected as the guiding lens to structure the interviews and code the collected data. The open and inductive round

[18] Since the data collection, data analysis, and research results are highly intertwined in an ADR process and follow different steps, this structure is more suitable to describe the ADR process, compared to a separate description of data collection and analysis. It has been adopted in similar form by other studies (Gill & Chew, 2019; Pan et al., 2020). Accordingly, in Section 4 the results will also be described throughout these four stages.

of coding of the exploratory interviews was followed by a synthesis of codes into higher-order categories. These were assigned to the different STS components to derive meta-requirements, formulated as challenges, for the design of a digital intrapreneurship platform. The IT artifact needed to address these challenges in order to solve the identified problem. In the next step, extant literature was reviewed to derive design knowledge for the planned platform to ensure the adherence to the second principle and to create a theory-ingrained artifact.

3.3.3.2 Building, Intervention, and Evaluation (BIE)

The second stage intertwines the building of the IT artifact, the intervention in the studied company and the evaluation of the IT artifact (Sein et al., 2011). The goal of the BIE stage is to realize the designed artifact and develop design principles for the identified class of problems through continuous evaluation (Sein et al., 2011). Three additional principles are suggested for the BIE stage by Sein et al. (2011): (3) reciprocal shaping, (4) mutually influential roles, and (5) authentic and concurrent evaluation of the artifact. According to the third principle of reciprocal shaping, ADR needs to account for the inseparability of the IT artifact and organizational context as well as the influence both exert on each other (Sein et al., 2011). The fourth principle suggests that all stakeholders of the ADR project, researchers and practitioners, influence and learn from each other (Sein et al., 2011). The fifth principle of authentic and concurrent evaluation points to the importance of interwoven nature of the design and evaluation of the artifact.

Based on the principles of reciprocal shaping the artifact in Paper IX was designed within the existing IT systems of the company (i.e., integration in the organizational wiki) and by balancing both technical and organizational aspects when aiming to increase intrapreneurial behavior among employees. Thus, the design balances the necessary functionalities of the platform with the organizational requirements essential for a high acceptance of the platform among employees. Following the fourth principle, the researchers and practitioners designed and evaluated the digital intrapreneurship in an iterative and interactive process through regular meetings and discussions and by combining their different perspectives. The fifth principle was applied using a comprehensive evaluation strategy, which involved evaluating the artifact initially within the ADR team and then by the end users.

Regarding the BIE stage, Sein et al. (2011) outline a spectrum for the research design extending from IT-dominant to organization-dominant BIE. While the ADR process of an IT-dominant BIE mainly focuses on designing an IT artifact, the organization-dominant BIE centers on the design of an organizational intervention (Sein et al., 2011). Paper IX follows a predominantly **IT-dominant BIE research design**, since it focuses on deriving design principles for a digital intrapreneurship platform, an IT artifact. For an IT-dominant research design, Sein et al. (2011) suggest that the alpha phase should target light interventions in a confined organizational context. Subsequently, the artifact is repeatedly instantiated, evaluated, and refined through organizational interventions, which form a participatory process in which researchers and practitioners express their assumptions, perceptions, and knowledge (Sein et al., 2011). In the beta cycle, the matured artifact is instantiated and evaluated in a wider organizational context, including the end users (Sein et al., 2011).

Figure 14 displays the BIE stage of the ADR project in Paper IX. Based on the challenges formulated in the first stage of the ADR process, the initial conceptual design and preliminary design principles were generated based on insights from extant literature. During the alpha cycle the ADR team developed, evaluated, and refined the design of the digital intrapreneurship platform iteratively using mock-ups and preliminary design principles. During the beta cycle, the results of the earlier cycle were utilized by the ADR team to refine the platform's design

further. Additionally, during the beta cycle, interventions and evaluations were conducted among employees of the department implementing the platform.

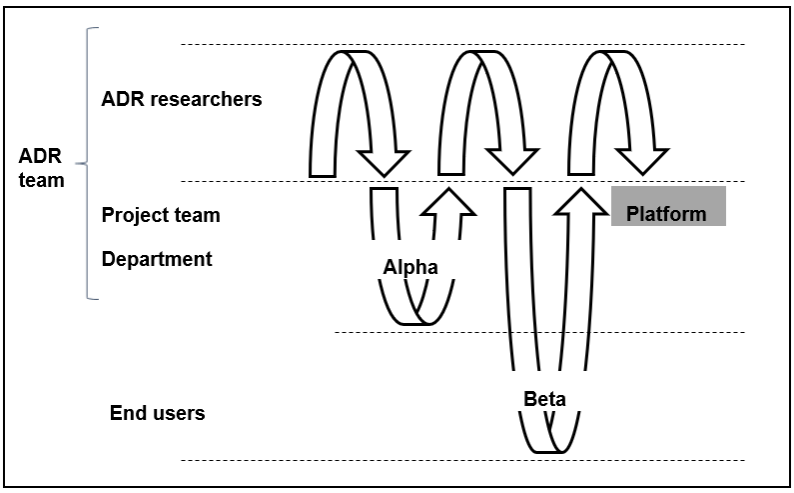


Figure 14: BIE stage in the intrapreneurship platform project (Reibenspiess et al. (2022, p.6), based on Sein et al. (2011))

DSR emphasizes the importance of a **rigorous and systematic evaluation** of the designed artifact (Hevner et al., 2004), which forms an essential component of the BIE stage. Following this requirement, Paper IX follows the established Framework for Evaluation in Design Science (FEDS) (Venable et al., 2016). FEDS is based on four steps: defining the goal of the evaluation, selecting the evaluation strategy, explicating the properties to be evaluated, and designing the individual steps in the evaluation strategy.

The evaluation in Paper IX aims to evaluate whether the design principles and the designed artifact, instantiated in the studied company, increase intrapreneurial behavior among employees and address the identified challenges within the organizational setting. In line with this goal, Paper IX relies on the human risk and effectiveness strategy, which should be selected if the research designs a "socio-technical artifact with major uncertainties about social and use issues" (Venable et al., 2016, p.83) and when the evaluation aims to rigorously establish the utility of the artifact in a real-world setting (Venable et al., 2016). The human risk and effectiveness strategy suggests formative evaluation early in the design process, followed by summative evaluations towards the end. While the formative evaluation provides indicators for valuable improvements to the artifact's design, the summative evaluations establish shared meaning regarding the artifact by evaluating its effectiveness within the organizational setting (Venable et al., 2016). All evaluations followed the principles for rigor in qualitative research outlined in Section 3.3.1.

The evaluation strategy in Paper IX comprised three steps. First, an iterative, formative evaluation within the ADR team was conducted, appraising the design principles and their separate effects on the platform's instantiation during the alpha cycle. Second, formative evaluations within focus groups and a pilot study took place during the beta cycle. The exploratory focus groups conducted within four workshops allowed for open discussion and insights into participants' opinions, understanding, and use of the beta version of the artifact (Tremblay et al., 2010). The 20 participants' feedback and reflections on anticipated and unanticipated consequences of the platform were later used to refine the artifact's design. Subsequently, a 3-month pilot study with the refined beta prototype was conducted to test the proposed design of the artifact and obtain in-depth insights into the intervention's effects. Semi-structured interviews among participants

accompanied the pilot study to evaluate the implemented prototype's design principles, design features, and organizational implications. The interviews' findings were used to derive refined design principles in the next stage. Third, a summative field study and an evaluative discussion with key decision makers were conducted to evaluate the overall design and combined effects of the design principles on the instantiation as part of the third stage.

3.3.3.3 Reflection and Learning

The third stage of the ADR process encompasses a reflection on the preceding stages to obtain learnings on a broad class of problems, not only a specific instance (Sein et al., 2011). Reflection and learning are guided by the principle of guided emergence, which characterizes the emergence of the artifact's design based on not only the preliminary design but also the insights from all members of the ADR team during the design process and the evaluation results during the BIE stage. Accordingly, in Paper IX, a revised set of design principles grounded in theory and practice, which accounted for new requirements emerging during the BIE stage, was derived. To this end, all data collected in the preceding stages and the insights of the literature review were consolidated and triangulated to derive a revised design of the artifact. The revised design principles and the digital intrapreneurship platform were subsequently evaluated against the identified challenges in a summative, ex-post field study. This field study also validated the design knowledge for a larger class of problems (Venable et al., 2016). The final evaluation took place in discussion with five key decision makers and 22 diverse field study participants, who provided feedback on the derived design knowledge. Paper IX concluded the final evaluation once data saturation in the replies of decision makers and participants was reached (Guest et al., 2006).

3.3.3.4 Formalization of Learning

Finally, the fourth stage formalizes the learnings into solutions for a general class of problems (Sein et al., 2011). Based on Gregor (2006), in Paper IX the design knowledge for digital platforms enabling intrapreneurial behavior among employees was formalized in a set of five validated design principles and corresponding design features, which can be applied to other organizational settings with similar challenges. Derived from continuous reflection on the practical problem, extant theoretical knowledge, and an iterative design process of the artifact, the findings constitute a nascent design theory. As such, Paper IX contributes to existing (design) knowledge, according to Gregor and Hevner (2013).

4 Main Research Results

The cumulative dissertation includes twelve papers divided into four parts that explore innovation champions in the digital age. Each research paper answers one or more research questions and contributes to responding to the overarching research question. The following sections outline the main findings of each paper. Table 9 provides an overview of the main findings corresponding to each research question. Moreover, it summarizes the main implications that can be drawn for innovation champions, which are discussed in detail in Section 5.

Table 9: Research questions and main findings on innovation champions (ICs)

	RQ1: Extant knowledge of ICs in the literature	**RQ2: Individual characteristics of ICs in digital age**	**RQ3: Organizational enablers and barriers of ICs in digital age**	**RQ4: Digital technology as enabler of championing**	**RQ5: Distinct characteristics of digital innovation and transformation**	*Main implications for research on ICs*
Part I - Understanding the Evolution of Innovation Champions (Literature Reviews)						
Paper I	ICs' activities and influence on organizational and network characteristics					Systematization of literatur and research agenda regarding ICs' activities and influences
Paper II	ICs' traits, skills, and knowledge as well as organizational enablers					Systematization of literature and research agenda regarding ICs' individual and organizational enablers
Paper III	Identification of changes in literature on ICs' role and organizational enablers in digital age	Emphasis on executive champions and groups of ICs in digital age	Increasing use of digital technology shifts ICs' organizational enablers			Systematization of literature and research agenda regarding ICs' changing roles and organizational enablers in digital age
Paper IV	ICs' activities and embeddedness in social networks in the digital age	Increasingly distributed championing of digital innovation		Enabling role of digital technology for ICs' activities in social network		Conceptual framework of interaction between digital technology and ICs in social network
Part II - Evaluating the Impact of Champions at the C-Level						
Paper V		Positive stock market reaction for CDO appointments with certain profile, education and experience	Positive stock market reaction for CDO appointments in companies without existing CIO			Empirical evidence for stock market reaction to CDO appointment and influence of individual and organizational characteristics
Paper VI		Overall stock market reaction for CDO appointments depends on CDOs' power profile; Diverging stock market reaction for CIO appointments	Stock market reaction depends on nature of CDO appointment: succession vs. new position			Prestige and expert power constitute important power dimensions - besides structural power - for CDOs; Empirical evidence for distinct nature of CDO compared to CIO
Paper VII	IS executives as possible ICs at the C-Level based on behavior, roles, and outcomes	Characterization of IS executives' education, experience, knowledge, skills, and traits in extant literature	TMT and organizational characteristics as enablers and barriers for IS executives			Systematization of literature on IS executives demonstrates research opportunity, e.g., on IS executives' relationship with other TMT members
Part III - Enabling Employees as Champions						
Paper VIII		ICs champion implementation of work model and encourage employees to participate		Identification of drivers and barriers of work model for employee-driven innovation		ICs as orchestrators of organizational change; Work model as enabler of employee-driven innovation

Table 9: Research questions and main findings on innovation champions (ICs)

	RQ1: Extant knowledge of ICs in the literature	**RQ2: Individual characteristics of ICs in digital age**	**RQ3: Organizational enablers and barriers of ICs in digital age**	**RQ4: Digital technology as enabler of championing**	**RQ5: Distinct characteristics of digital innovation and transformation**	*Main implications for research on ICs*
Paper IX				Derivation of design principles for a digital intrapreneurship platform for employee-driven innovation		Design knowledge for enabling championing among employees and identification of ICs
Part IV - Understanding Champions' Context - Digital Innovation and Transformation						
Paper X		(Increasingly heterogeneous, distributed, less predefined groups or collectives of actors)[19]			Extant knowledge on digital innovation and its determinants	Review of digital innovation research shows, e..g., increasing need for orchestration of digital innovation
Paper XI					Systematic differences in companies' stock prices and characteristics based on digital innovation engagement	ICs' context depends partly on organizational engagement with digital innovation
Paper XII					Conceptualization of the relationship between digital innovation and transformation	Interrelationship between digital innovation and transformation shapes ICs' context

4.1 Part I - Understanding the Evolution of Innovation Champions

Part I analyzes and synthesizes extant literature on innovation champions. Literature reviews focusing on innovation champions are rare and predominantly take a discipline-specific perspective or limit their research focus to individual characteristics (e.g., Jenssen & Jørgensen, 2004; Renken & Heeks, 2019). The literature reviews in Paper I to IV address this shortcoming by reviewing a broad literature sample spanning multiple disciplines. Besides literature from the field of IS, which can shed light on the role of digital technology for innovation champions, the reviews also consider research in Innovation Management, where the concept originated half a century ago (see Section 2.1.1), and cover Human Resources, Organization, and Business Administration research. This interdisciplinary approach enables the development of a comprehensive perspective on innovation champions from an individual and organizational perspective.

Paper I to IV strive to cover innovation champions comprehensively with limited prepossessions on the research topic. Accordingly, a broad range roles characterizing innovation actors who champion innovation in the reviews. As outlined earlier, championing behavior occurs on a spectrum (e.g., Markham & Griffin, 1998), with many actors exhibiting some championing behavior. To explore innovation actors comprehensively and from multiple perspectives, Paper

[19] Paper X not only studies executive champions, but all all IS executives. Accordingly, the findings extracted only apply to a certain extent to executive champions in the digital age.

I to IV include all individuals exhibiting championing behavior.[20]

Paper I and II map existing knowledge on innovation champions overall. While **Paper I** explores innovation champions' activities and influences on organizational and network characteristics, **Paper II** focuses on innovation champions' individual and organizational enablers. **Paper III and IV** specifically focus on the changing nature of innovation champions in the digital age. Thus, **Paper III** contrasts knowledge of innovation actors' roles and organizational enablers in a digital and non-digital context, and **Paper IV** studies the characteristics of innovation champions' social networks in the digital age. **Paper I to IV** also identify existing research gaps and develop an agenda for future research. **Paper IV** moves beyond synthesizing the literature by also developing a theoretical framework of innovation champions' social network.

4.1.1 Paper I: Innovation Champions' Activities and Influences in Organizations - A Literature Review[21]

Organizations can only tap into innovation champions' potential, if they understand how these actors promote innovation (Howell & Higgins, 1990). Paper I sets out to synthesize the current knowledge on innovation champions' activities and their influence on organizational and network characteristics when promoting innovation. To this end, Paper I conducts an assessing literature review based on a systematic methodology covering 92 relevant research articles across four disciplines (see Section 3.1.1).

Paper I finds that innovation champions' activities have been explored in detail in existing research. Innovation champions are most often described as promoting and supporting an idea or innovation, gathering access to or obtaining resources, gaining support from other people, building networks, relationships, and coalitions, and overcoming obstacles (e.g., Hayton & Kelley, 2006; Howell & Shea, 2001). The literature review also shows that research studying how innovation champions promote innovation by inducing changes in organizations' and social networks' characteristics is somewhat limited. Yet, the six studies exploring this interrelationship show that innovation champions influence culture and climate, promote knowledge management, shape human resource practices and impact the strategy of organizations when driving innovation projects (e.g., Edmondson et al., 2001; Watts & Henderson, 2006). Moreover, innovation champions influence other employees' structural and relational embeddedness in the organization, for instance, by acting as network facilitators (e.g., Fichter, 2009; Hemmert et al., 2014).

In addition, Paper I identifies gaps in our current understanding of how innovation champions promote innovation and provides suggestions for future research questions in five research areas. Thus, it shows that innovation champions' activities across the different stages of the innovation lifecycle, innovation champions' organizational impact, networks among innovation champions, innovation champions' influence on networks,and the role of innovation champions for digital innovation form five areas that offer promising avenues for future research. Paper I suggests, for instance, to investigate the relationship between innovation champions' activities and their impact on organizational outcomes, such as entrepreneurial orientation or financial success.

In summary, this structured literature review corresponds to RQ1 by synthesizing the current state of knowledge on how innovation champions promote innovation and proposing an agenda

[20] While a distinction is made between the different roles in the respective papers, this introductory paper, for the sake of simplicity, refers to all actors who engaged in championing behavior as innovation champions or actors championing innovation without differentiating further.

[21] Drechsler, K., Reibenspiess, V., Eckhardt, A., & Wagner, H. T. (2021b). Innovation champions' activities and influences in organisations - A literature review. *International Journal of Innovation Management*, *25*(6), 2150066.

for future research surrounding innovation champions' activities and influences. Additionally, Paper I suggests that innovation champions are not only enabled or hindered by organizational characteristics but may themselves shape these characteristics when promoting innovation.

4.1.2 Paper II: Enabling Innovation Champions in Organizations - Results of a Systematic Literature Analysis[22]

Organizations also need to understand the individual and organizational characteristics enabling innovation champions to promote innovation projects in order to develop and support innovation champions (Kelley & Lee, 2010) as well as identify and recruit innovation champions (Mansfeld et al., 2010). Paper II explores and compiles the findings in extant literature regarding innovation champions' individual and organizational enablers based on an assessing literature review, which follows a systematic methodology and covers 85 research articles across four disciplines (see Section 3.1.1).

The scientometric analysis in Paper II shows that innovation champions have been covered in different disciplines, especially in Information Management. In contrast, IS research has less often explored innovation champions' enablers. Further, the content-based analysis covering traits, skills, and knowledge based on a competency matrix (Hayton & Kelley, 2006) depicts a comprehensive characterization of innovation champions on the individual level (see Figure 15 left box). Innovation champions are characterized as creative, enthusiastic, self-confident, and risk-taking individuals who possess a high level of technical knowledge and the skills to support other employees, innovate and build networks (e.g., Mascitelli, 2000; Miron et al., 2004; Schweisfurth & Raasch, 2015).

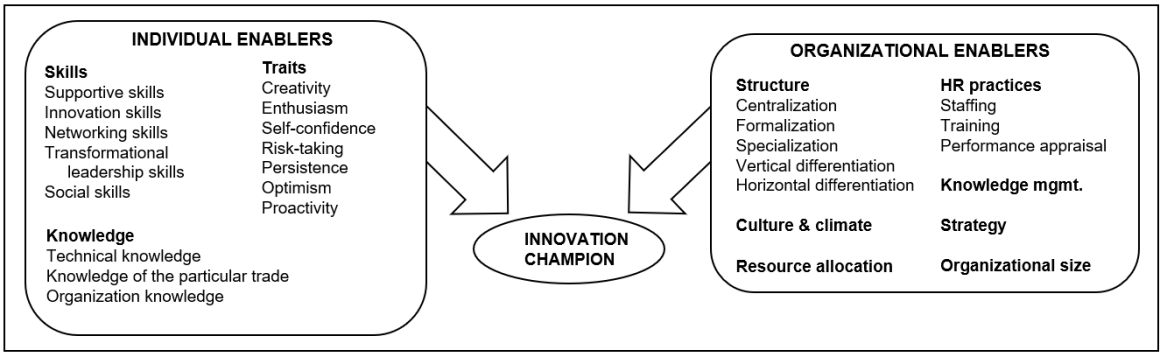


Figure 15: Results of Paper II - Innovation champions' individual and organizational enablers (Reibenspiess et al., 2018, p.4166)

On the organizational level, the analysis in Paper II reveals various organizational characteristics, such as the organizational structure, human resource practices, or culture and climate (see Figure 15 right box), which can enable innovation champions. Thus, innovation champions, for instance, thrive in organizations with low levels of centralization and formalization and favor behavior-based performance appraisal (e.g., Ebers & Maurer, 2014; Globocnik & Salomo, 2015; Hayton & Kelley, 2006). Additionally, the literature review also points to gaps in research and proposes promising avenues for future research regarding innovation champions' individual and

[22] Reibenspiess, V., Drechsler, K., Eckhardt, A., & Wagner, H. T. (2018). Enabling innovation champions in organizations – Results of a systematic literature analysis. *Proceedings of the 51st Annual Hawaii International Conference on System Sciences*, 4161–4170.

organizational enablers. For instance, Paper II reveals a shortcoming of prior research concerning innovation champions' negative personality traits, innovation champions' organizational enablers, and the interaction of enablers on the individual and organizational level.

Overall, Paper II addresses RQ1 by characterizing innovation champions based on prior research and offering comprehensive insights into the existing knowledge on individual and organizational characteristics that enable champions to promote innovation projects in organizations. Additionally, Paper II proposes an agenda for future research regarding innovation champions' enablers on the individual and organizational level.

4.1.3 Paper III: The Changing Roles of Innovation Actors and Organizational Antecedents in the Digital Age[23]

Digital technology and its distinct characteristics have radically transformed innovation and its development process (Nambisan et al., 2017; Yoo et al., 2010), as discussed in Section 2.2.2. In light of the changing nature of innovation and to understand the implications for innovation champions in the digital age, Paper III explores extant knowledge on the changing roles of actors championing innovation and their organizational enablers (or antecedents) in the digital age. To this end, Paper III performs an assessing literature review based on a systematic methodology (see Section 3.1.1), covering 110 research articles.

With respect to the roles of actors championing digital innovation, Paper III finds a rising emphasis on the importance of certain roles, such as executive champions. Especially the role of the CDO, who promotes digital innovation and transformation, has been emphasized in the literature (e.g., Singh & Hess, 2017; Tumbas et al., 2018). Whereas actors championing innovation have traditionally been characterized as lone wolfs, literature exploring digital innovation frequently identifies groups of innovation actors, who perform distributed championing activities in teams (e.g., van Laere & Aggestam, 2016) or communities (e.g., Parmentier & Mangematin, 2014).

Concerning organizational enablers of innovation actors championing innovation in the digital age, Paper III finds literature to focus on changes in actors' work environments triggered by the increasing use of digital technologies. Echoing the identified changes in innovation actors' roles, literature, for instance, proposes that human resources needs to account for the shift towards distributed championing activities by recruiting a diverse group of actors with complementary skills, knowledge, and social networks (e.g., van Laere & Aggestam, 2016). Similarly, companies' structures and knowledge management need to enable collaboration and knowledge exchange among groups of champions (e.g., Ansari & Munir, 2010; Mahr & Lievens, 2012).

The literature review also derives an agenda for future research on innovation actors' roles and organizational enablers in the digital age. For instance, Paper III discusses the need to explore which organizational structures can facilitate collaborative and interactive innovation processes among actors championing innovation in the digital age. Another topic for future research concerns mechanisms that human resource departments can use to identify and hire actors participating in distributed championing activities.

In summary, Paper III addresses RQ1 by offering a comprehensive literature review on the changing nature of innovation actors championing innovation in the digital age. In doing so, Paper III also contributes to RQ2 by illustrating the increasing emphasis on executive champions and

[23] Drechsler, K., Reibenspiess, V., Eckhardt, A., & Wagner, H.-T. (2019a). The changing roles of innovation actors and organizational antecedents in the digital age. *Proceedings of the 14th International Conference on Wirtschaftsinformatik*, 802–816.

groups of champions in the digital age. Moreover, Paper III corresponds to RQ3 by synthesizing knowledge on the changing nature of organizational characteristics enabling innovation champions in the digital age.

4.1.4 Paper IV: Understanding the Role of Innovation Actors' Social Network in the Digital Age[24]

For carrying out digital innovation, social networks play an instrumental role in facilitating the creation and sharing of knowledge (Lyytinen et al., 2016). Digital innovation frequently combines heterogeneous knowledge from different industries and disjoint stocks of knowledge (Barrett et al., 2012; Yoo et al., 2012). Therefore, digital innovation depends on social networks of diverse innovation actors. Besides transforming the outcome of innovation processes, the widespread use of digital technology has also opened up new opportunities for social interactions and knowledge sharing among innovation actors (Nambisan et al., 2017).

Paper IV explores the current state of knowledge on the characteristics of innovation champions' social networks in the digital age. The paper builds an understanding of how innovation actors use their social networks to champion innovation in the digital age and which network characteristics enable the successful championing. To this end, a specific theorizing literature review based on a systematic methodology and covering 61 research articles across four disciplines was conducted to analyze the literature on actors championing innovation (see Section 3.1.1 for details on the research method). Paper IV develops and uses a framework based on the typology of social network research by Borgatti and Foster (2003) to analyze innovation champions' social networks (see Table 4 in Section 2.5.1) from an actor-network and network-actor perspective.

The left side of Table 10 summarize extant knowledge on innovation actors championing innovation from an actor-network perspective within this framework. The distinct strategies innovation champions use to create and use the social ties in their network are outlined. One important observation is that digital technology here is an enabler of innovation. Thus, digital technology leads to gradual shifts in innovation champions' activities in the social network, for instance, by enabling innovation champions to use their network more effectively to orchestrate innovation projects or facilitate knowledge exchange (e.g., Kawakami et al., 2015; Yan et al., 2018).

An analysis of actors championing innovation from a network-actor perspective reveals the structure and quality of champions' social network ties. The results of this analysis of innovation champions' structural and relational embeddedness, as presented by extant literature, are depicted on the right side of Table 10. From an network-actor perspective, digital technology has led to a significant shift for actors championing digital innovation: an emphasis on teams of innovation actors driving and co-championing innovation (e.g., Klerkx & Aarts, 2013; van Laere & Aggestam, 2016). Based on the empirical evidence in extant literature, Paper IV conceptualizes that champions are situated within two layers of social networks: (1) with other actors (e.g., employees) and (2) with other innovation champions.

Building on the analysis, Paper IV develops an agenda for future research with a specific focus on digital innovation and digital technology as an enabler of collaboration among heterogeneous innovation actors. While early insights into the mechanisms and motivations leading to the formation of groups of innovation actors are slowly emerging (e.g., van Laere & Aggestam, 2016), ample opportunities for future research on this topic exist. Additionally, the significant shift

[24]Drechsler, K., Reibenspiess, V., Eckhardt, A., & Wagner, H.-T. (2022a). Understanding the role of innovation actors' social network in the digital age: A literature review and avenues for future research. *Under review*.

	Actor-network: Activities in network	**Network-actor**: Network characteristics
Network topology (structuralist)	**Creating social ties:** ▸ Forming social networks and coalitions ▸ Boundary spanning ▸ Scanning the environment	**Structural embeddedness:** ▸ High density in internal network, low density in external network ▸ Central network position ▸ High breadth of external network with other organizations ▸ Structural embeddedness in network with other innovation actors
Network flows (connectionist)	**Using social ties:** ▸ Getting access to or obtaining resources ▸ Gaining the support of other people ▸ Brokering ▸ Sharing information and knowledge ▸ Drawing attention to the importance of IT or digital technology	**Relational embeddedness:** ▸ High level of trust in internal and external networks ▸ Character of network: informal vs. formal network; friendship vs. communication network ▸ Necessity to manage relational embeddedness throughout phases of the innovation process ▸ Relational embeddedness with other innovation actors: division of labor vs. collective activities ▸ Changing relational embeddedness among innovation actors

Table 10: Results of Paper IV - Innovation actors' activities and network characteristics

toward network organizations in the digital age (Benkler, 2006), characterized by the formation of loose networks or communities of innovation actors (Negoita et al., 2022), raises questions about suitable coordination mechanisms and the dynamics in network organizations.

Overall, Paper IV responds to RQ1 by characterizing innovation champions' activities and embeddedness in their social networks in the digital age. Moreover, Paper IV corresponds to RQ4 by identifying digital technologies' role in these social networks. Additionally, Paper IV offers answers to RQ2 by pointing out the increasingly distributed nature of championing in digital innovation.

4.2 Part II - Evaluating the Impact of Champions at the C-Level

Part II analyzes the impact of champions at the C-level on companies' financial performance. Recent literature has emphasized the increasing importance of the Chief Digital Officer (CDO) as executive champions of digital innovation (e.g., Singh & Hess, 2017; Tumbas et al., 2018), also a finding of Paper III. Promoting digital innovation is one of the key responsibilities of CDO, in addition to managing and orchestrating the digital transformation in companies (Singh & Hess, 2017; Tumbas et al., 2017). Especially companies with high transformation urgency and coordination needs have increasingly appointed CDOs in recent years (Firk et al., 2021). At the same time, the causal effect of innovation champions on companies' organizational outcomes is generally difficult to pin down, leading to scarce evidence in prior research, as outlined in Paper I. The appointment of a new executive, such as the CDO, is of strategic importance and closely observed by external stakeholders, such as investors, since it may signal intended actions and influence a company's future prospects (Chatterjee et al., 2001; Zmud et al., 2010).

Against this backdrop, **Paper V and VI** study CDOs' impact on short-term financial performance by examining the stock market reaction to companies' announcements to appoint a CDO. Both papers use an event study method (see Section 3.2.3). Paper V and VI also study how individual

and organizational characteristics affect the relationship between CDO appointments and the stock market reaction. Whereas **Paper V** predominantly relies on signaling theory and existing literature on IT leadership to formulate and test hypotheses, **Paper VI** studies CDO appointments using the lens of managerial power theory.

In numerous companies, CDO appointments have also led to changes in the structure of the top management team (TMT) and threatened the position of another executive, the Chief Information Officer (CIO). Whereas the CIO used to have responsibilities for companies' IT, including IT-enabled innovation (Peppard et al., 2011), part of this responsibility, for instance, the development of digital products, has been taken over by the CDO in recent years (Tumbas et al., 2018). In other companies, the strategic importance of the CIO has been heightened by increasing their scope and strategic responsibility (Carter et al., 2011). **Paper VII** reviews extant literature on both CIOs and CDOs to understand the nature of these executives and the processes underlying their contribution to innovation and organizational success in the digital age.

4.2.1 Paper V: Risk and Return of Chief Digital Officers' Appointment - An Event Study[25]

CDOs drive digital innovation and play an essential role in leading companies' digital transformation (Singh & Hess, 2017; Tumbas et al., 2017), which - if successful - may increase companies' productivity and generate new revenue streams (Bharadwaj et al., 2013). Thus, investors may evaluate a CDO appointment favorable if they interpret it as a convincing signal that a company promotes digital transformation and organizational success. However, a negative perception of a CDO appointment is possible in a company, where the CDO's responsibilities overlap with those of the CIO, which can give rise to conflicts. Investors may also react negatively to CDO appointments if they perceive the appointment as merely lip service, since the appointed CDO lacks the required experience.

Paper V conducts an event study (see Section 3.2.3) to identify conditions under which the CDO appointment leads to positive or negative abnormal returns on the stock market. A particular focus of the hypothesis development and testing is on the overall stock market reaction and the influence of CDOs' role profile, education, and experience on the stock market reaction. Furthermore, the paper explores how the simultaneous presence of a CIO in the appointing company affects the stock market reaction to CDO appointments. Based on a dataset of 101 CDO announcements of companies listed on the stock exchange in Europe and North America, Paper V first analyzes the overall reaction of the stock market and then conducts a subsampling analysis to compare abnormal returns for different groups of the sample (see Section 3.2.3.4).

Table 11 shows the overall stock market reaction to the announcement of CDO appointments. While abnormal returns are slightly positive, they are only statistically significant for one studied event window. For instance, within the event window [0; 2], covering the event day and the two days following the event, a cumulative, positive abnormal return of 0.29% can be observed following the announcement of CDO appointments. A post-hoc analysis shows that positive stock market reactions to CDO appointments are especially strong for announcements in the early years of the sample.

The results of the subsampling analysis are illustrated in Table 12. Thus, the stock market shows no abnormal returns in response to the appointment of CDOs with a generalist role profile, but a strong positive and statistically significant stock market reaction for the appointment of CDOs

[25] Drechsler, K., Wagner, H.-T., & Reibenspiess, V. (2019b). Risk and return of chief digital officers' appointment – An event study. *Proceedings of the 40th International Conference on Information Systems*, 1–17.

Event window	Obs.	Mean	Patell test z-score	GST z-score
[−2; 2]	101	0.31%	1.25	1.58
[−2; 0]	101	0.08%	0.26	1.11
[0; 2]	101	0.29%	1.84*	1.69*
[−1; 1]	101	0.16%	0.80	0.77

Note: *, **, *** statistically significant at the 0.10, 0.05 and 0.01 levels, respectively, in two tailed test. GST = Generalized sign test

Table 11: Results of Paper V - Cumulative abnormal stock return

who take up a specialist role (i.e., CDOs responsible for a specific function, such as marketing or customer engagement, or a business unit) (Table 12, Panel A). This result may indicate that investors value the establishment of a CDO position tailored to the business needs and strategy of the appointing company. Moreover, the appointment of a CDO in a company where a CIO position already exists is associated with no abnormal stock returns (Table 12, Panel B, left). In contrast, a statistically significant positive stock market reaction can be observed for CDO appointments to companies without a CIO position (Table 12, Panel B, right). Thus, investors may only perceive CDO appointments as positive, if no power struggles and jurisdictional issues between CDO and CIO could arise.

	Obs.	Mean	Patell z-score	GST z-score	Obs.	Mean	Patell z-score	GST z-score
Panel A	Generalist role				Specialist role			
	41	0.02%	0.53	-0.12	60	0.47%	2.23**	1.69*
Panel B	Parallel existence of CIO				No parallel existence of CIO			
	22	0.00%	0.60	0.24	79	0.41%	2.03**	2.20**
Panel C	CDO with STEM background				CDO with other educational background			
	32	-0.42%	-0.14	-0.73	69	0.56%	2.18**	2.51**
Panel D	CDO with profound IT experience				CDO with no profound IT experience			
	27	-0.13%	0.20	-0.06	74	0.44%	2.29**	2.29**

Note: *, **, *** statistically significant at the 0.10, 0.05 and 0.01 levels, respectively, in two tailed test. GST = Generalized sign test

Table 12: Results of Paper V - Subsampling analysis for event window [0; 2]

Additionally, the analysis shows negative but statistically insignificant abnormal returns for CDOs with a STEM background and profound IT experience (Table 12, Panel C and D, left), but a positive and statistically significant stock market reaction for CDOs with a non-STEM education and no profound IT experience (Table 12, Panel C and D, right). While more research may be needed to understand this finding in depth, the positive reaction for CDOs without a profound IT background may underscore the importance of broad business skills and knowledge for CDOs to manage the digital transformation of the appointing company successfully.

In summary, Paper V provides insights into RQ2 by showing that certain individual characteristics of CDOs, namely a specialist role profile, non-STEM educational background, and no profound IT experience, are associated with a positive stock market reaction. Additionally, the paper corresponds to RQ3 by identifying a positive stock market reaction for CDO appointments in companies where no CIO exists in parallel.

4.2.2 Paper VI: CDOs' Managerial Power: Market Reactions to Chief Digital Officer Appointments[26]

Managerial power is an established theory used in research across disciplines to investigate the influence of C-level executives on measures of organizational performance (e.g., Bradley et al., 2012; Garms & Engelen, 2019). In doing so, prior research on CIOs has predominantly studied structural power awarded to executives through their hierarchical position (Chen et al., 2010; Taylor & Vithayathil, 2018), but neglected other types of managerial power, expert and prestige power derived from knowledge and experience or personal status, respectively. Paper VI argues that for CDOs, other types of power may be even more relevant than structural power due to the wide range of responsibilities assigned to CDOs (Singh & Hess, 2017; Tumbas et al., 2018). Accordingly, it theorizes that three types of managerial power, structural, prestige, and expert power, need to be considered to understand CDOs' impact on financial performance.

Paper VI studies the stock market reaction to CDO appointments from 2009 to 2020 and analyzes the power profile of CDOs whose appointment leads to positive abnormal returns on the stock market by relying on an event study and extending the analysis in Paper V. Paper VI uses a comprehensive global sample of 307 press releases announcing CDO appointments in the period 2009 to 2020. For supplementary analysis, additional datasets encompassing data on announcements of CIO appointments in US-based companies were collected for two periods: (1) 1987-1998, the timeframe used by an earlier event study in IS research exploring the stock market reaction to CIO appointments (Chatterjee et al., 2001), and (2) 2011-2020, a timeframe comparable to the sample of CDO appointments. While the first timeframe allows us to establish a connection to the earlier study in IS and show the consistency of our methodological approach, the second timeframe enables a comparison of stock market reactions to CDO and CIO appointments.

Table 13 summarizes the overall stock market reaction to CDO appointments, measured by the cumulative abnormal return, in the timeframe 2009-2020. It shows different configurations of the event window and differentiates between CDO appointments to new positions and successions. Without accounting for other characteristics, Paper VI finds a positive stock market reaction for CDO appointments to new positions. This effect is statistically significant for the event windows $[-2; 2]$ and $[0; 2]$. For example, in the event window $[-2; 2]$, a company's valuation on the stock market rises by 0.57% with the appointment of a CDO to a new position. In contrast, Paper VI identifies a negative and unanimously statistically significant reaction for CDO succession appointments. For instance, in the event window $[-2; 2]$, a company's stock value decreases by an average of 0.76% after its announcement to appoint a CDO.

The finding for CDO appointments to new positions is in line with earlier results on CIO appointments to new positions. Chatterjee et al. (2001) identified a positive stock market reaction for the period 1987-1998. Paper VI confirms this finding based on an analysis of stock market reactions to CIO appointments for the period 1987-1998 (not shown, see Paper VI). However, Paper VI also identifies a negative stock market reaction for CIO appointments to both new positions and succession in the period 2011-2020 (not shown, see Paper VI).

[26] Drechsler, K., Wagner, H.-T., & Weitzel, T. (2022b). CDOs' managerial power: Market reactions to chief digital officer appointments. *Under review*.

An earlier version was presented at: Drechsler, K., Wagner, H.-T. (2020). Illusive or elusive relationship in the digital age? The interplay of CIOs and CDOs and its effect on the financial market. *1st AIS SIG DITE Paper Development Workshop on Digital Innovation, Transformation and Entrepreneurship*.

	New position				Succession			
Event window	**Obs.**	**Mean**	**Patell z-score**	**Patell p-value**	**Obs.**	**Mean**	**Patell z-score**	**Patell p-value**
[−2; 2]	90	0.57%	2.52***	0.01	217	-0.76%	-4.93***	0.00
[−2; 0]	90	0.09%	0.71	0.48	217	-0.57%	-4.43***	0.00
[0; 2]	90	0.49%	2.76***	0.01	217	-0.46%	-3.96***	0.00
[−1; 1]	90	0.22%	0.74	0.46	217	-0.50%	-3.97***	0.00

Note: *, **, *** = statistically significant at the 10%, 5% and 1% level, respectively, in a two-tailed test.

Table 13: Results of Paper VI - Cumulative abnormal return of CDO appointments

Paper VI also analyzes the power profile of CDOs whose appointment is associated with a positive stock market reaction. Table 14 summarizes the results of a multivariate regression of the cumulative return on the stock market in the event window [−2; 2] on CDOs' structural, prestige, and expert power characteristics for appointments to new positions and successions. For CDO appointments to new positions (Models I and II), characteristics of CDOs' structural power, such as title rank, membership in the TMT, and endowment with a subordinate team or business unit, do not influence the stock market reaction. Surprisingly, Table 14 depicts a negative and statistically significant effect for a direct reporting line between CDO and CEO. Prestige power does not significantly influence investors' perception of CDO new position appointments. For expert power, Models I and II show that investors value an interdisciplinary educational background, which combines a degree in business and computer science, but perceive in-depth knowledge in only one of these disciplines as unfavorable.

For succession appointments (Models III and IV), structural, prestige, and expert power's influence differs. With respect to structural power, Model III illustrates that whereas CDOs' team endowment is perceived as positive by the stock market, an adverse effect of CDOs' reporting line to the CEO exists. Further, Model III and IV show that abnormal returns are positively related to CDOs' prestige power, measured as CDOs' experience in start-ups. For expert power, Model III and IV illustrate that the stock market reacts positively and statistically significantly to CDOs hired externally. At the same time, the stock market perceives CDO appointments with degrees in engineering or humanities as negative.

A post-hoc analysis (not shown) illustrates that the surprising negative stock market reaction to CDOs with a reporting line to the CEO can be attributed to a misalignment between CDOs' reporting line and profile. In addition, comparing the reported results to CIO appointments, an additional analysis (not shown) demonstrates that in the time frame 2011-2020 only expert power derived from business knowledge is associated with a positive and statistically significant stock market reaction. Yet, structural power and other expert power variables exhibit no statistically significant effect.

Overall, Paper VI responds to RQ3 by demonstrating the diverging stock market reaction to CDO appointments to new positions and succession. Moreover, Paper VI offers answers to RQ2 by demonstrating that for CDO appointments to new positions, the overall positive stock market reaction can turn negative for CDOs with a direct reporting line to the CEO or in-depth knowledge of business or IT only. In contrast, for CDO succession appointments, the overall negative stock market reaction can turn positive for CDOs with strong structural, expert, and prestige power. Thus, CDOs who are hired externally (structural power), with an elite education (prestige power), or hired externally (expert power) are perceived by investors to contribute to

Power dimension	Variables	New position		Succession	
		I	II	III	IV
	Constant	-0.0117	0.0004	-0.0099	-0.0305***
		(0.0473)	(0.0168)	(0.0190)	(0.0094)
Structural power	Title Rank	0.0025		-0.0043	
		(0.0088)		(0.0035)	
	TMT	0.0230	0.0310	0.0110	0.0088
		(0.0271)	(0.0237)	(0.0106)	(0.0107)
	Team	0.0254	0.0229	0.0324*	0.0301
		(0.0242)	(0.0231)	(0.0193)	(0.0184)
	Reporting Line CEO	-0.0461**	-0.0454**	-0.0253*	-0.0280**
		(0.0209)	(0.0197)	(0.0148)	(0.0143)
Prestige power	Elite Education	-0.0016		0.0258*	0.0243*
		(0.0193)		(0.0140)	(0.0142)
	Experience Big Tech	-0.0115		0.0004	
		(0.0183)		(0.0168)	
	Experience Start-up	0.0299		0.0099	0.0093
		(0.0482)		(0.0122)	(0.0108)
Expert power	Outside	0.0249	0.0269	0.0251**	0.0270**
		(0.0216)	(0.0205)	(0.0114)	(0.0112)
	Interdisciplinary	0.0850*	0.0844**	-0.0070	-0.0050
		(0.0441)	(0.0409)	(0.0179)	(0.0166)
	Business Degrees	-0.0334*	-0.0354**	-0.0120	-0.0100
		(0.0190)	(0.0174)	(0.0093)	(0.0093)
	Computer Science Degrees	-0.0420***	-0.0424***	0.0079	0.0069
		(0.0155)	(0.0119)	(0.0096)	(0.0071)
	Other Degrees	-0.0047		-0.0339**	-0.0338**
		(0.0214)		(0.0135)	(0.0138)
	Sample size	90	90	217	217
	Adjusted R-squared	0.00%	4.26%	3.81%	4.15%

Note: *, **, *** statistically significant at the 0.10, 0.05 and 0.01 levels, respectively, in two tailed test. Robust standard errors are given in brackets. For new positions and succession for the complete and then the consolidated model is shown.

Table 14: Results of Paper VI - Regression analysis: CDO appointments and abnormal returns

companies' success. Additionally, Paper VI answers RQ2 by identifying a shifting stock market reaction to CIO appointments compared to earlier time periods.

4.2.3 Paper VII: Information Systems Executives: A Review and Research Agenda[27]

In some companies, the new appointment of a CDO has threatened the position of the established CIO, as outlined above. When studying CDOs as champions of digital innovation and their impact on organizational performance, it is vital to understand this setting, especially since some CIOs have been crucial drivers, or even champions, of IT-enabled innovation (Karahanna & Preston, 2013; Watts & Henderson, 2006). Against this background, Paper VII studies prior knowledge of executives responsible for companies' information system[28] (henceforth: IS executives). Thus, Paper VII presents the findings of an organizing literature review (see Section 3.1.1) by synthesizing extant literature covering IS executives' inputs, mediators, and outcomes.

[27] Drechsler, K. (2020). Information Systems executives: A review and research agenda. *Proceedings of the 28th European Conference on Information Systems*, 1–16.

[28] In most companies, CIOs and CDOs constitute executives responsible for companies' information systems and technologies. In a few companies this role may also be taken over by the Chief Technology Officer or other executives. However, these executives are not considered in this review.

The paper relies on the inputs-mediators-outcome (IMO) framework (Ilgen et al., 2005; Klotz et al., 2014) when coding and analyzing the 47 publications encompassing the literature review. The IMO framework allows for the synthesis of knowledge across the individual, team, and organizational levels and enables developing an understanding on how inputs influence outcomes considering mediators. It has frequently been applied in team research (e.g., Klotz et al., 2014; Mathieu et al., 2008). The IMO framework enablers the analysis of the link between IS executives' individual characteristics and organizational performance, while also considering IS executives' relation with other TMT members and environmental characteristics.

Figure 16 presents themes identified in extant research using the IMO framework. On the individual level, prior research has explored the influence of IS executives' educational and professional background, knowledge, skills and traits, and behavior and roles (e.g., Chen et al., 2010; Singh & Hess, 2017). On the team level, IS executives are influenced by their relationship with the CEO and other TMT members and their level of power (e.g., Benlian & Haffke, 2016; Lim et al., 2013). On the organizational and environmental level, extant literature finds structure, strategy, and IT to form significant inputs influencing IS executives (e.g., Banker et al., 2011; Chatterjee et al., 2001). IS executives have been shown to impact intermediate outcomes, such as IT assimiliation and IT innovation (e.g., Armstrong & Sambamurthy, 1999; Leidner et al., 2010), and economic performance, for instance stock returns and return on assets (e.g., Chatterjee et al., 2001; Karahanna & Preston, 2013). This relationship is mediated by processes and emergent states, such as the development of mutual trust or a shared understanding of IS (e.g., Johnson & Lederer, 2005; Karahanna & Preston, 2013). IS executives may also be subject to temporal dynamics, such as episodic cycles and developmental processes.

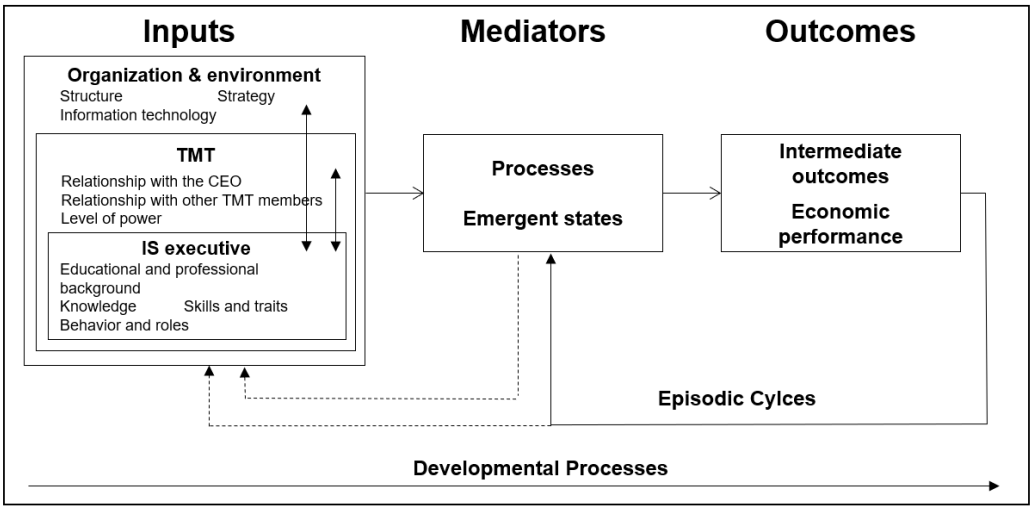


Figure 16: Results of Paper VII - IS executives' inputs, mediators, and outcomes (Drechsler, 2020, p.5)

Based on the analysis of existing research, Paper VII identifies several gaps in our current understanding of IS executives. Regarding inputs, IS executives' personality traits and IS executives relationship with middle managers and other C-level executives besides the CEO offer promising avenues for future research. Moreover, to enable a clear distinction between IS executives' inputs and outcomes, the direction of causality of IS executives' association with intermediate outcomes or economic performance needs greater attention in the future. Finally, studies analyzing the long-term effects of IS executives or considering international samples (in addition to US samples) are currently rare.

Overall, Paper VII contributes to RQ1 to RQ3 by providing a multifaceted characterization of IS executives based on existing literature. Corresponding to RQ1, Paper VII characterizes IS executives as champions in some companies based on their behavior, role, and output. Moreover, the paper answers RQ2 by depicting IS executives' education, experience, knowledge, skills, and traits in extant literature. Paper VII also delivers insights into RQ3 by synthesizing knowledge on the TMT and organizational characteristics as enablers and barriers for IS executives.

4.3 Part III - Enabling Employees as Champions

The widespread adoption of digital technologies enables companies to build the processes and infrastructure to involve new stakeholders in innovation development (Benbya & Leidner, 2018; Mahr & Lievens, 2012). Accordingly, open innovation and employee-driven innovation, where external users or employees outside the R&D department are involved in innovation, have increasingly gained importance (Birkinshaw & Duke, 2013; Chesbrough, 2003). Existing literature illustrates that employees' ideas and innovation can yield a significant revenue stream (Benbya & Leidner, 2018). Yet, the development and implementation of processes that encourage employees in companies to contribute to and promote innovation projects, such as work models that combine a digital platform with organizational measures, are not well understood. Especially, the design of digital platforms presents challenges, for instance, concerning employees' incentivization and when aiming to create constant momentum for innovation development among employees (de Reuver et al., 2018).

Part III explores how companies can enable employees to contribute to innovation, perform championing behavior, or become champions using work models that combine the collaboration tools offered by digital platforms with dedicated time slots for idea generation and innovation development. **Paper VIII** uses a case study to explore the drivers and barriers to developing and implementing a work model for employee-driven innovation. **Paper IX** derives theoretically grounded and rigorously evaluated design principles for a digital platform encouraging intrapreneurship among employees (referred to as a digital intrapreneurship platform) based on ADR. Both studies also analyze the role of championing behavior and innovation champions for the work model and digital intrapreneurship platform. In their analyses, Paper VIII and IX focus on developing, implementing, and launching a work model and digital intrapreneurship platform at an IT service provider in the public sector.

4.3.1 Paper VIII: A Work Model for Employee-Driven Innovation in Public Organizations[29]

Paper VIII studies the development, implementation, and launch of a work model promoting employee-driven innovation consisting of two elements: (1) the allocation of dedicated innovation time of five percent of employees' regular working time and (2) the creation of a digital platform to enable the collaborative work on innovative ideas and projects. The work model aims to increase employees' engagement with innovation development and mainly focused on incremental (process) innovation. By relying on an interpretive, exploratory case study (see Section 3.3.2), Paper VIII explores drivers and barriers of the development and implementation of the work model. In its analysis, Paper VIII uses the STS theory as a theoretical lens (see Section 2.5.2) to identify changes for employees, technology, and the organization during the development and implementation of the work model.

[29] Reibenspiess, V., Drechsler, K., & Eckhardt, A. (2019). A work model for employee-driven innovation in public organizations. *Proceedings of the 27th European Conference on Information Systems*, 1–15.

For technology-enabled drivers and barriers, especially the existing technological infrastructure (e.g., the intranet) constitutes an important driver, as it enables the rapid development of the new digital platform and high familiarity among employees, resulting in a high participation rate in the work model. Moreover, the digital platform's new functionalities enable collaborative work on innovation projects across departments. However, the platform that promotes communication without consideration of hierarchical levels also disrupts organizational processes and causes friction between employees and management.

For organization-enabled drivers and barriers, the low centralization and the attractive reward system of the work model constitute important drivers of employees' participation in the work model. In contrast, the work council and its requirements (e.g., formal review and approval of the work model) hamper the launch of the work model. The case study also reveals significant changes in the management and employees' attitudes towards innovation with the implementation of the work model, as gradually innovation is seen as the responsibility of everybody in the company. Creative thinking and innovation development become regular components of employees' work, and employees develop new skills when managing innovation projects. Moreover, job satisfaction among employees increases, as they can freely choose a part of their working tasks and collaboration partners during the dedicated innovation time. Overall, the introduction of the work model impacts technological and social components of the company and may form the first stepping stone to broader cultural change in the company towards innovation.

Additionally, the case study reveals the critical role of a single actor in the development and implementation of the work model. Based on the identified characteristics, this actor is named the innovation champion of the work model. In promoting the work model and encouraging other employees to use the work model, the innovation champion impacts other actors, technology, task, and structure, as summarized in Table 15 and triggers the rise of additional interdependences (compared with the model depicted in Figure 7 in Section 2.5.2). Through her role, the innovation champion functions as an orchestrator of organizational change.

Interdependences	**Activities of innovation champion**
Innovation champion–actors	▸ Creation of awareness concerning the work model among employees ▸ Recruitment of employees ▸ Managing development and implementation team; inspiration of employees ▸ Reduction of employees' resistance
Innovation champion–structure	▸ Overcoming resistance of works council ▸ Formation of new social networks ▸ Overcoming administrative obstacles
Innovation champion–technology	▸ Promotion of platform development and implementation ▸ Customization of platform features ▸ Improvement of user experience
Innovation champion–task	▸ Creation of new ideas ▸ Planning, controlling, and promotion of ideas ▸ Selection of promising ideas

Table 15: Results of Paper VIII - Innovation champion's role in work model

In summary, Paper VIII answers RQ4 by identifying the drivers and barriers of a work model promoting employee-driven innovation and championing among employees. At the same time, Paper VIII responds to RQ 2 by identifying the vital role of an innovation champion, who endorses the work model and motivates other employees. Thus, the innovation champion facilitates employee-driven innovation by influencing the different components of a work model.

4.3.2 Paper IX: Tapping into the Wealth of Employees' Ideas: Design Principles for a Digital Intrapreneurship Platform[30]

Paper IX derives design principles of a digital intrapreneurship platform fostering employee-driven innovation. The design principles are derived following an ADR method (see Section 3.3.3) and are theoretically grounded in extant research and the STS theory (see Section 2.5.2). In the following, the results are summarized based on the four-stage approach proposed by Sein et al. (2011) for the ADR method and outlined in Section 3.3.3: (1) problem formulation, (2) building, intervention, and evaluation (BIE), (3) reflection and learning, and (4) formalization of learning.

In the **problem formulation stage**, Paper IX identified five challenges of the existing system, a physical suggestion box, in generating employee-driven innovation in the studied company. These challenges are summarized in Table 16. First, the process of idea submission, selection and evaluation was neither transparent nor comprehensible, so the current status of submissions could not be tracked and decisions were not traceable. Second, the existing system suffered long throughput times with slow or no feedback to the submitting employees. Third, the suggestion box allowed no collaboration on innovation projects among employees or integration of peers' feedback. Fourth, employees showed a low commitment to innovation overall and perceived it as the responsibility of the R&D department, which led to a low number of idea submissions. Fifth, the existing system hardly allowed for identifying intrapreneurial employees who contribute and promote innovative ideas in the company. Overall, an analysis using STS theory as a theoretical lens led to the conclusion that the existing system was characterized by strong imbalances between social and technological components. Based on the identified challenges and imbalances and in alignment with practitioners at the case company, the design of a platform, was envisioned to facilitate intrapreneurship among employees.

During the **BIE stage**, five preliminary design principles (DPs) were developed based on design knowledge in prior research and by relying on the STS theory: (DP1) transparency, (DP2) real-time capture and alert function, (DP3) community integration, (DP4) infusion of innovation culture, (DP5) identification of informal roles. As depicted in Table 16, each design principle was derived to address one challenge. A prototype of the digital intrapreneurship platform was designed based on the design principles and the corresponding features. Overall, this approach builds on the working proposition that a platform designed according to these principles facilitates intrapreneurial behavior, especially idea submission and innovation development among employees, more effectively and efficiently than the existing system.

The 3-month pilot study during the beta cycle showed that the design principles are able to address the five challenges, but also offered some negative (DP1 to DP4) and positive (DP5) unanticipated consequences. For instance, with respect to DP2, concerned with real-time capture and alert function, some employees felt monitored and feared privacy violations due to real-time tracking of their idea submissions on the platform. Concerning DP5, which focuses on identifying informal roles, the pilot study revealed previously unrecognized key contributors who promote promising idea and recruit other employees to contribute to the platform.

[30] Reibenspiess, V., Drechsler, K., Eckhardt, A., & Wagner, H.-T. (2022). Tapping into the wealth of employees' ideas: Design principles for a digital intrapreneurship platform. *Information and Management*, *59*(3), 103287.

An earlier version with the same title and authorship was presented at: SIGPrag Pre-ICIS Workshop 2018: Practice-based design and innovation of digital artifacts in San Francisco, USA and the 6th International Conference on the Changing Nature of Work (CNoW): Bridging the Workplace of People, Data and Things in San Francisco, USA.

Challenges	Design principles (DP)	Description of preliminary (*α*) and revised (*α* + *β*) design principles
Idea management process as black box	**DP1′** - Transparency *with user control*	Innovation idea process and progress should be visible and accessible for all employees. (*α*) *Main control of the submitted idea should rest with the contributor.* (*β*)
Long throughput time	**DP2′** – Real-time capture and alert function *with user control*	The system should track submitted ideas and the idea management process in real time to discover bottlenecks and generate information on the organizational innovation activities. (*α*) *However, only contributors should be able to alter the system's representations of their submitted ideas.* (*β*)
Exclusion of contributors' peers	**DP3′** – Community integration *with prereview option*	Innovation ideas can be submitted, refined, and evaluated by all members of the company. (*α*) *Review of all comments through administrators. Only the submitting employee can accept proposed changes to his/her idea.* (*β*)
Low employee commitment to employee-driven innovation	**DP4′** – Infusion of innovation culture *with integrated management actions*	The configuration of the platform infuses an innovation culture inside the company. (*α*) *Idea requirements should be predefined. Revised incentive structure (i.e., prizes) and offering of project-related components (i.e., slack time).* (*β*)
Difficulty to identify intrapreneurs	**DP5′** – Identification *and formalization* of informal roles	Identification of innovative individuals, which develop innovation ideas for the company. (*α*) *Formalization of informal roles (i.e., intrapreneurs) within the platform.* (*β*)

(*α*) = learnings after alpha cycle; (*β*) = learnings after beta cycle; The revision of the design principles after the beta cycle are shown in italics.

Table 16: Paper IX - Challenges and revised design principles (Reibenspiess et al., 2022, pp.9, 13)

During the **reflection and learning stage**, all DPs were revised to circumvent the unanticipated negative consequences for DP1 to DP4 and to promote the unanticipated positive consequences of DP5. The original and revised design principles are depicted and described in Table 16. For instance, a user control mechanism was introduced that allows employees to decide which information of a submitted idea is disclosed to others (DP2). With regard to DP5, key contributors are promoted to the formal role of the intrapreneur to enable the company to exploit their innovation potential fully. They receive specific training to manage the idea platform and support other employees when submitting ideas and developing them. The final 3-month field study evaluated the revised design principles and their instantiated form, the digital intrapreneurship platform. Overall, the participants agreed that the platform solves the initially identified goal of increasing the generation of innovative ideas among employees and addresses the shortcomings of the existing system. Thus, the evaluation demonstrates the proof-of-value of the platform's design by increasing employees' intrapreneurial behavior.

Finally, during the **formalization of learning stage**, the prototype of the digital intrapreneurship platform is concluded to represent an instance of the larger class of digital intrapreneurship platforms facilitating intrapreneurial behavior among employees. Accordingly, the derived design principles make a significant contribution to design knowledge.

In summary, Paper IX answers RQ4 by deriving design principles for a digital intrapreneurship platform that promotes intrapreneurship activities (including championing) among employees.

Thus, Paper IX gives insights into the organizational conditions facilitating employees to champion innovation. Additionally, Paper IX indicates the possibility of identifying intrapreneurs and champions among employees through implementing of the digital intrapreneurship platform.

4.4 Part IV - Understanding Champions' Context - Digital Innovation and Transformation

Part IV encompasses research articles that aim to understand the changing context in which innovation champions operate in the digital age. Extant research has pointed to the constant change in the organizational and industrial environment in the digital age (Porter & Heppelmann, 2014; Yoo et al., 2012). Since organizational and environmental characteristics can significantly influence innovation champions' emergence and success (Greene et al., 1999; Shane et al., 1995), an in-depth understanding of the champions' context, which is shaped by digital innovation and transformation, is essential. Thus, Part IV builds the frame for this dissertation by studying the distinct nature of digital innovation and transformation.

Paper X explores the current state of knowledge on digital innovation and suggests opportunities for future research. Based on one of the distinct characteristics of digital innovation, the increasing blurring of industry boundaries, **Paper XI** then studies the implications of digital innovation for stock returns. Finally, **Paper XII** considers the bigger picture and examines the crossroad between digital innovation and transformation by exploring how and why digital innovation triggers digital transformation in incumbent companies and the resulting trajectories of digital transformation in these companies.

4.4.1 Paper X: The Current State and Future Opportunities of Digital Innovation: A Literature Review[31]

Paper X conducts an organizing literature review (see Section 3.1.1) to synthesize the current knowledge on digital innovation. The review is based on a sample of 26 studies published across four disciplines. Based on the multi-dimensional framework on innovation by Crossan and Apaydin (2010), Paper X systematizes the research findings are systematized by differentiating between two dimensions, digital innovation as a process and outcome, and by analyzing digital innovation determinants across three levels: individual, organizational and environmental.

The content-based analysis reveals distinct characteristics of digital innovation's dimensions and determinants. Digital innovation as a process is characterized by a higher distribution across actors (e.g., Lyytinen et al., 2016) and flexibility (e.g., Fichman et al., 2014). Digital innovation as an outcome offers more possibilities for recombination due to its layered modular architecture (Yoo et al., 2010). Moreover, literature outlines an increasing difficulty in measuring the value of digital innovation underscoring the user base's importance (Huang et al., 2017). At the same time, the analysis reveals the increasing blurring of digital innovation's process and outcome as the two become increasingly interwoven (e.g., Nambisan et al., 2017).

Regarding determinants of digital innovation on the individual level, extant research reveals a higher heterogeneity of contributors to digital innovation (e.g., Barrett et al., 2012) and the rise of innovation collectives (e.g., Boland et al., 2007). Moreover, digital innovation shifts the characteristics of innovation actors, for instance, by giving rise to a distinct personal identity

[31] Hund, A., Drechsler, K., & Reibenspiess, V. (2019). The current state and future opportunities of digital innovation: A literature review. *Proceedings of the 27th European Conference on Information Systems*, 1–15.

(e.g., Polykarpou & Barrett, 2017). On the organizational level, a new division of labor (e.g., Lee & Berente, 2012) and the re-definition of organizational boundaries and collaboration within ecosystems (e.g., Selander et al., 2010) can be observed. Additionally, the literature points to the heightened importance of platforms for digital innovation (e.g., Huang et al., 2017). On the environmental level, prior research identifies the emergence of novel industrial structures (e.g., Fichman et al., 2014).

Based on the analysis, the paper also outlines topics and methods which offer fruitful and promising opportunities for future research. Against the blurring of digital innovation's process and outcome, Paper X calls for novel theorizing regarding the nature of digital innovation. The focus of existing research has predominantly been digital innovation and its development process, but to a lesser extent the involved actors (see Section 2.3). Accordingly, numerous open questions regarding the changing characteristics of innovation actors remain, for instance, concerning the collaboration of heterogeneous actors and the evolution of innovation collectives.

Overall, Paper X answers RQ5 by providing a comprehensive synthesis of extant knowledge on digital innovation and its determinants and by laying out a path for promising future research. Thus, Paper X systematizes prior knowledge on changes in innovation champions' immediate surroundings, that is, the organizational and environmental context in which champions operate in the digital age. At the same time, Paper X also touches upon RQ2 by exploring innovation actors in general (with some applicability to innovation champions). Here Paper X shows the increasingly heterogeneous, distributed, and less-predefined nature of digital innovation actors.

4.4.2 Paper XI: Digital Innovation…and the Cross-Section of Stock Returns[32]

Digital innovation has been argued to blur the boundaries of industries by giving rise to products that combine heterogeneous types of knowledge from different industries (Seo, 2017; Yoo et al., 2012). Moreover, the layered modular architecture of digital technologies (Yoo et al., 2010) favors the convergence of devices and product offerings across industries (Nambisan et al., 2017; Yoo et al., 2012). This can lead to companies from different industries becoming competitors for certain products and sharing similar expertise in digital technology (Seo, 2017; Yoo et al., 2010). These developments have implications for capital markets, because they challenge existing classifications of companies by industry and may instead suggest categorizing companies based on their engagement with digital innovation.

Paper XI explores this research topic by studying systematic differences in companies' characteristics and financial performance based on their level of engagement with digital innovation using asset pricing analysis. To this end, Paper XI first derives a company-specific measure of digital innovation using CATA (see Section 3.2.4) in order to measure the extent to which companies develop and use digital innovation. Paper XI then uses Fama-MacBeth regression and portfolio sorting (see Section 3.2.1) to study systematic differences in companies' characteristics and financial performance.

In the cross-sectional Fama-MacBeth regression (not shown), company characteristics, namely company age and size, S&P and NASDAQ membership, and analyst coverage, are regressed against the measure of digital innovation. The multivariate regression's low R-squared, which ranges between 1% and 3% illustrates that company characteristics can only explain a low proportion of companies' engagement with digital innovation. Thus, the measure of digital innovation

[32] Drechsler, K., Müller, S., & Wagner, H.-T. (2021a). Digital innovation…and the cross-section of stock returns. *SSRN Working Paper*. https://dx.doi.org/10.2139/ssrn.3972173.

captures a unique characteristic that is not already captured by other company-level characteristics. Additionally, the results of the portfolio sorting analysis, depicted in Table 17, illustrate that companies with a high engagement with digital innovation differ significantly from those with a low engagement with digital innovation. Thus, companies sorted in the lowest (Q1) and highest (Q5) quintile portfolio, based on their level of digital innovation, experience significant differences with respect to book-to-market ratio, sales growth, return on assets (ROA), long-term return forecasts, stock volatility and cost ratio (COGS/ Assets). These differences are statistically significant at the 1%-level (se last row of Table 17).

Variables / quantile	Book-to-market	Sales growth	ROA	Long-term forecast	Stock volatility	COGS/ assets
Q1	0.71	0.15	0.03	14.44	0.12	2.05
Q2	0.75	0.15	0.01	14.00	0.14	2.17
Q3	0.71	0.16	0.01	15.26	0.14	1.91
Q4	0.66	0.19	0.01	17.28	0.16	1.66
Q5	0.59	0.27	0.00	20.55	0.18	1.32
Q5-Q1	-0.12***	0.12***	-0.03***	6.11***	0.06***	-0.73***
t-stat Q5-Q1	-19.02	21.05	-19.02	159.24	233.53	-44.05

Note: The final rows display the difference between the fifth and first quantile as well as the t-statistic associated with this portfolio difference. The significance level is indicated as follows: * significant at the 10% level; ** significant at the 5% level; and *** significant at the 1% level.

Table 17: Results of Paper XI - Portfolio sorting analysis

Next, Paper XI studies the relationship between digital innovation and stock returns by constructing a digital innovation factor using long-short portfolios (see Section 3.2.5) and relying on established asset pricing factors (see Section 3.2.5.1). Table 18 illustrates that the digital innovation factor has significant explanatory power for expected stock returns. Model 6 illustrates that the digital innovation factor results in a monthly alpha (or abnormal return) of 0.92 % when controlling for other asset pricing factors. Thus, companies with a higher level of engagement with digital innovation earn higher stock returns. These results are robust to different specifications and when controlling for industries (not shown). Paper XI shows in additional analyses and robustness checks that companies' engagement with digital innovation constitutes not only a critical company characteristic but expresses systematic risk differences in the capital market.

Regression model / variables	(1)	(2)	(3)	(4)	(5)	(6)
Alpha	0.0069**	0.0044*	0.0042**	0.0051***	0.0087***	0.0092***
	(2.48)	(1.74)	(2.40)	(3.02)	(6.03)	(6.51)
MKTR		0.4331***	0.3216***	0.2573***	0.1194***	0.0834**
		(7.93)	(8.30)	(6.43)	(3.26)	(2.27)
SMB			0.4177***	0.4429***	0.1582***	0.1849***
			(7.47)	(8.16)	(3.15)	(3.75)
HML			-0.8416***	-0.9109***	-0.4494***	-0.5241***
			(-16.02)	(-17.19)	(-7.42)	(-8.50)
UMD				-0.1595***		-0.1167***
				(-4.54)		(-4.08)
RMW					-0.8252***	-0.7945***
					(-12.18)	(-11.98)
CMA					-0.2717***	-0.2378***
					(-3.08)	(-2.76)
Sample size	275	275	275	275	275	275
Adjusted R-squared	0.000	0.187	0.622	0.649	0.758	0.772

Note: The significance level is indicated as follows: * significant at the 10% level; ** significant at the 5% level; and *** significant at the 1% level. The portfolios shown are equally-weighted.

Table 18: Results of Paper XI - Abnormal returns of the digital innovation factor

In summary, Paper XI responds to RQ5 by exploring systematic differences in company characteristics and financial performance based on companies' engagement with digital innovation and identifying a new asset pricing factor. As such, Paper XI lends further evidence to the distinct context in which innovation champions operate in the digital age and where industrial boundaries become less pronounced.

4.4.3 Paper XII: At the Crossroads Between Digital Innovation and Digital Transformation[33]

Digital innovation and transformation are deeply intertwined. Rapid and concentrated digital innovation in an industry may lead companies to undergo digital transformation due to pressure to change their structure, management, and strategy fundamentally (Gregory et al., 2015; Tumbas et al., 2018; Vial, 2019). Paper XII reports on a professional development workshop (PDW) at the International Conference on Information Systems 2019 focused on issues at the crossroads between digital innovation and transformation on the individual, organizational, and societal levels. During the PDW, the participants shared insights on the current state of digital innovation and digital transformation research. Based on common patterns that emerged before, during, and after the PDW, Paper XII derives a theoretical framework to understand the relationship between digital transformation and digital innovation in incumbent companies by relying on theory development (see Section 3.1.2).

Paper XII outlines how digital innovation gives rise to a more distributed and networked organizational form and why this new organizing logic triggers a digital transformation in incumbent companies. Based on prior research (e.g., Gersick, 1991; Romanelli & Tushman, 1994; Tushman & Anderson, 1986), organizational change is described to occur along evolutionary paths. Rapid and fundamental change occurs periodically and is triggered by factors in companies' immediate environment. Paper XI conceptualizes and argues that the phenomena of new platform logic, IT consumerization, and democratization form triggers and drivers of digital transformation in incumbent companies. Moreover, digital transformation is conceptualized as a multi-layered phenomenon encompassing organizational strategy, structure, and technology. Successful transformation requires a holistic approach toward digital transformation to address tensions that occur within and across layers as companies create new elements and abandon old elements within these layers. The digital transformation journey is primarily characterized by three elements which are the result of changes in the three layers: (1) business model innovation, (2) new product development, and (3) IT transformation. These three components and the relationship between them are conceptualized in Paper XI. Based on the derived framework shown in Figure 17, Paper XI also illustrates that the trajectory of digital transformation still remains an open question.

Based on the key insights derived from three keynotes on digital innovation and transformation at the PDW and the roundtable discussions among participants, the paper then discusses methodological and theoretical challenges in research on digital innovation and transformation. Moreover, Paper XII suggests avenues for future research at the crossroads between digital innovation and transformation. One theme is the struggle between old and new technological

[33] Drechsler, K., Gregory, R. W., Wagner, H. T., & Tumbas, S. (2020). At the crossroads between digital innovation and digital transformation. *Communications of the Association for Information Systems*, *47*(1), 521–538.

An earlier version was published: Gregory, R. W., Wagner, H.-T., Tumbas, S., Drechsler, K. (2019). At the crossroads between digital innovation and digital transformation. *Proceedings of the 40th International Conference on Information Systems: 1-9.*

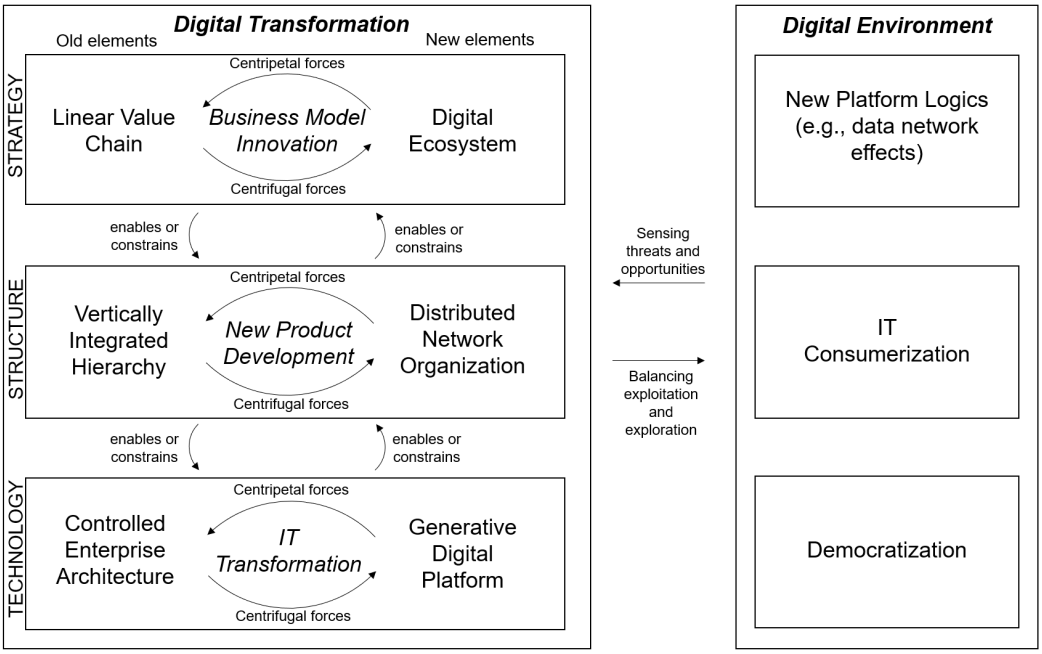


Figure 17: Results of Paper XI - Theoretical framework: Digital transformation in incumbent companies (Drechsler et al., 2020, p.524)

and organizational elements. Paper XII suggests several theoretical lenses, such as dynamic capabilities and dependence theory, to deepen our understanding of this struggle in digital innovation and transformation. Additionally, the need to transcend beyond the boundary of the IS discipline when studying digital innovation is discussed.

In summary, Paper XII corresponds to RQ5 by conceptualizing the interrelationship between digital innovation and transformation as well as triggers and drivers of digital transformation in companies' digital environment. The developed theoretical framework deepens our understanding of links between different types of digital innovation and the interdependence between digital innovation and digital transformation in incumbent firms. Accordingly, Paper XII presents an overview of dominating interrelationships in innovation champions' context in the digital age.

5 Discussion

This dissertation raises the overarching research question: *What makes innovation champions successful in the digital age?*. In answering this question, the twelve papers of this dissertation offer several implications and contributions to extending knowledge on innovation champions in the digital age. Due to the interdisciplinary nature of the research topic and the applied methods, the contributions to research and theory are not limited to the Information Systems discipline but also extend to Innovation Management and Finance. The following discussion predominantly focuses on implications for IS research, but also points to contributions to other fields. Section 5.1 outlines the implications of the dissertation's findings and illustrates the dissertation's contributions to research and theory. Subsequently, Section 5.2 presents the dissertation's contributions to practice.

5.1 Implications and Contributions to Research and Theory

This dissertation offers several contributions to research and theory, which are structured along the five research questions raised in this dissertation. Section 5.1.1 presents the contributions to existing knowledge on innovation champions based on existing literature (RQ1). Then, Section 5.1.2 offers contributions regarding individual characteristics and organizational enablers of innovation champions in the digital age (RQ2 & RQ3). After the theoretical insights into digital technology as an enabler of innovation champions are presented (RQ4) in Section 5.1.3, the contributions to understanding innovation champions' context in the digital age, characterized by digital innovation and transformation, are discussed (RQ5) in Section 5.1.4. Finally, Section 5.1.5 turns to the overall contribution of the dissertation and discusses the concept of innovation champions by unraveling existing myths and offers a path towards a new conceptualization of innovation champions in the digital age. All sections briefly summarize the findings and then connects them to extant literature to illustrate the dissertation's contribution to research and theory.

5.1.1 Extant Knowledge of Innovation Champions

The first research question is: *What do we know about innovation champions' individual characteristics, resource acquisition strategy, and performance, as well as organizational enablers, based on extant literature?* **Paper I to IV** and **Paper VII** answer this question by systematically reviewing the literature on innovation champions with a broad literature base spanning four disciplines. **Paper I and II** provide a broad characterization of innovation champions' traits, skills, knowledge, and activities. Moreover, the papers identify innovation champions' organizational enablers and influence on organizational and network characteristics. Additionally, **Paper III** identifies changes regarding the roles of innovation actors championing innovation and organizational enablers in the digital age. The papers also identify relevant gaps in our current understanding, for instance, the scarcity of research regarding innovation champions' impact on financial success, organizational structures enabling actors to champion innovation in teams, and HR mechanisms for identifying innovation champions.

Paper IV characterizes innovation champions' activities and embeddedness in social networks. The paper further identifies avenues for future research on the formation of groups of innovation champions and coordination mechanisms within networks of innovation champions. Moreover, exploring extant literature on IS executives, **Paper VII** characterizes CDOs and CIOs as possible executive champions and systematizes existing knowledge on IS executives' inputs, mediators, and outcomes. It also reveals research gaps in our understanding of IS executives concerning their relationship with other TMT members and middle managers as well as their causal effect on companies' financial performance.

This dissertation makes several contributions to research in answering the first research question. The most notable contributions are outlined in the following and summarized in Table 19. First of all, **Paper I to IV** and **Paper VII** systematize and synthesize extant literature on innovation champions. Research on innovation champions is diverse and multifaceted, has a long history, and spans multiple disciplines. Gaining a comprehensive understanding of the existing knowledge on innovation champions is therefore not without difficulties. Literature reviews are generally rare, and the few existing ones have mainly focused on one specific discipline, one particular type of champion, or individual characteristics of innovation champions only (e.g., Jenssen & Jørgensen, 2004; Renken & Heeks, 2019).

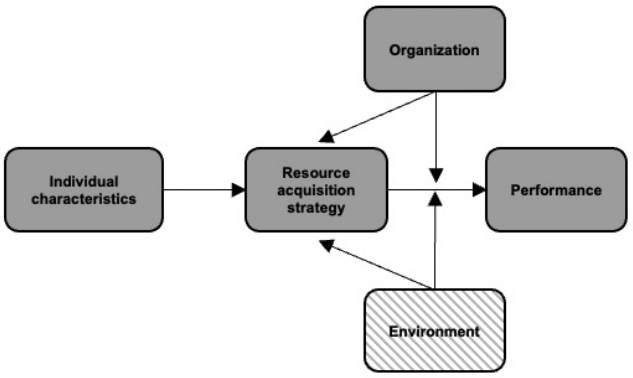
RQ1: What do we know about innovation champions' individual characteristics, resource acquisition strategy, and performance, as well as organizational enablers, based on extant literature?	
Past research	**Contribution**
Few existing literature reviews focus on one specific discipline or individual characteristics of innovation champions	Detailed understanding of innovation champions' individual characteristics, resource acquisition strategy, performance and interaction with organizational and network characteristics across disciplines and development of agenda for future research through systematization and synthesis of existing literature
Consideration of innovation agency for digital innovation on an abstract level	Provision of nuanced perspective on implications of the digital age for innovation champions through a synthesis of extant research
Predominant focus on champions of IT implementation in IS literature	Extension of champion concept in the IS literature by focusing on champions as promoters of innovation development
Call for research on the role of digital technology for innovation actors	Development of a conceptual framework to explore the interaction between digital technology and innovation champions' social network in digital age building on social network research

Table 19: Theoretical contribution regarding extant knowledge of innovation champions (RQ1)

Paper I to IV and Paper VII contribute to research through synthesizing and systematizing extant knowledge on innovation champions. The multidisciplinary reviews offer a comprehensive characterization of innovation champions' individual characteristics, resource acquisition strategies, and organizational enablers as well as their impact on performance. These literature reviews cover not only innovation champions' individual characteristics or behaviors but build a comprehensive understanding of other important aspects of innovation champions explored in existing literature, such as champions' social network and organizational enablers (e.g., De Brentani & Reid, 2012; Howell & Boies, 2004). Moreover, the five papers identify existing research gaps and develop research agendas for future research that can guide researchers and pave the way for future knowledge discovery. By formulating questions for Innovation Management and IS research, these studies contribute to theory, since such questions form intermediate products of theorizing (Hassan et al., 2022).

Paper III, IV and VII contribute to IS research by focusing on innovation champions in the digital age. The papers provide insights into the implications of the digital age for innovation champions. Thus, they respond to calls for future research to explore innovation actors' characteristics and interactions with the organizational environment in the digital innovation process in depth (Holmström, 2018) and to study digital innovation from an interdisciplinary perspective (Nambisan et al., 2017). Whereas the nature of agency in digital innovation has predominantly been considered on an abstract level, the multidisciplinary reviews allow to identify and analyze individual characteristics and organizational enablers of champions of digital innovation with a great attention to nuances in prior research (see Section 5.1.2).

Furthermore, Paper III, IV, and VII add a novel perspective of champions to IS research. The champions concept has been explored in the discipline in the last thirty years, since the research article by Beath (1991). However, the focus was to a great extent on champions of IT implementation (e.g., Lin et al., 2014; Negoita et al., 2022; Tona et al., 2016), but not the innovation process of digital or information technology. Additionally, **Paper VII** builds a comprehensive understanding of executive champions in IS by analyzing and reviewing the literature on the newly emerging role of the CDO and the established CIO, who can both take over the role of innovation champions. While a broad body of literature on the CIO exists, synthesizing literature reviews are rare, and Paper VII contributes to existing knowledge by building a comprehensive understanding of these executives.

Moving beyond a pure systematization of the literature, **Paper IV** additionally contributes to social network research (Borgatti & Foster, 2003; Borgatti & Halgin, 2011) by developing a conceptual framework to explore the role of digital technology in innovation champions' social networks. Thus, Paper IV identifies two roles of digital technology: (1) an enabler of innovation champions and (2) a component of digital innovation promoted by innovation champions[34], and explores the mechanisms underlying these two roles of digital technology within innovation champions' social network. This finding responds to the call for research by Yoo et al. (2012) for a deepened understanding of the use of digital technology among innovation actors.

5.1.2 Individual Characteristics and Organizational Enablers of Innovation Champions' Success in the Digital Age

The second research question inquires: *What characterizes innovation champions who contribute to companies' success in the digital age?* The third research question is: *Which organizational characteristics enable or hinder innovation champions in promoting innovation and contributing to companies' success in the digital age?* In answering these research questions, this dissertation takes two different angles.

On the one hand, **Paper III, IV and VII** identify shifts in extant literature, especially in innovation champions' nature, characteristics, and organizational enablers in the digital age. **Paper III** points to an increasing emphasis on executive champions in the digital age, such as CDOs and CIOs. Based on this finding, **Paper VII** provides a characterization of CDOs and CIOs by synthesizing knowledge on their education, experience, knowledge, skills, and traits. Additionally, **Paper III and IV** identify a shift from innovation champions as lone wolves toward groups of champions, where championing digital innovation occurs as a distributed activity. **Paper X** connects with this finding by identifying the general nature of digital innovation actors as heterogeneous, distributed, highly varying, and less-predefined. Building on the observation that championing increasingly takes place in groups, the literature reviewed in **Paper III and IV** outline the importance of organizational and social network characteristics enabling collaboration and promoting complementary skills among groups of champions, but also points to the partially scant empirical evidence.

On the other hand, **Paper V and VI** build on the knowledge derived in the literature reviews and explore the link between executive champions and organizational performance, one gap identified in Paper III and VII. **Paper V** identifies a slightly positive overall market reaction to CDO appointments based on an event study. **Paper VI** further differentiates between CDO appointments to new positions and successions. It determines a significant, positive stock market

[34]Note, this understanding also guided the review of innovation champions in the digital age in Section 2.3. It was used to develop an extended champion model (see Figures 4 and 5) but was first conceptualized in Paper IV.

reaction for the former and a significant, negative stock market reaction for the latter. These diverging findings in **Paper V and VI** may be attributed to different samples and timeframes considered in both papers. In line with this, **Paper V** shows that a positive stock market reaction can only be measured for companies appointing a CDO up until 2016 and demonstrates a negative stock market reaction for later years. Additionally, **Paper VI** compares the negative stock market reaction of CDO appointments to CIO appointments.It finds a positive stock market reaction to CIO appointments for the period 1987-1998, comparable to results of an earlier study by Chatterjee et al. (2001), but an adverse market reaction to CIO appointments in the period 2011-2020.

Paper V and VI also demonstrate that the stock market reaction is influenced by individual characteristics of the appointed CDO and organizational circumstances. **Paper VI** shows that the identified positive reaction for CDO appointments to new positions can turn negative for CDOs with in-depth knowledge of business or IT only or a misalignment between reporting line and role profile. In contrast, for CDO succession appointments, the overall negative stock market reaction can turn positive for CDOs with a strong power profile. Similarly, **Paper V** identifies a strong, positive stock market reaction for CDOs with a specialist role profile, non-STEM educational background, and no profound IT experience.

In answering the two research questions, as summarized above, this dissertation makes several contributions to knowledge and theory. These are outlined in Table 20 and discussed in the following. First, **Paper III and IV** contribute to extant knowledge by characterizing and conceptualizing the shifts in innovation champions' nature in the digital age. The innovation champion used to be characterized as a vibrant individual promoting an innovation project on his or her own (e.g., Howell et al., 2005; Shane et al., 1995), or, in some instances, a group of champions dividing the labor of championing (e.g., Chakrabarti & Hauschildt, 1989). Now numerous research articles characterize champions of digital innovation as groups or collectives co-performing championing with different, rapidly changing roles for all actors involved (e.g., Klerkx & Aarts, 2013; van Laere & Aggestam, 2016). Furthemore, **Paper IV** uses the theoretical lens of social networks to describe and conceptualize this phenomenon. Thus, champions are situated in two distinct network layers: among themselves and other stakeholders. With this, the paper substantiates the concept of distributed agency identified in earlier digital innovation literature (Nambisan et al., 2017; Yoo et al., 2012).

Second, **Paper V and VI** contribute to research by quantifying CDOs' impact on companies' short-term financial performance. Innovation champions have generally been considered beneficial for the organizational performance of companies (e.g., Howell & Boies, 2004; Jenssen & Jørgensen, 2004). Yet, studies have rarely used methods that enable the identification of a causal link between innovation champions and organizational or financial performance. Paper V and VI close this gap in the literature by establishing clear causation between the appointment of CDOs as executive champions and financial performance and by exploring distinct individual and organizational characteristics influencing this link. While the studies measure financial performance in the short term, they can also offer longer-term implications, since estimated abnormal returns reflect changes in investors' perception of company's future prospects.

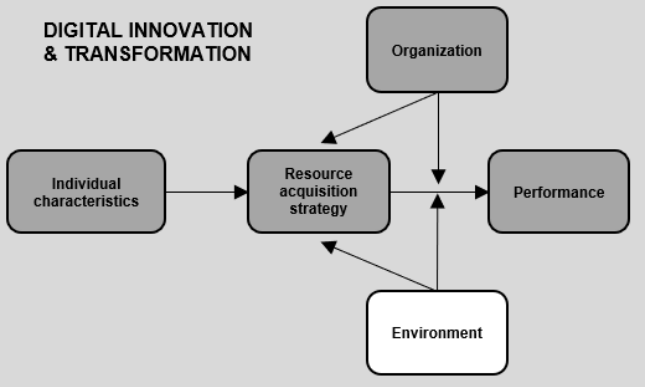
RQ2: What characterizes innovation champions who contribute to companies' success in the digital age? *RQ3: Which organizational characteristics enable or hinder innovation champions in promoting innovation and contributing to companies' success in the digital age?*	
Past research	**Contribution**
Predominant characterization of innovation champions of 'traditional' innovation as lone wolves	Characterization of a shift in innovation champions' nature and organizational enablers towards championing in groups with a division of labor in the digital age
Conceptualization of distributed innovation agency in digital innovation projects but unclear link to champion literature	Conceptualization and deepened understanding of distributed agency among innovation champions, including their activities and embeddedness in the social network
Scarce evidence on the causal link between innovation champions and organizational performance	Identification and quantification of stock market reaction to the appointment of the CDO as an executive champion in the digital age
Predominantly evidence of positive stock market reaction to the appointment of C-level executives, except during organizational turmoil	Empirical evidence for different stock market reactions depending on individual characteristics of appointee and organizational circumstances
CDOs establish own jurisdiction and sphere of influence to differentiate themselves from the established IT function and CIO	Additional empirical evidence for strategically distinct nature of CIO and CDO due to diverging stock market reaction to CIO and CDO appointments
Evidence of positive stock market reaction to the appointment of CIO	Empirical evidence of changes in the stock market reaction to CIO appointments over time (1987-1998 vs. 2011-2020), possibly due to shifts in investors' perception of the CIO role
Qualitative studies point to possible conflicts among CIOs and CDOs due to competing spheres of influence	Additional quantitative evidence for the negative perception of the parallel existence of CIO and CDO
Predominantly no consideration for different power dimensions or focus on structural power only in research on functional executives	Empirical evidence for prestige and expert power as important dimensions of power - in addition to structural power
Focus on specific dimensions of power in extant research: structural power derived from hierarchical authority and IT-related expert power	Identification of new conceptual dimensions of power: Structural power derived from resource endowments and expert power derived from interdisciplinary and company-external knowledge → Proposition of unfolding CDO impact theory

Table 20: Theoretical contribution regarding individual characteristics and organizational enablers of innovation champions' success in the digital age (RQ2 & RQ3)

Paper V and VI also generally extend knowledge on IS executives' appointments by demonstrating differences in investors' reactions to these appointments across time and roles. In existing research, C-level appointments have generally been linked to positive stock market reactions in Management and IS literature (e.g., Chatterjee et al., 2001; Huson et al., 2004). Negative reactions have been predominantly recorded in situations of organizational turmoil (Gangloff et al., 2016). In contrast, Paper V and VI show that a strong positive stock market reaction can only be measured for companies appointing CDOs to a new position (Paper VI) and companies joining digital transformation efforts early on (Paper V). Moreover, the stock market reacts only positively to CDO appointments if no CIO already exists at the appointing company (Paper V). Additionally, only the appointment of CDOs with a strong power profile (Paper VI) or specific individual characteristics (Paper V, e.g., specialist role profile) are perceived as positive. In contrast, appointments of CDOs with a weak power profile and CDO succession appointments (Paper VI) are linked to an adverse stock market reaction. Accordingly, it can be concluded that earlier findings on a positive stock market reaction to C-level appointments in general cannot easily be transferred to the new role of the CDO.

This conclusion is further sustained by the empirical evidence in **Paper VI** on diverging stock market reactions to CDO and CIO appointments to new positions in recent years. Investors may perceive CDOs as positive but CIOs as negative, due to the distinct nature of both roles. This explanation of the distinctiveness of CDOs compared to CIOs is backed by extant research, which shows how CDOs establish their own jurisdiction and differentiate themselves from the existing IT function and CIO (Tumbas et al., 2018). Therefore, Paper VI provides empirical evidence for the strategically distinct nature of CDOs compared to CIOs.

The changing investor reaction to CIO appointments over time may be explained by the possibility that investors evaluate the novelty of C-level appointments and its implications for a company's competitive position. Thus, C-level appointments may only be valued positively by investors, if these appointments are new to the company and new across industries. By establishing a CDO position as one of the first, companies signal leadership in the industry by setting a new strategic direction for digital initiatives. In contrast, the appointment of a CIO, responsible for the innovative use of IT, may no longer constitute a competitive advantage, as it did three decades ago (Chatterjee et al., 2001). Instead, the link between IT investment and organizational success now depends on other organizational factors, such as R&D expenditure (Bardhan et al., 2013), possibly making the CIO appointment less decisive for organizational success. Paper VI illustrates investors' changing perception of CIOs' role.

Third, **Paper V** contributes to the literature on IS executives by providing empirical evidence for investors' negative perception of the parallel existence of CIO and CDO. A possible conflict of influence spheres between CIOs and CDOs has been described in extant literature (Haffke et al., 2016). Information technologies have traditionally fallen under the responsibility of the CIO (Chen et al., 2010; Peppard et al., 2011), but frequently the use of and innovation with information or digital technology also constitute responsibilities of the CDO (Singh & Hess, 2017; Tumbas et al., 2018). Paper V adds further quantitative evidence to the existing - partly speculative - argumentation and findings in qualitative studies.

Fourth, **Paper VI** expands the understanding of functional executives' power profile by demonstrating the importance of expert and prestige power, in addition to structural power. While in his original work Finkelstein (1992) suggests several types of power, prior research studying functional executives, such as CIOs or CMOs, has - with few exceptions - either not differentiated between different types of power (e.g., Baker et al., 2019; Feng et al., 2015) or only studied structural

power (e.g., Bradley et al., 2012; Chen et al., 2010). Paper VI provides empirical evidence of the importance of CDOs' expert power and - to a smaller degree - prestige power, especially for turning investors' reaction to CDO succession appointments from negative to positive. As these dimensions of power have scarcely been considered in prior research, the paper contributes significantly to better understanding the power of functional managers in general, and CDOs as executive champions in particular, and their link to financial performance.

Furthermore, Paper VI contributes by identifying novel dimensions of structural and expert power, which are associated with significant stock market reactions, namely structural power derived from resource endowments and expert power derived from interdisciplinary knowledge and company-external knowledge. Paper VI finds that CDOs' power derived from their hierarchical position, a dimension of structural power frequently used in prior literature (e.g., Chen et al., 2010; Lim et al., 2013), is not associated with financial performance. In contrast, structural power derived from resource endowment, a newly identified dimension, has a positive and statistically significant association with financial performance for CDO succession appointments. Moreover, a positive stock market reaction can be observed for the newly identified dimensions of expert power derived from interdisciplinary knowledge (CDO appointments to new positions) and company-external knowledge (CDO succession appointments).

Based on the findings in Paper VI, the paper proposes an unfolding CDO impact theory. This proposed theory suggests that all three dimensions of CDOs' power should be considered in concert, rather than in isolation. As illustrated in Figure 3 it suggests proposes that CDOs' power dimensions moderate the effect of CDOs' presence on financial performance. The proposed theory can provide the basis for further studies on CDOs' impact on financial performance and constitutes a vital contribution to theory.

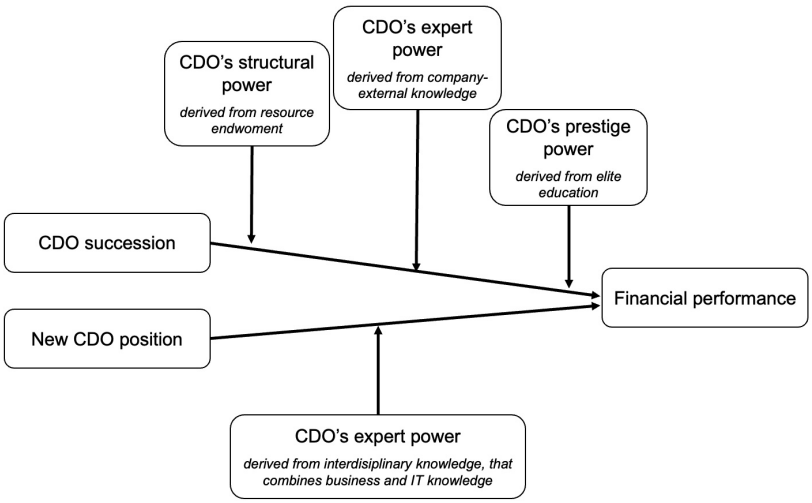


Figure 18: Contribution of Paper VI - Unfolding CDO impact theory (Drechsler et al., 2022b, p.41)

5.1.3 Digital Technology as an Enabler of Championing

The fourth research question asks: *How can digital technology enable championing behavior within companies?* This research question is again addressed from two angles in this dissertation. On the one hand, the synthesis of existing literature in **Paper IV** touches upon this question. Thus, the literature review in Paper IV illustrates that the availability of digital technology has led to

gradual shifts in innovation champions' activities and their effectiveness. Thus, digital technology has been shown to enable faster and more targeted knowledge exchange and orchestration of innovation projects. Innovation champions may adjust their strategies in digital innovation processes to the specific nature of digital technology. However, Paper IV also illustrates gaps in our understanding of the role of digital technology in enabling innovation champions and their collaboration with heterogeneous innovation actors.

On the other hand, building on the identified gaps in our understanding, the qualitative studies reported in Part III provide detailed insights. **Paper VIII and Paper IX** study the role of digital technology as an enabler of championing activities among employees and - in some instances - innovation champions. Thus, Paper VIII and IX identify the work model, which combines the collaboration tools offered by digital platforms with a dedicated time slot for idea generation and innovation development, as a driver of championing among employees. Moreover, **Paper IX** shows drivers and barriers to the development and implementation of such a work model and illustrates the significant role of the innovation champion in endorsing it. Additionally, Paper IX derives theoretically grounded and empirically evaluated design principles for a digital intrapreneurship platform, which promotes intrapreneurship and championing among employees. Thus, Paper IX suggests that intrapreneurship platforms need to (1) ensure high transparency while allowing for user control, (2) provide real-time capture and alerts with user control, (3) enable community integration while providing the opportunity to pre-review proposed changes, (4) promote an innovation culture through management actions, (5) enable the identification and formalization of informal roles of intrapreneurs on the platform.

With these findings, this dissertation contributes to knowledge and theory in several ways, as summarized in Table 21. First, **Paper VIII and IX** extend our knowledge on the development of innovative ideas and products in the digital age. While extant literature has described the novel opportunity for open and user-driven innovation offered through digital technology (Chesbrough, 2003; Mahr & Lievens, 2012), the main focus has been on such phenomena outside organizational boundaries. Only Benbya and Leidner (2018) have offered an exception by identifying the high potential of comprehensive approaches towards employee-driven innovation, for example, work models, for enabling idea generation among employees. Paper VIII and IX extend this knowledge by identifying the drivers and barriers of such a work model, which enables the democratization of innovation discovery and development.

Moreover, the papers demonstrate how implementing such a work model can form the first step towards creating an innovative culture, which acts as a catalyst for employee-driven innovation in public companies. Whereas the importance of organizational culture for employee-driven innovation has generally been outlined in prior research (e.g., Abu El-Ella et al., 2013), suggestions for concrete measures to establish an innovation-promoting culture are more difficult to find. Paper VIII and IX suggest a comprehensive approach to how the participation of employees in innovation can be increased in companies by combining free time for innovation with a digital platform. Such an approach can lead to changes in the employees' mindsets towards higher commitment to generating innovation, even if they are not members of a company's R&D department. Therefore, it may form the stepping stone for creating an innovation culture, as Paper VIII and IX illustrate.

Second, **Paper IX** contributes to design theory by deriving principles for the design of digital intrapreneurship platforms facilitating employee-driven innovation, which can be applied to a broader context and serve as a blueprint for establishing similar platforms in other companies. Extant research in ADR and Innovation Management has either derived design insights for

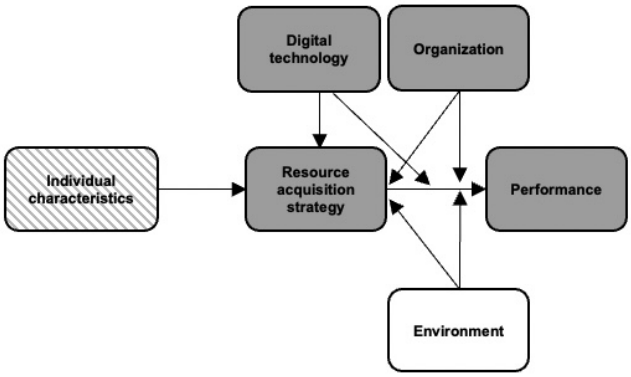
RQ4: How can digital technology enable championing behavior within companies?	
Past research	**Contribution**
Primary focus on open and user-driven innovation outside an organization	Identification of drivers and barriers for work model enabling employee-driven innovation & creation of innovative culture within an organization
Studies provide design knowledge for other platforms or explore employee-driven innovation without providing explicit design recommendations; design of platforms for idea generation presents challenges	Derivation of design knowledge in the form of design principles for digital intrapreneurship platform
Identification of innovation champions based on individual characteristics (e.g., traits, skills, behaviors etc.)	Theoretically ingrained digital intrapreneurship platform and work model as novel mechanism to identify innovation champions
STS theory: a change in one component of the organizational system results in compensatory changes in other components	Identification of new path for oganizational change: Innovation champion, situated within 'actor' element, orchestrates change in all other elements of the STS

Table 21: Theoretical contribution regarding digital technology as an enabler of innovation champions (RQ4)

different platforms and goals (e.g., Marjanovic, 2016; Mettler et al., 2017) or studied employee-driven innovation without providing explicit recommendations on the design of measures to promote this type of innovation (e.g., Benbya & Leidner, 2018; Ciriello & Richter, 2015). Additionally, de Reuver et al. (2018) have pointed to challenges in designing of digital platforms for idea generation, such as mechanisms ensuring incentivization and sustainable employee motivation. The five design principles derived in Paper IX address these shortcomings and extend existing research on platforms and innovation management using information systems.

Third, **Paper VIII and IX** deepen our knowledge of champions. Innovation champions have predominantly been described to emerge due to their traits, skills, knowledge, leadership behaviors, and influence tactics (Howell & Boies, 2004; Howell & Higgins, 1990). Accordingly, recommendations on how managers can identify innovation champions have focused on using questionnaires or job interviews to hire and promote employees with the potential to turn into champions (Howell, 2005). Paper VIII and IX extend this knowledge by identifying and demonstrating the use of a work model and digital intrapreneurship platform as a mechanism to identify champions.

Fourth, this dissertation also contributes to STS theory. **Paper VIII** identifies innovation champions as essential in implementing the work model. The innovation champions influence all components of the STS theory when promoting the work model. This influence was especially

powerful for the components 'actors' and 'task', as the innovation champion convinced reluctant employees to participate in the new work model by endorsing its legitimacy. Traditionally, the STS theory has assumed that organizational change is induced by changes in one element, which lead to compensatory changes in other elements (Leavitt, 1964; Lyytinen et al., 1998). Yet, the critical role of the innovation champion forms a deviation from this general assumption, since the innovation champion, part of the component 'actors', influenced all other elements and orchestrated organizational change through the implementation of the work model. Accordingly, the component 'actors' plays a much more prominent role than the other elements of the model. Thus, this dissertation shows that, with the involvement of innovation champions, organizational change can unfold differently than generally assumed in the STS theory.

5.1.4 Characteristics of Innovation Champions' Context in the Digital Age

The fifth research question inquires: *What characterizes digital innovation and transformation?* This dissertation responds to this research question predominantly in **Paper X to XII** and derives implications for innovation champions' working context inseveral ways. **Paper X** systematizes extant research on digital innovation and identifies gaps in our current understanding of digital innovation. Thus, Paper X shows that the nature of digital innovation is characterized by an increasing blurring of innovation process and outcome and identifies new phenomena in innovation champions' working environment, such as the redefinition of organizational boundaries and the emergence of new industrial structures in the digital age.

Paper XII develops a theoretical framework on the interplay between digital innovation and transformation in incumbent companies. Digital transformation is conceptualized as a multilayered phenomenon encompassing changes in organizational strategy, structure and technology. Changes in the organizational strategy, in the form of business model innovation, need to be balanced against changes in the structure, through new product development, or technology, through IT transformation. Additionally, tensions within the layers themselves may arise when companies create new elements and abandon old elements.

Furthermore, **Paper XI** responds to the fifth research question by identifying systematic differences in companies' characteristics and financial performance depending on companies' engagement with digital innovation. Companies with a high engagement with digital innovation show a statistically significant lower ROA and cost ratio, but higher sales growth and long-term forecasts. The paper further indicates that companies with a high level of engagement perform better on the stock market and identifies a novel asset pricing factor, which has significant explanatory power for the expected stock return of companies. Thus, companies' engagement with digital innovation is not captured by existing asset pricing factors, but constitutes an essential factor in explaining asset pricing in the digital age comprehensively. Paper XI provides empirical evidence for the changing environment in innovation champions are situated in the digital age.

In responding to the fifth research question, **Paper X to XII** also make several research contributions, as argued in the following and summarized in Table 22. They predominantly contribute to digital innovation and transformation literature. Yet, Paper X to XII also offer implications for innovation champions in the digital age. First, the systematization of literature on digital innovation and transformation in **Paper X** and the developed theoretical framework on digital transformation in incumbent companies in **Paper XII** extend our understanding of the digital age and its distinct characteristics. Thus, the studies informed this dissertation's motivation and theoretical background and illustrated the necessity to reconsider established concepts in the innovation literature, such as champions. Additionally, Paper XII offers a joint conceptualization

of digital innovation and transformation and their interplay. The literature of digital innovation (Hund et al., 2021) and digital transformation (Vial, 2019) has been rapidly growing in recent years. However, both literature streams have predominantly considered the phenomena in isolation. Paper XII contributes to theory in both streams by developing a conceptualization linking both phenomena. This conceptualization suggests important components and triggers for digital innovation and transformation, which may also influence innovation champions. Thus, Paper XII indicates that the new organizing logics of digital innovation and broader change processes through digital transformation can influence innovation champions' nature and way of working.

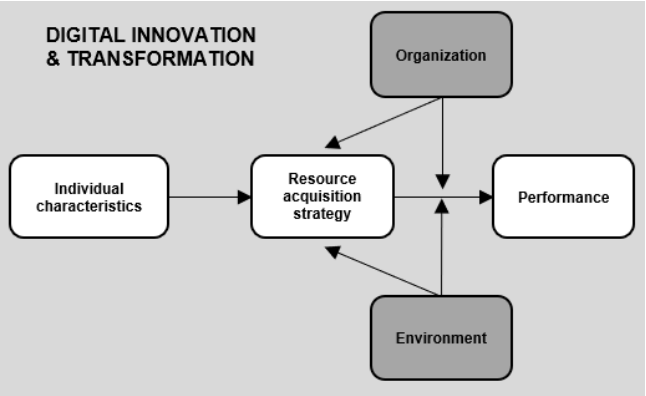
RQ5: What characterizes digital innovation and transformation?	
Past research	**Contribution**
Predominantly separate streams of literature on digital innovation and transformation	Conceptualization of interplay between digital transformation and digital innovation in a theoretical framework
Research using textual analysis predominantly confined to documents' readability, similarity, changes in language, and sentiment	Measurement of digital innovation using textual analysis through theoretical refinement and application to a large, longitudinal sample of stock-listed companies in the US
Predominantly conceptual research and anecdotal evidence on blurring boundaries between industries and competition of companies across, instead of, within industries	Empirical evidence of low explanatory power of industry classification for differences in company characteristics and returns in the digital age
Failure of established asset pricing models to account for intangible assets	Proposition of asset pricing factor, which accounts for digital innovation as an intangible asset in the digital age

Table 22: Theoretical contribution regarding innovation champions' context in the digital age (RQ5)

Second, **Paper XI** makes a contribution to IS and Finance research by measuring companies' engagement with digital innovation based on a large sample of annual reports. Typical applications of CATA have been the assessment of documents' readability, similarity, or sentiment (e.g., Cohen et al., 2020; Hillert et al., 2014; Hoberg & Phillips, 2016). Attempts to derive a measure of companies' engagement with (digital) innovation from textual, secondary data have been scarce. Traditionally, innovation activities in companies were frequently measured using patent data (e.g., Hall et al., 2005). Yet, this brings challenges when it comes to measuring digital innovation comprehensively since the developed digital products (e.g., software) cannot always be patented. By theoretically refining the word list first developed and tested by Kindermann et al. (2021) and applying it to a longitudinal analysis of an almost complete sample of stock-listed companies in the US, this dissertation further contributes toward refining a measure of digital innovation.

Third, **Paper XII** extends our knowledge of the distinct characteristics of digital innovation and transformation for the competitive environment of companies. Predominantly conceptual papers in IS have argued that industrial boundaries are blurring in the digital age, as digital innovation requires the integration and recombination of heterogeneous knowledge from different industries (Seo, 2017; Yoo et al., 2012). Moreover, digital innovation has been argued to lead to a convergence of products across organizational and industrial boundaries (Nambisan et al., 2017; Porter & Heppelmann, 2014), making companies that belong to different industries competitors. Accordingly, classifying companies based on their industry classification appears outdated. Our analysis provides the first empirical evidence indicating the existence of these previously theoretically conceptualized changes. Thus, Paper XII shows that industry classifications cannot fully explain differences in company characteristics and abnormal returns. Instead, companies' level of engagement with digital innovation needs to be taken into account. This observation further emphasizes the distinct nature of innovation champions' context in the digital age .

Fourth, Paper XII contributes to asset pricing theory of intangible assets in Finance. While intangible assets make up around one third of total investment volume in the US (Corrado & Hulten, 2010), research on asset pricing of intangible assets constitutes a small research stream. Therefore, several studies explore the extent to which intangible assets can explain asset pricing (e.g., Ai et al., 2013; Eisfeldt & Papanikolaou, 2014). Yet, existing asset pricing models (e.g., Fama & French, 1993, 2015; Hou et al., 2015) struggle in accounting for intangible assets (e.g., Daniel & Titman, 2006). Especially, the engagement of companies with digital innovation has so far been lacking almost completely from asset pricing literature. Paper XII contributes to asset pricing theory by proposing a new asset pricing factor to account for intangible assets in the digital age.

5.1.5 Towards a Novel Concept of Innovation Champions in the Digital Age

The dissertation's findings on innovation champions make a reconsideration of the concept of innovation champions in the digital age necessary. A concept is an array of ideas associated with a term and forms a product of theorizing (Hassan et al., 2022; Sartori, 1975). In order to reconsider and theorize about the concept of innovation champions in the digital age, this section presents several myths on innovation champions prevailing in extant IS and Innovation Management research. A myth is an "unquestioned belief about the practical benefits of certain techniques and behaviors that is not supported by demonstrated facts" (Trice & Beyer, 1984, p.655). Myths form significant inputs to theory building and are intermediate products of theorizing (Hassan et al., 2022). Accordingly, myths can guide us towards a new concept of innovation champions in the digital age. Subsequently, the myths are unraveled considering this dissertation's theoretical and empirical evidence and it is argued how the findings make a reconsideration of the ideas associated with champions necessary.

Myth 1: Innovation champions always contribute to innovation and organizational success. Prior research has generally characterized the emergence of innovation champions as desirable and beneficial for companies' innovation success and performance (e.g., Howell & Shea, 2001; Howell et al., 2005; Markham & Aiman-Smith, 2001). For instance, the innovation champion model by Jenssen and Jørgensen (2004) explicitly assumes a positive effect of innovation champions on organizational performance. This positive sentiment toward innovation champions is widely echoed across the literature (e.g., Day, 1994; Howell & Boies, 2004; Howell & Shea, 2006), and frequently this optimistic view of innovation champions has been based on anecdotal evidence or conceptual considerations (e.g., Markham, 1998; Schön, 1963).

Yet, in recent years, evidence has emerged that the influence of innovation champions may tilt

towards harming organizational performance, if the innovation champions are overly committed to an idea and show a high persistence in promoting an innovation project (Walter et al., 2011). In this dissertation, the myth is also substantiated by the mixed empirical evidence on investors' reaction toward the appointment of CDOs as executive champions of digital innovation in Paper VI. For instance, CDO succession appointments have a negative impact on financial performance. Only executive champions of digital innovation appointed to new positions or with a strong power profile are perceived as positive by financial markets.

Myth 2: Innovation champions are heroic, lone wolves of innovation. Literature has predominantly depicted innovation champions as outstanding individuals who drive an innovation project forward on their own while risking their careers (Howell & Higgins, 1990; Schön, 1963; Shane et al., 1995). The characterization of innovation champions by Schön (1963) presented in Section 2.1.1 illustrates this understanding of innovation champions excellently. In line with this, a significant focus within the body of research on innovation champions is on identifying individual characteristics, such as traits, skills, and knowledge, characterizing this heroic individual (e.g., Greene et al., 1999; Howell & Boies, 2004; Howell & Shea, 2001; Jenssen & Jørgensen, 2004). Similarly, the behaviors and strategies used by innovation champions to drive innovation projects forward have received a high level of attention in research (e.g., Howell et al., 2005; Roure, 2001; Walter et al., 2011).

In recent years, literature has increasingly described championing as a distributed phenomenon (e.g., Klerkx & Aarts, 2013; van Laere & Aggestam, 2016), a trend identified in Paper III and IV. The ubiquity of digital technology and digital innovation has undoubtedly been one of the reasons for this trend, as extant literature has pointed to the increasingly distributed nature of innovation actors overall (Nambisan et al., 2017; Yoo et al., 2012). Therefore, groups of champions have been characterized as rapidly changing and iteratively developing units (Klerkx & Aarts, 2013; van Laere & Aggestam, 2016). As a result of the distributed nature of championing, the social interaction between the different individuals collectively performing champion behaviors and leveraging distinct elements of social capital has moved to the foreground (Negoita et al., 2022; van Laere & Aggestam, 2016). Moreover, van Laere and Aggestam (2016) emphasize the need to hire innovation champions with complementary skills and to establish organizational structures enabling collaboration.

At the same time, this has resulted in the role of the individual champion losing importance. Some earlier literature already considered champions to fall within a spectrum, where some individuals qualify as fully-fledged champions while others perform only some championing behavior (Markham & Griffin, 1998). This has made the identification of degrees of championing necessary (Howell & Shea, 2001; Walter et al., 2011). Yet, this shift away from individuals' outstanding and heroic roles in championing innovation is new. Thus, when studying IT champions Negoita et al. (2022) focus on the championing behavior and the process of championing, but pay less attention to the role profile of the individual champion. Moreover, championing behavior within the group is considered to "form a meaningful whole" (van Laere & Aggestam, 2016, p.53).

As a consequence, the concept of innovation champions needs to be expanded to include groups of champions. While the outstanding, heroic individual may still exist in some circumstances, especially when considering executive champions in the digital age, another type of entity championing innovation may be overlooked if only heroic, lone wolves are considered as innovation champions. This has implications for our understanding of champions within existing models, such as the champion model by Jenssen and Jørgensen (2004). Thus, the complementarity of skills and knowledge within groups of actors championing innovation forms another important

component of champions' success. Similarly, the collaboration and communication skills, and social relationships among actors championing innovation constitute important enablers for their resource acquisition strategy.

Simultaneously, digital technology is an essential enabler for the orchestration of diverse and every-changing groups of actors. As illustrated in Paper VIII and IX the combination of a digital platform with innovation time positively influences and enables groups of employees championing innovation. Thus, digital technology can address the paradox of change in digital innovation, which characterizes the tension between stability and flexibility (Tilson et al., 2010). Digital platforms provide a high degree of flexibility for actors to spontaneously join and participate in the innovation process and champion digital innovation projects. Due to the different features of the digital platform (e.g., documentation, comment functions, etc.) and the predetermined amount of innovation time available to employees, innovation can also occur within a highly stable environment. Thus, digital technology in general and work models in particular offer a structured way for companies to manage the increasingly distributed and heterogeneous group of champions of digital innovation. Accordingly, digital technology needs to be considered as an essential enabler of innovation champions.

Myth 3: Innovation champions emerge spontaneously as needed and without external influences. A widely accepted, predominantly implicit assumption in many studies exploring innovation champions is the understanding that individuals predisposed with specific individual characteristics spontaneously emerge as innovation champions, if the right conditions prevail in a company (Howell & Higgins, 1990; Markham, 2000). Research has recommended that managers screen employees for certain characteristics (Howell, 2005) in order to identify and develop innovation champions and increase a company's chances to exploit its innovation potential fully. Even executive champions have predominantly been assumed to perform the role of champions, in addition to their assigned roles, if they see the need arising (Maidique, 1980; Markham et al., 2010). Ideas surrounding the formal assignment of champions to their role to establish championing institutionally within the structure of a company have been scarce and restrained to untested suggestions for managers (e.g., Kawakami et al., 2015).

For the digital age, this myth is refuted, as empirical evidence and the findings of this dissertation suggest. Research has confirmed the success of a formal assignment of championing activities to executive champions, such as CDOs, who have been described as promoting digital innovation as part of their role (Singh & Hess, 2017; Tumbas et al., 2017). To do so, they build a digital logic of action within companies to establish the legitimacy of their claim on innovation and their sphere of influence (Tumbas et al., 2018). As Paper V and VI show, this strategy is also perceived as positive on the stock market, if the CDO is appointed to a new position or has a strong power profile or other fitting individual characteristics.

Paper IX further shows that it is possible to design and use digital technology in order to identify innovation champions. Thus, some employees performing championing behavior stand out when using the digital platform (e.g., high number and quality of submitted ideas and comments), making it possible to identify them directly. Consequently, they can be formally assigned to a formalized role, where they have more freedom and autonomy to champion innovation. This can enable companies to promote the realization of innovation projects and enhance their innovation success, as Paper IX shows, without relying on innovation champions' spontaneous emergence.

Myth 4: Innovation champions promote innovation throughout the different stages of the development process. Existing definitions and conceptualizations of innovation champions emphasize the continuous efforts that innovation champions exert to drive an innovation

project forward from the initial idea until final implementation. This can be exemplified by the following characterization of innovation champions, who: "bring product innovation attempts to successful fruition" (Howell & Shea, 2001, p.15) or "take an inordinate interest in seeing that a particular process or product is fully developed and marketed" (Rosenau et al., 1996, p.519). Thus, innovation champions have traditionally been assumed to drive an innovation project throughout its different stages until the end of the development process.

Yet, with the increasing blurring of the process and outcome of digital innovation (Bailey et al., 2012; Nambisan et al., 2017) and the distributed nature of championing (see Myth 2), this understanding of innovation champion is outdated. Thus, a product or service may be constantly developed further in the digital age. Moreover, championing is co-performed in cycles where the behaviors performed by different champions are interrelated and reinforce each other (Negoita et al., 2022; van Laere & Aggestam, 2016). Thus, individuals may only drive a digital service or product for parts of the development process before turning to other tasks (van Laere & Aggestam, 2016). This process may be overseen by an executive champion, such as the CDO, who orchestrates efforts in driving the innovation project forward (Singh & Hess, 2017).

For this to be possible for digital innovation, some individuals involved in championing an innovation project, especially executive champions, need to closely follow the development paths of innovation beyond the creation of a marketable product and including further development cycles. Moreover, individuals involved in championing must have a very deep understanding of the overall technological trends to discover a promising technological idea in a world characterized by the ever-changing nature of digital technology. This is also echoed in the findings of Paper VI on the positive perception of expert power derived from interdisciplinary knowledge, which combines expertise in business and IT, for CDO appointments to new positions. Additionally, to enable successful championing under these circumstances, companies may use digital technology to balance central control and individual autonomy in digital innovation agency and rethink their strategy or structure to find an equilibrium between stability and flexibility in digital innovation processes, as outlined in Paper VIII and IX. Accordingly, innovation champions may form an integral part when companies address the existing paradoxes of digital innovation.

Overall, this dissertation, specifically this section, contributes to theory by unraveling four commonly believed myths about innovation champions. Based on the guidelines by Hassan et al. (2022), this dissertation moves towards a new theoretical conceptualization of innovation champions in the digital age. Moreover, it also contributes to our knowledge of digital innovation by outlining how the paradoxes arising from digital innovation's generative nature can be addressed and managed.

5.2 Contributions to Practice

This dissertation makes a number of contributions to practice. In the following, Section 5.2.1 outlines the most important practical implications of this dissertation that enable practitioners to identify innovation champions in companies. Subsequently, Section 5.2.2 synthesizes the most significant managerial implications for enabling innovation champions in companies.

5.2.1 Identifying Innovation Champions in Companies in the Digital Age

Prior research on innovation emphasizes champions' vital role in innovation projects' success (e.g., Howell, 2005; Howell & Shea, 2001). Accordingly, companies need to be able to identify the individuals performing championing behavior. The comprehensive characterization of

innovation champions, as provided in **Paper I, II, and VII**, enables practitioners to identify filter out potential innovation champions based on their traits, skills, and knowledge. Moreover, practitioners can gain a deeper understanding of the influence innovation champions exert on a company and their social network through their different behaviors and strategies, as synthesized in **Paper I, IV, and VII**, which may further facilitate the identification of individuals championing innovation.

Additionally, the findings in **Paper V and VI** can guide practitioners wishing to establish the position of the CDO in the future. The results provide insights into individual characteristics, such as prior experience and education, under which the appointment of a CDO is positively or negatively associated with the company's short-term financial performance. For appointments to new positions, especially CDOs with an interdisciplinary educational background are perceived as positive on the stock market. For succession appointments, CDOs with structural power derived from resource endowment, prestige power derived from an elite education, or expert power derived from company-external knowledge can lead to a positive reaction on the stock market. Since the effects on the stock market following CDO appointments are sizable, the identification of an appointee with a fitting profile can have a significant positive impact on a company's equity value. Thus, Paper V and VI provide practitioners with insights into how companies can identify and appoint a suitable CDO to send a credible signal of strategic change.

Among employees the identification of innovation champions can be enabled using a digital platform. The design principles derived in **Paper IX** can guide the development and implementation of such a digital intrapreneurship platform. If a digital intrapreneurship platform to promote employee-driven innovation is designed and implemented following the five derived design principles, the platform can be a tool for recognizing innovation champions based on their activities on the platform. Besides the design principles, Paper IX presents specific features implemented in the case organization and can serve as a blueprint for other companies wishing to promote employee-driven innovation and to identify innovation champions.

5.2.2 Enabling Innovation Champions in Companies in the Digital Age

After identifying innovation champions, companies can enhance their innovation potential by creating the right organizational conditions to enable champions to promote innovation (Jenssen & Jørgensen, 2004; Markham, 2000). The synthesis of extant literature on organizational and network characteristics enabling innovation champions derived in **Paper II, III, IV, and VII** provide in-depth guidance for practitioners aiming to promote innovation champions in their company. The shift toward a more distributed innovation agency in the digital age makes it necessary for companies to take a different perspective when designing measures to support innovation actors, compared to the past when innovation actors predominantly acted as lone wolfs. **Paper III and IV** specifically synthesize knowledge on organizational characteristics enabling innovation champions in the digital age. Practitioners can use these findings to transform the conditions prevailing in their company to facilitate innovation actors' efforts to drive innovation projects.

Moreover, the findings of **Paper V and VI** suggest which organizational conditions companies should create to maximize the positive impact appointed CDOs can achieve, as perceived by investors. Thus, **Paper V** suggests companies should refrain from appointing a CDO, if a CIO already exists in the company and conflicts surrounding the spheres of influence could arise. Companies should preferable appoint CDOs to specialist, instead of a generalist role. When conferring a high degree of structural power, companies should ensure an alignment between

CDOs' role profile and reporting line, as **Paper VI** suggests, to maximize short-term financial performance. Furthermore, Paper VI also shows that the endowment of CDOs with a team or business unit can enhance the value created on the stock market through a CDO appointment. Accordingly, the findings of Paper V and VI can guide companies aiming to appoint a CDO in the future.

Additionally, **Paper VIII and IX** provide practitioners with insights on how they can enhance employee-driven innovation and encourage championing behavior in their company by designing a work model that combines a digital platform with innovation time. **Paper VIII** shows how a work model enhancing championing behavior among employees should be implemented in order to create value in a company. Thus, the paper's findings on drivers and barriers to implementing a work model can make companies aware of possible inhibiting factors in their organizational environment and enable them to adjust their existing organizational setting before establishing a work model. In doing so, the companies cannot only exploit the innovative potential of some of their employees, but create an organizational climate favoring innovation overall, as Paper VIII suggests.

Paper IX goes one step further by proposing design principles that can guide companies in designing a platform to promote and facilitate employees' contribution to innovation. The digital intrapreneurship platform can serve as a tool for companies to support the development and championing of innovative ideas among employees, as Paper IX demonstrates. Companies can use the five design principles, combined with specific design features described in Paper IX, as a design blueprint that can be adjusted to align with organizational characteristics, such as structure, culture, industry, etc. Since the derived design principles were meticulously evaluated and the practical benefit of the design features was demonstrated, Paper IX provides design suggestions with a proven track record of creating value in companies. Companies can implement their own instantiations of the digital intrapreneurship platform to encourage the creation and championing of innovation among their employees.

The five design principles derived in Paper IX offer detailed insights to managers when implementing a digital intrapreneurship platform, as outlined in the following. The first design principle emphasizes the importance of transparency throughout the idea management process, while giving users the control over their contributed ideas and data. Thus, the terms of participation, organizational process, and goals of employee-driven innovation are necessary information to disclose in order to motivate employees to participate in innovation. At the same time, employees also need to feel in control over their intellectual property. The second design principle stresses the significance of real-time capture and alert function while giving users the option to adjust these functions. On the one hand, the features allow employees to stay informed about the progress of their own ideas and newly submitted ideas. On the other hand, they also allows managers to monitor the idea submission and development process closely and to intervene if necessary.

The third design principle highlights the significance of creating a sense of community for employee-driven innovation. Employees should be able to collaborate across hierarchical and departmental boundaries to fully exploit their potential as a community. At the same time, employees must feel secure in contributing, developing, and promoting ideas. The availability of a pre-review option on the digital intrapreneurship platform, which gives idea contributors control over their idea, enables the fulfillment of this requirement. The fourth design principle emphasizes creating an innovation culture with targeted management actions. Management needs to support the creation of an innovation culture, for instance, by articulating a vision

and by allocating time and resources for employee-driven innovation. Finally, the fifth design principle stresses the significance of identifying intrapreneurial employees and assigning them to formalized roles to fully exploit the innovation potential of these individuals and enhance a company's innovativeness in the long term.

6 Limitations

As outlined in the previous section, this dissertation offers several contributions to theory and practice. At the same time, it also exhibits some limitations due to the chosen research methods. While each paper outlines the specific limitations, overarching limitations are discussed below.

First, the literature reviews conducted in **Paper I to IV, VII and X** are focused only on peer-reviewed research articles and applied selection criteria regarding the publication outlets and the time period covered in the literature search. This approach ensures a high quality of the reviewed research articles. At the same time, it cannot be completely ruled out that some relevant research articles may not be covered n the literature reviews. Additionally, the literature reviews relied on a keyword approach when searching for relevant research articles using familiar terms on innovation champions. The keyword approach benefits from high transparency and replicability of the research process. Yet, it is possible that research articles using diverging terminology may have been missed. To limit the scope of both problems, all reviews conducted a forward and backward search, as suggested by Webster and Watson (2002).

Second, the quantitative studies in this dissertation are conducted within specific settings, which may limit the generalizability of the derived results. **Paper V, VI, and XI** use secondary data of companies listed on the largest stock markets. While the large samples allow a generalization of the findings to this group of companies, one has to be careful when transferring the results to other types of companies (i.e., small and medium-sized companies, privately owned companies). Additionally, the data samples are restricted to certain regions. Even though **Paper V and VI** use global sample of companies announcing CDO appointment, companies in English-speaking countries may be represented disproportionately, since only English press releases were taken into account. **Paper XI** uses an almost complete sample of companies listed on the largest US stock markets. In doing so, the study ensures the high validity of the implications drawn for US, stock-listed companies. At the same time, the applicability of the results to other world regions should be treated with caution, since stock market pricing in the US has been shown to exhibit distinct characteristics compared to international stock markets (e.g., Jacobs & Müller, 2020).

Third, the results of **Paper V and VI** need to be interpreted in light of the general limitations of the methodological approach of the event study. The press releases may not be issued by a publicly traded company when appointing a CDO, if the CDO is not a member of the TMT and no obligations exist to report such an appointment. Thus, press releases may predominantly be issued by companies with numerous TMT positions, where the appointment of the CDO as part of the TMT entails reporting obligations, and large companies with sizable communication departments, who will use the voluntary disclosure of CDO appointments as an opportunity to promote the company. Accordingly, the results may be especially valid for large companies, but to a lesser extent for small stock-listed companies.

Moreover, investors may not have been surprised by companies announcing the appointment of the CDO, if the appointment was expected beforehand and the press releases did not carry new information. If such cases exist, the measured reactions and effects may underestimate the

true impact of CDO appointments on the stock market. In line with other event studies (e.g., Chatterjee et al., 2001), we account for possible information leaks by measuring abnormal returns one or two days before the event to limit this issue. Furthermore, the event study method limits the time horizon for which conclusions about executive champions' effect on organizational performance can be drawn. While the event study offers the advantage of enabling the isolation of a causal link between the announcement of CDO appointments and stock market returns, the results can only indicate investors' perception of companies' future prospects. Long-term effects would need to be explored and confirmed using alternative methods.

Fourth, the two qualitative studies in this dissertation, **Paper VIII and IX**, are conducted in one German public company. Thus, the results of the two studies consider the specific innovation processes, stakeholders, and organizational setting in this company. Moreover, in the ADR project in **Paper IX**, the design knowledge was derived with the involvement of practitioners, who are particularly familiar with the specific setting and context of the case organization. Considering this, the findings cannot be easily generalized to a larger population following the notion of statistical generalizability (Lee & Baskerville, 2003).

However, the empirical observations can be generalized to theoretical statements, such as the design principles in Paper IX (Lee & Baskerville, 2003). The grounding of our results in the STS theory, as well as the integration of design insights from extant research, allow for an analytical generalization of our findings to the general class of problems of digital platforms facilitating intrapreneurship and championing (Paper IX) or drivers and barriers of work models for employee-driven innovation (Paper VIII) (Sein et al., 2011; Yin, 2018). Accordingly, the validity of insights drawn from one case study is generally accepted in the literature (Sarker et al., 2013). Nevertheless, the applicability of the findings to specific empirical settings needs to be demonstrated in future research (Lee & Baskerville, 2003)

Finally, the ADR study in **Paper IX** provides a proof-of-value, since the value of the developed artifact could be demonstrated in a real-world setting (Nunamaker & Briggs, 2011). Yet, Paper IX falls short of establishing the user acceptance of the designed artifact as an implemented platform available to all employees in everyday use, also called proof-of-use (Nunamaker & Briggs, 2011). During the research project, resistance to a company-wide rollout emerged among the work council of the studied company, resulting in the project's termination after the artifact's final evaluation, as reported in Paper IX. As a result, the interaction of the digital intrapreneurship platform with the organizational characteristics and all employees could not be tested. Moreover, whether such a platform can sustain employee-driven innovation among employees over a couple of months or years remains an open question for future research.

7 Future Research Opportunities

The dissertation's findings offer several intriguing avenues for future research. In the following, six research opportunities and perspectives are discussed that may further enhance our understanding of innovation champions and their context.

Studying the long-term impact of champions on organizational performance. The event study method used in this dissertation to study the effect of executive champions of digital innovation on financial performance (Paper V and VI) offers the benefit of enabling the isolation and estimation of a causal effect. At the same time, the method limits the conclusions from the analysis to the short-term impact on the stock market, a general shortcoming of event

studies (e.g., Yang et al., 2012). To evaluate the value created by executive champions of digital innovation, an analysis of the long-term effect of executive champions on organizational or financial performance offers a future avenue for research.

As employed by Bose and Leung (2019), a calendar-time portfolio analysis, could measure the long-term impact of CDO appointments on financial performance. Alternatively, a panel regression analysis comparing the long-term performance of Tobin's Q or sales in companies with and without an executive champion of digital innovation, while controlling for organizational characteristics that change over time, forms one possibility to extend our understanding of the significance of executive innovation champions for digital innovation success. Besides traditional indicators of financial or organizational performance, considering differences in companies' engagement with digital innovation (Paper XI) could offer important insights into the effectiveness of executive champions, such as CDOs. A starting point for future analysis of CDOs' long-term impact could be the unfolding theory of CDOs' impact (see Figure 3).

Theorizing and studying the role of and conflicts between executive innovation champions. This dissertation (Paper V) and extant research indicate a conflict between CDO and CIO (e.g., Haffke et al., 2016; Tumbas et al., 2017). Yet, we still know little about the relationship between CDO and CIO and the possibilities to mitigate conflicts between both executives. At the same time, the role of the CIO is still characterized by high ambiguity, since the CIO has undergone multiple changes of responsibility and role over the last decades (Chun & Mooney, 2009). Thus, the CIO has evolved from an IT manager responsible for providing cost-effective IT infrastructure (Ives & Olson, 1981) to a C-level executive focused on strategic IT planning (Feeny et al., 1992) to a visionary driving IT strategy and using IT for innovation (Chun & Mooney, 2009; Leidner et al., 2010). Thus, exploring the role of the CIO in depth and understanding role conflicts between CDO and CIO offers an exciting avenue for future research.

Especially, role theory could offer a reference point for understanding the role of the CIO and theorizing about the role conflict between CIO and CDO. Role theory describes individuals' behavior as a function of the functional, relational and structural characteristics of the organization they are a part of (Biddle, 1979; Katz & Kahn, 1978). It builds on the assumption that individuals hold a social position within an organization and form expectations about their and other people's behavior (Biddle, 1986). Biddle (1986) points to three different perspectives on how roles emerge as a result of interactions between people: (1) functionalism, (2) social interactionism, and (3) structuralism. The functionalism perspective argues that roles are predetermined by the functional title assigned to an individual and then remain constant. The interactionism perspective, in contrast, proposes that roles are dynamically determined by social interactions between actors and evolve depending on the relationship characteristics (e.g., trust, identity). Finally, structuralism posits that roles are a function of the structural and power differentials between individuals.

In leadership research, role theory has been used to build a comprehensive understanding of the determinants of leadership roles and their evolution (e.g., Biddle, 1979; Georgakakis et al., 2022). The literature review synthesizing knowledge regarding IS executives in Paper VII could form a starting point to theorize about the complex nature of CIOs' roles relying on role theory. After categorizing the findings about CIOs' role assumptions and interactions in extant research (Georgakakis et al., 2022), a theoretical model describing CIOs' strategic leadership based on the three perspectives offered by role theory could be derived. Additionally, an explorative research study could provide insights into the interaction between CIOs and CDOs and analyze possible conflicts between both roles. While using the role theory as a guiding lens, the study's exploratory

nature would allow for novel concepts to emerge to theorize about the relationship between CDO and CIO and role theory in the context of IS executives.

Theorizing about rapidly changing groups of actors championing innovation. The dissertation identifies an increasing shift toward championing in groups and communities (Paper III and IV) and outlines how digital technology can enable communities of employees to champion innovation (Paper VIII and IX). At the same time, not much is known about how groups of champions coordinate cognitively when co-championing. Transactive memory theory forms one promising theory to study this question in the future. The theory describes the cognitive division of labor in processing information from different knowledge areas, frequently used in groups of individuals working together (Wegner, 1987). Transactive memory is an individual's awareness of information and knowledge held by others, with the goal of sharing responsibility for the information (Brandon & Hollingshead, 2004). It has been linked to higher team performance (Lewis & Herndon, 2011).

Yoo et al. (2012) point to the importance of 'task-expertise-people units' for digital innovation. This term coined by Brandon and Hollingshead (2004) to extend the concept of transactive memory, which links knowledge and individuals, to include the task. To understand the underlying process of co-championing in groups, tracing the formation of task-expertise-people units could offer a promising research opportunity. Transactive memory theory has been widely applied to understand (virtual) teams (Heavey & Simsek, 2014; Lewis & Herndon, 2011). Yet, our understanding of the formation of task-expertise-people units for complex, dynamic tasks, such as the development and championing of digital innovation is still limited (Choi et al., 2010; Lewis & Herndon, 2011).

Theorizing and studying the emergence of complex systems of digital innovation. Increasing complexity and heterogeneity characterize digital innovation. For instance, Internet of Things (IoT) systems, which are increasingly used to improve the flexibility and resource-efficiency of industrial production processes, are complex systems of interconnected digital technologies and physical assets linked to information systems and relying on data generated from different devices throughout distinct steps in the manufacturing processes (Sisinni et al., 2018). Such systems are characterized by a high interdependency between subsystems and the organizational environment and require the involvement of different, highly knowledgeable stakeholders to develop such types of digital innovation (Nambisan et al., 2017). Yet, the development of such complex systems and the interaction between the stakeholders have received little attention from a socio-technical viewpoint (Baiyere et al., 2020). Moreover, the study of innovation champions in the digital age has predominantly been refined to less complex software projects (e.g., Negoita et al., 2022; van Laere & Aggestam, 2016). Yet, studying and theorizing about the development of IoT projects in companies could open up ways to understand the complex interaction between actors in such projects. Moreover, the analysis of championing in such complex systems of digital innovation could help to further refine the concept of innovation champions in the digital age.

One possible theoretical lens could be the literature on digital options, a theoretical concept adopted in IS research (Sambamurthy et al., 2003; Sandberg et al., 2014), but which originated from the concept of financial options. Digital options characterize "a set of IT-enabled capabilities in the form of digitized enterprise work processes and knowledge systems" (Sambamurthy et al., 2003, p.247). Digital options evolve throughout four stages: (1) an available option, a possible IT investment whose potential still needs to be recognized; (2) an actionable option, a desirable and feasible IT investment; and (3) the realized option (Sandberg et al., 2014). Extant research has

relied on the theory of digital options to extend our understanding of the evolution of one IT system (Sandberg et al., 2014) or digital platform (Rolland et al., 2018). The theory of digital options offers a promising opportunity to explore the development and evolution of complex systems, such as industrial IoT systems and the dependencies between stakeholders (e.g., champions) associated with such complex development projects.

Using the theoretical lens of digital options, it is possible to trace the system's evolution together with the distinct decisions made over the development process. Consequently, this avenue for future research offers the possibility to understand the dependencies in development decisions over time. Innovation champions may drive the implementation of the overall complex system or specific subsystems by promoting the realization of one specific digital option. Studying such complex innovation, therefore, offers novel insights into championing in the digital age. It may even provide the possibility to understand dangerous championing behavior, where champions promote digital options enthusiastically, even though their championing can hurt the overall company, since it may set the company on the wrong technological development path by opening up a limited set of newly available options for the future. The topic of dangerous championing behavior has been pointed out in the literature, but has scarcely been explored in depth (Gogan et al., 2020) and offers a promising research topic to better understand the boundaries of champions' positive impact on companies.

Developing a design theory for digital intrapreneurship platforms. The digital intrapreneurship platform designed in Paper IX contriubtes to design knowledge by providing a theory-ingrained and empirically tested artifact and design principles derived during the development and evaluation of the artifact. Yet, it falls short of offering a complete design theory, since the independence between the derived artifact and the specific research context cannot be fully ensured. Accordingly, developing a design theory for the class of digital intrapreneurship platforms provides a promising avenue for future research.

Gregor and Jones (2007) outline eight elements of an IS design theory: (1) purpose and scope, (2) constructs, (3) principle of form and function, (4) artifact mutability, (5) testable propositions, (6) justificatory knowledge, (7) principles of implementation and (8) expository instantiations. Paper IX specifies the purpose and constructs and outlines the principles of form and function in the form of a blueprint for the platform. Moreover, through the ingraining of theory, the artifact benefits from justification knowledge. Additionally, design principles and expository instantiations of the artifact are provided. Yet, a design theory would also need to specify anticipated changes in the state of the artifact and provide testable propositions. To further develop the derived design knowledge into a design theory, an avenue for research would be to instantiate and evaluate the platform in other organizational settings in order to derive more generalizable knowledge about digital intrapreneurship platforms.

Studying blurring industrial boundaries. Paper XI identifies systematic differences in companies' characteristics and financial performance depending on their level of engagement with digital innovation. Thus, companies intensively pursuing digital innovation systematically differ from companies not engaging in digital innovation, a characteristic not explainable by industry affiliation. Prior research has theoretically argued that the boundaries between industries are blurring (Seo, 2017; Yoo et al., 2012), as digital innovation requires integrating and recombining heterogeneous knowledge from different areas and industries. This has also been associated with industry convergence, which describes the increasing competition between companies from different industries who rely on similar digital technologies (Seo, 2017; Yoo et al., 2010). The

measure of digital innovation derived in Paper XI provides the opportunity to validate this argument. Using cluster analysis, future research could analyze the composition and development of clusters based on companies' engagement with digital innovation over time. Consequently, our understanding of the nature of digital innovation and its effect on the competitive landscape could be deepened.

8 Conclusion

The main objective of this dissertation is to understand what makes innovation champions successful in the digital age. Based on a multi-method approach, this dissertation offers novel insights with significant implications for research and practice regarding innovation champions, i.e., individuals who vigorously drive innovation projects inside organizations. By tracing the evolution of innovation champions based on a synthesis of extant research, this dissertation shows that a multitude of individual and organizational characteristics need to interact if innovation champions are to succeed in their efforts to promote innovation projects. In the digital age, champions increasingly promote innovation as part of a diverse group of actors working together to drive innovation projects forward, based on a division of labor. This requires changes in the champions' organizational environment, for instance, regarding collaboration and coordination mechanisms among these groups of actors.

Studying the link between CDOs, as executive champions, and stock market performance, the dissertation also identifies significant differences in the stock market reaction to CIO and CDO appointments. Moreover, it demonstrates the substantial role of managerial power in investors' perception of the CDO. The analysis shows that the overall positive stock market reaction for CDO appointments to new positions can reverse for CDOs with weak power profiles. Based on these findings and the discovery of the significant impact of CDOs' prestige and expert power - in addition to the generally studied structural power - an unfolding CDO impact theory is proposed. Additionally, this dissertation demonstrates that the success of employees championing innovation can be significantly enhanced by using a work model, which combines a digital platform with innovation time. The derived design knowledge in the form of design principles can guide the development and implementation of a digital intrapreneurship platform, which fosters championing activities among employees and enables the identification of innovation champions.

This dissertation also contributes to a deeper understanding of the context in which innovation champions operate in the digital age by extending our knowledge of the nature of digital innovation and digital transformation. It identifies significant differences in companies' characteristics and financial performance based on their engagement with digital innovation. This finding then enables identifying a new asset pricing factor. Finally, the dissertation unravels myths about innovation champions based on empirical and theoretical findings and moves towards a novel conceptualization of innovation champions. Consequently, even half a century after the significant role of innovation champions was first discovered, the statement by Schön (1963, p.84) still holds true: *"the new idea either finds a champion or dies"*.

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Part I

Understanding the Evolution of Innovation Champions

Note: Elements of Part I were in a previous version part of my master's thesis thesis titled "An Organizational Perspective on Innovation Champions – A Systematic Literature Analysis" submitted to the faculty of Computer Science and Mathematics at the Goethe University Frankfurt(Main) to obtain the degree Master of Science in Information Systems.

Paper I

Innovation Champions' Activities and Influences in Organizations
A Literature Review

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Paper II

Enabling Innovation Champions in Organizations
Results of a Systematic Literature Analysis

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Paper III

The Changing Roles of Innovation Actors and Organizational Antecedents in the Digital Age

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Paper IV

Understanding the Role of Innovation Actors' Social Network in the Digital Age

A Literature Review and Avenues for Future Research

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Understanding the Role of Innovation Actors' Social Network in the Digital Age

A Literature Review and Avenues for Future Research

Abstract

Digital technologies have radically altered the nature of innovation and its development process. Digital innovations are characterized by a higher heterogeneity of knowledge and a reliance on a network of diverse actors. Despite the important role of innovation actors' social network in enabling interactions and collaboration in digital innovation processes, extant research lacks a synthesis of knowledge on innovation actors' social network in the digital age. We provide a comprehensive, multi-disciplinary literature review on innovation actors' social network and its interplay with digital technology. This analysis is based on a theoretical framework derived from social network theory and extant knowledge about different innovation actors, such as innovation champions, boundary spanners, and sponsors.

Our analysis gives detailed insights into the flows and structure of innovation actors' social network. We find that innovation actors perform a variety of activities to create and use their ties in the social network. Digital technology has predominantly led to gradual changes in innovation actors' activities by functioning as an enabler or catalyst. Concerning literature on the characteristics of innovation actors' network, we identify extensive knowledge about the structural and relational embeddedness conducive to innovation success. We find more fundamental changes in the agency of digital innovation, as innovation actors form innovation communities and perform activities collectively. Building on digital innovation literature, we identify promising avenues for future research. Overall, our literature review contributes to the understanding of the role of innovation actors' social network in digital innovation processes and provides a research agenda for future research.

Keywords: literature review, innovation actors, digital innovation, digital technology, social network

1 Introduction

Digital technologies have become ubiquitous and increasingly permeate all aspects of value creation in organizations (Iansiti & Lakhani, 2014; Yoo et al., 2012). Accordingly, organizations increasingly digitalized their business operations, spanning from the machine operations in manufacturing, which increasingly rely on the Internet of Things, to managerial processes, driven by the necessity and opportunity to create new value propositions and business models (Iansiti & Lakhani, 2014; Vial, 2019). The distinct characteristics of digital technology, such as reprogrammability, homogenization of data, and the self-referential nature of digital technology (Yoo et al., 2010), have also radically altered the nature of product and service innovations as well as their development processes by giving rise to a new layered modular architecture that offers unprecedented opportunities for innovation through recombination (Yoo et al., 2012; Yoo et al., 2010). Accordingly, Yoo et al. (2010, p.725) define digital innovation "as the carrying out of new combinations of digital and physical components to produce novel products".

For carrying out these new combinations of components, i.e., digital innovation, networks exhibit a significant role in enabling knowledge sharing and creation (Lyytinen et al., 2016). Digital innovation encompass profoundly heterogeneous knowledge (e.g., Yoo et al., 2012), as they

require unrelated bodies of knowledge from different industries (Barrett et al., 2012; Nambisan et al., 2017) and thus rely on networks of diverse actors. Such actors have been known in innovation management literature for more than half a century. Thus, Schön (1963, p.84) pointed out the importance of innovation actors by stating that: "[…] the emergence of a champion is required. […] the new idea either finds a champion or dies." Since then innovation researchers have emphasized the particular importance of actors who promote innovation (e.g., Jenssen & Jørgensen, 2004), such as innovation champions who may "bring [the] ideas to life" or boundary spanners who "acquire, translate, and distribute external information within the organization" (Tushman & Nadler, 1986, p.89). Due to the inclusion of diverse actors across unit and firm boundaries, digital innovation is characterized by less predefined and more distributed agency (Dhanaraj & Parkhe, 2006; Fichman et al., 2014; Sawhney & Prandelli, 2000). Moreover, the pervasiveness of digital technology has not only influenced the outcome of innovation processes but also offered the opportunity of novel ways for social interactions, knowledge exchange, and orchestrating collaborations among actors driving innovation processes (Nambisan et al., 2017). Overall, these distinct characteristics of digital innovation have raised the question about the appropriateness of existing innovation theories (Barrett et al., 2015; Benner & Tushman, 2015; Nambisan et al., 2017), including extant literature's considerations on the role of actors and networks.

Despite this important role of innovation actors' social network in enabling interactions and collaboration in digital innovation, our knowledge on innovation actors in the digital age is scattered. Studies, especially literature reviews, assessing innovation actors' social networks and taking the novel perspectives that the pervasiveness of digital technology and the increasing importance of digital innovation offer into account are scarce, even though the actors' interactions are important for explaining digital innovation (Hanseth & Lyytinen, 2010; Lyytinen et al., 2016; Nambisan et al., 2017). The perspective in existing literature reviews is primarily limited to digital innovation without considering innovation actors (e.g., Kohli & Melville, 2018) or takes an individual perspective on innovation actors without considering their social network (Jenssen & Jørgensen, 2004; Renken & Heeks, 2019). Moreover, information systems literature has predominantly focused on the specific notion of champions who drive the adoption and diffusion of novel information systems (Lin et al., 2014; Renken & Heeks, 2019), but less so on the role of innovation actors in actively promoting innovation processes. Accordingly, recent literature has called for an in-depth analysis on the role of innovation actors' social network in the digital innovation process by acknowledging "the complexity of how their actions interact with, and can be shaped by, wider change processes" (Holmström, 2018, p.108). As a step towards improving the knowledge gap in the literature, we examine the following research questions: *What characterizes innovation actors' social network in the digital age?*

We address our research question by conducting a systematic review of the literature on innovation actors in the IS field and three related disciplines in the social sciences: business administration, human resources and organization, and innovation management. Based on existing literature we define innovation actors as individuals or groups who promote an innovation vigorously through the various stages of the development process against potential resistance (e.g., Howell & Shea, 2001; van Laere & Aggestam, 2016). To explore innovation actors comprehensively we do not focus on one specific type of innovation actor, such as the innovation champion, but include different types of innovation actors. Thus, considering our definition of innovation actors, we refer to literature on, for instance, innovation champions (Jenssen & Jørgensen, 2004; Jervis, 1975; Schön, 1963), sponsors (Markham et al., 2010; Tushman & Nadler, 1986), and knowledge brokers (Burt, 2004; Kirkels & Duysters, 2010) to gain a broad and multifaceted understanding of innovation actors' social network and interplay with digital technology. We develop and use

a framework based on social network theory (Borgatti & Foster, 2003; Granovetter, 1985) to analyze innovation actors' social network. This framework enables us to explore and analyze the interplay of innovation actors with digital technology from an organizational perspective.

We identify different activities that innovation actors use to create and use social ties to promote innovation, such as scanning the environment or sharing information and knowledge. We find that digital technology increasingly enables innovation actors to use their network more effectively and by relying on other stakeholders, such as external users. Moreover, we outline strategies innovation actors only use in digital innovation processes in order to align their actions with the distinct nature of digital technology. Additionally, we find that extant literature characterizes the structural and relational network characteristics that enable innovation actors' success. We observe a shift in the role of teams of innovation actors in driving innovation as a collective. Building on our analysis, we point to avenues for future research, especially with respect to digital innovation and the facet of digital technology as an enabler of innovation processes.

2 Theoretical Background and Framework

In this section, we introduce the theoretical framework that we use in our literature analysis on innovation actors in Sections 4 and 5 as a guiding lens. We base this framework on social network theory and extant literature on innovation actors. First, discuss extant research on social networks and introduce terminology. Next, we outline different innovation actors by first focusing on the innovation champion literature and then discuss other innovation actors, whose social network characteristics and interplay with digital technology we analyze in sections 4 and 5. Based on these two strands of literature we then introduce our research framework that delivers a multi-faceted view of the innovation actors from an organizational perspective.

2.1 Innovation and Social Networks

According to the Schumpeterian perspective, innovation is the recombination of existing resources in new ways (Schumpeter, 1934). This perspective has been echoed in information systems research, as digital innovation has been defined as "carrying out new combinations of digital and physical components to produce novel products" (Yoo, 2010, p.725). Thus, innovation arises from the formation of new connections between actors and the exchange of ideas, resources, and knowledge among actors (e.g., Ahuja, 2000; Kogut & Zander, 1992; Wang et al., 2014) enabling the combination of digital and physical components. Consequently, researchers have emphasized the essential role of social networks in the creation of innovation (Burt, 2004; Obstfeld, 2005; Tsai, 2001). Social networks enable information exchange, interaction, and collaborations of actors (Granovetter, 1985). In order to build a comprehensive understanding of the role of innovation actors' social network in driving organizational innovation in the digital age, we use social network theory as our theoretical lens.

Based on social network theory (Borgatti & Foster, 2003; Borgatti & Halgin, 2011), the social network is composed of multiple nodes, each node representing one actor. Depending on the level of analysis, actors can be individuals, teams, or organizations. Ties between actors indicate the social relationships among the actors. Ties can either be dichotomous, characterizing the presence or absence of a social relationship, or denote a valuation, depicting the strength of a relationship. Additionally, ties can be directed (e.g. characterized by the direction that resources

flow from actor to actor) or undirected (i.e. characterizing the close relationship between two actors). The pattern of ties in a network results in a network structure, wherein each actor occupies a specific position. Moreover, actors can be part of different networks, whereby the characteristics of the relationships will vary between a collaboration network and a friendship network.

Granovetter (1985) introduces the concept of embeddedness by describing how economic exchanges are embedded in social networks. This concept allows him to move beyond explaining economic exchanges as interactions between purely rational actors. Embedded ties in the social network, characterized by long-term cooperation, have been shown to provide a performance benefit up to a certain point, as actors can benefit from information exchange, learning, and risk-sharing from closer relationships with other actors (Uzzi, 1996). Figure 1 depicts a snapshot of an organization's social network. Network analysis allows us to learn about the network structure and the position of specific actors. Innovation actor A and innovation actor B, represented by two nodes, form a social tie. Actor A takes a rather central position in the social network, as she possesses six other social ties, while Actor B only forms a tie with one other actor.

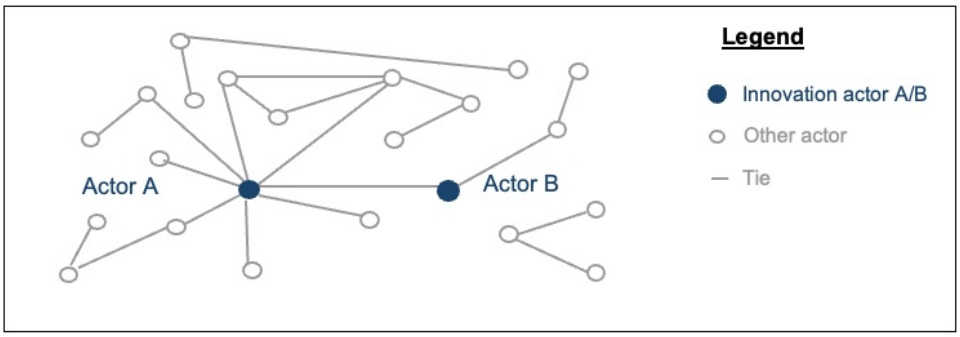


Figure 1: Innovation actors' social network

2.2 Innovation Champions in Innovation Management and Information Systems Literature

The innovation management literature identified more than half a century ago that the success of innovation projects is predominantly driven by some individuals who play a key role in the development process by promoting the innovation project inside the organization. First and foremost, the innovation champion was identified as such an important innovation actor by Schön (1963). He described the champion as "a man willing to put himself on the line for an idea of doubtful success", who uses "any and every means of informal sales and pressure in order to succeed" and might "display persistence and courage of heroic quality" (Schön, 1963, p.84). In subsequent literature, a variety of definitions for the phenomena of innovation champions emerged. Jenssen and Jørgensen (2004, p.65) attempted to synthesize these in their literature review by defining the innovation champion as "an individual that is willing to take risks by enthusiastically promoting the development and/or implementation of an innovation inside a corporation through a resource acquisition process without regard to the resources currently controlled".

There exists a consensus in the literature that an innovation champion promotes an innovation vigorously through the various stages of the development process against potential resistance by taking risks (Howell & Shea, 2001; Jervis, 1975; Maidique, 1980). Nevertheless, other aspects are less clear-cut and vary across literature, such as the question of whether champions can be found

in managerial positions (e.g., Hameed et al., 2012) or whether champions promote their own idea or the innovation idea of others (e.g., Tushman & Nadler, 1986). Similarly, innovation champions' actions employ to support innovation projects studied in extant research fluctuate sharply across research articles extending beyond the resource acquisition process described in the definition by Jenssen and Jørgensen (2004). Innovation champions have been described to select promising creative ideas and sell them to other actors in the organization (e.g., Howell & Boies, 2004; Roure, 2001), motivate their innovation team by building up confidence in their capabilities and the innovation's success (Howell & Shea, 2006), inspire others with their vision (e.g., Mascitelli, 2000), transfer information and knowledge (e.g., Reid & de Brentani, 2004; Schweisfurth & Herstatt, 2016), control resources (Jenssen & Jørgensen, 2004), connect with others and build networks (e.g., Greene et al., 1999; Howell & Shea, 2001), bring different actors in the organization together (e.g., Mansfeld et al., 2010; Shane et al., 1995), and gain management support (Howell & Shea, 2001).

Even though the conceptualization of the innovation champion as described above has also been used in the information systems field before (van Laere & Aggestam, 2016), the champion concept has been predominantly applied differently in Information Systems. Thus, the term champion has frequently been used to label individuals who proactively promote the use of novel information technology (Bassellier et al., 2003; Beath, 1991). For instance, IT championing has been defined as "being proactive in promoting and supporting innovative IT utilization" (Lin et al., 2014, p.2) or " a social process that seeks to promote and "sell" a particular technology" (Negoita et al., 2012, p.6). This conceptualization led existing studies in the field to mostly focus on the adoption and diffusion of information technology. In our literature review, we take a different, innovation-oriented perspective by focusing on innovation champions' activities throughout the different stages of the development process of innovation.

2.3 Other Types of Innovation Actors Promoting Innovation

Besides the innovation champion extant literature identifies several other important actors of innovation. As outlined above, extant literature attributes a wide variety of behaviors to innovation champions in their pursuit to promote innovation. Some of these behaviors have traditionally been assigned to other innovation actors, such as knowledge brokers, boundary spanners, and sponsors. For instance, while sponsors perform one particular type of championing, distinctively characterized through their managerial position, the innovation champion combines a wider variety of behaviors that also include but are not limited to sponsoring. Consequently, we see championing on a spectrum of activities, where individuals may enact only parts of the activities that encompass the spectrum. We use the concept of the innovation actors, defined as individuals who promote an innovation vigorously through the various stages of the development process against potential resistance by taking risks (Howell & Shea, 2001; Jervis, 1975; Maidique, 1980) to account for all innovation actors that overlap with the concept of the innovation champion. In the following paragraphs, we outline and discuss other types of innovation actors, besides the innovation champion, that fit our definition in an innovation context.

The sponsor, or executive champions, supports innovation projects by relying on his formal power as an executive by offering advice, providing resources, and conferring legitimacy (Hayton & Kelley, 2006; Tushman & Nadler, 1986). Additionally, extant literature identifies several other roles that drive the success of innovation projects, such as the boundary spanner, knowledge broker, or corporate entrepreneur. Even though these concepts expand far beyond championing and the innovation context, we consider them in our review of literature on innovation actors, if they fit within the scope of our definition of innovation actors.

Two other actors, the knowledge broker and boundary spanner, also play an important role in the innovation context[1]. A boundary spanner is characterized as an actor who is well-connected inside and outside the organization and responsible for the interaction of the organization with its environment or internally of one group with another group (Ebers & Maurer, 2014; Tushman & Scanlan, 1981). If boundary spanners interact with contacts that are non-redundant to the organization or group, they occupy a structural hole (Burt, 1992). The innovation literature focuses especially on two subsets of boundary-spanning activities, ambassador and scout activities (Ancona & Caldwell, 1990; Wong & Boh, 2014). Ambassador activities entail lobbying for financial and personal resources as well as obtaining management support and legitimacy for a project. Scout activities encompass external scanning for new ideas and information about competencies as well as technologies. Boundary spanners connect different actors. In contrast, the knowledge broker's task is to transfer knowledge between actors who are not linked to each other themselves (Belso-Martínez et al., 2015; Burt, 2004; Kirkels & Duysters, 2010). Especially critical to the success of innovation projects are gatekeepers, individuals who gather knowledge externally, filter valuable information, and share it within the organization (Howell & Higgins, 1990; Kandemir & Acur, 2012).

Alongside these concepts, corporate entrepreneurs play a critical role in driving innovation in organizations. Corporate entrepreneurship, defined as the process of creating a new venture or initiating renewal or innovation within an existing organization (Sharma et al., 1999) exceeds the scope of the phenomena under investigation as a whole. Nevertheless, successful corporate entrepreneurship is based on four competencies: inventing, brokering, championing, and sponsoring (Hayton & Kelley, 2006). Thus, even though a corporate entrepreneur covers a wider variety of competencies, components and partly exceeds the scope of innovation actors by also including the inventor, a role not considered in this analysis, the concept also exhibits a high overlap with the innovation champion.

2.4 Development of the Research Framework

In the following, we rely on the term innovation actor to refer to individuals who promote innovation vigorously through the various stages of the development process against resistance by taking risks (Howell & Shea, 2001; Jervis, 1975; Maidique, 1980). Our motivation to use this terminology is twofold. First, innovation actor serves as an umbrella term to integrate other important actors of innovation who also actively promote the innovation development process, such as boundary spanners and knowledge brokers. In our analysis and discussion, we use specific terminology whenever possible but otherwise refer to the more generic term 'innovation actor'. Second, we want to delineate our research focus on champions of innovation in the digital age from IT championing, a concept widely used in extant IS literature to refer to actively promoting the use of information technology.

Innovation actors (IA) derive their influence from the social network, which they use to exchange information, knowledge, and resources (e.g., Chakrabarti & Hauschildt, 1989; Maidique, 1980). Thus, innovation actors often inspire others with their visions (Howell & Higgins, 1990), transfer information and knowledge (Chakrabarti & Hauschildt, 1989; Howell & Shea, 2006), and connect with others and build networks (Howell & Shea, 2006; Kessler & Chakrabarti, 1999). By exploring the distinct elements of the social network in depth we can reveal the breadth of interacting

[1]We are aware that the concepts of knowledge broker and boundary expand far beyond championing and the innovation context, as they compromise separate strands of literature. Accordingly, we only include knowledge brokers and boundary spanners that fit within our definition of innovation actors in our literature review.

factors in the innovation process for innovation actors. We build an understanding of how innovation actors use their social network to promote innovation in the digital age and which network characteristics enable the success of digital innovation projects.

One approach to study actors' social network is to differentiate between different levels of analysis, such as actors' dyadic relationships, ego-network, and network level. This approach is especially suited to explore an innovation actor's network based on primary or secondary data. However, the distinction between these different levels cannot always be sharply separated, as different levels may interact and blur within and across studies (Borgatti & Foster, 2003). Therefore, we take a different approach in studying innovation actors' network by building a research framework based on Borgatti and Foster (2003)'s typology of network research and extended to the context of innovation actors. Table 1 depicts the research framework that we will derive in the following.

	Actor-network: Activities of innovation actors in social network	**Network-actor**: innovation actors' network characteristics
Topology of innovation actors' social network (structuralist)	Creating social ties	Structural embeddedness
Flows in innovation actors' social network (connectionist)	Using social ties	Relational embeddedness

Table 1: Development of research framework based on social network theory

Social network theory has a rich and diverse tradition in the social sciences. According to the typology of network research by Borgatti and Foster (2003), research on the consequences of networks can be distinguished based on the explanatory goals and explanatory mechanisms. With respect to the former dimension, we take a social capital perspective, which aims to explain the relationship between variations in individual or organizational performance and social network ties' characteristics (Burt, 1992; Granovetter, 1985). Thus, we focus on how certain characteristics in innovation actors' network have performance implications, as they may enable or hinder actors to succeed when promoting innovation projects.

Concerning explanatory mechanisms, Borgatti and Foster (2003) differentiate between two strands in the literature: structuralist and connectionist perspective, which treat ties in a social network differently. The *structuralist* stream of literature explores the topology of a social network by focusing on the structure and configuration of social ties in a network (Burt, 1992; Coleman, 1990). Literature in this stream builds on the idea that two actors with similar central positions in a social network or certain structures of their ego-network will achieve similar results (Burt et al., 2000; Powell et al., 1996). Yet, the optimal structure of actors' network has been debated. Coleman (1990) argues that a dense ego-network will give actors an advantage, since they may be able to better coordinate with other actors. In contrast, Burt (1992) outlines the benefits of structural holes, that allow an actor to exploit the lack of a social connection between its alters by acting as a broker. In contrast to this perspective, the *connectionist* research stream has focused on analyzing the flow of information and knowledge in the network and by considering the quality of ties (Lin, 2001). This literature relates the success of an actor to his or her access to resources and knowledge and resources available through his or her existing social ties. Granovetter (1992) reflects this distinction by differentiating between structural and relational embeddedness when studying networks. Following this differentiation between structuralist and connectionist

research stream, we analyze two dimensions of innovation actors' social network: *topology* and *flows* when reviewing the literature.

Moreover, we take two perspectives in our analysis of innovation actors' interaction with the social network by considering the direction of causality (Borgatti & Foster, 2003). The *actor-network* perspective allows us to study innovation actors' activities in their network to understand how actors use their network to drive innovation and how their actions affect and shape their social network. Additionally, a *network-actor* perspective enables us to identify how the characteristics of innovation actors' social network shape their actions and promote or hinders the success of innovation projects. As a result of these two dimensions (topology vs. flows) and two perspectives (actor-network vs. network-actor), our research framework on innovation actors forms a two-by-two matrix, as depicted in Table 1.

When we take an actor-network perspective to study innovation actors' activities in the social network, we consider both the topology of innovation actors' and flows of innovation actors' social network by analyzing the activities that innovation actors take to create and use social ties in their network. Thus, innovation actors perform different activities in the network to *create social ties* and change the structure of their social network. For instance, innovation actors build novel relationships and coalitions to advance innovation (e.g., Hayton & Kelley, 2006; Walter et al., 2011). At the same time, innovation actors *use* their *social ties*, for instance, to gather access to or obtain resources from the social network (e.g., Howell & Shea, 2001, 2006).

Analyzing the extant literature on innovation actors from a network-actor perspective, we also differentiate between the two dimensions of topology and flow of innovation actors' network. innovation actors' embeddedness in the social network can be characterized by the network position and the quantity and quality of their relationships with other actors (e.g., Dougherty & Bowman, 1995; Jenssen & Nybakk, 2009). Following Granovetter (1992) we differentiate between structural and relational embeddedness to consider an IA's network structure and quality of relationships that enable innovation actors to promote innovation. Structural embeddedness is defined as "the impersonal configuration of linkages between people or units" (Nahapiet & Ghoshal, 1998, p.244) and describes the structure of actors' network ties. Relational embeddedness is defined as the "personal relationships people have developed with each other through a history of interactions" (Nahapiet & Ghoshal, 1998, p.244) and describes the character of ties in the social network.

3 Methodology

We conduct a systematic literature analysis based on Webster and Watson (2002). Rowe (2014) emphasized the importance of outlining the goal of the literature review in his classification of literature reviews. We aim to provide a comprehensive review, which synthesizes knowledge on innovation actors' social network and explores the facet that digital technologies and information technologies plays in these networks, identifies important knowledge gaps in the extant literature and proposes future research directions. The underlying three-step methodological approach: search process, selection of relevant articles, and coding and review of literature was adopted from Rowe (2014) and is described below.

3.1 Search Process

A comprehensive literature review covers all relevant literature on the topic, including related fields of research (Webster & Watson, 2002). As prior literature has found innovation actors to play an important role in the context of digital innovation and information technology (e.g., Benbya & Leidner, 2018; van Laere & Aggestam, 2016), high-quality journals[2] in the field of IS were included in the search. Furthermore, since this paper aims to analyze innovation actors by taking a social network perspective, leading journals in organizational science, human resources, and business administration were searched. Moreover, important contributions from the field of innovation management also needed to be incorporated in a comprehensive literature review, since the scientific concept of innovation actors originates there (Schön, 1963). Overall, this systematic literature review synthesizes innovation-related literature from four disciplines: (1) business administration, (2) human resources and organizational science, (3) information systems as well as (4) technology, innovation and entrepreneurship.

To ensure that the literature base consisted of publication outlets that were recognized as leading in the field, the journal selection was determined using the German VHB-JOURQUAL3 (Hennig-Thurau et al., 2015) in connection with the Journal Quality List (Harzing, 2018), a meta-ranking of 12 different journal ratings, such as the Financial Times 50 Ranking 2016 or the. For the German VHB-JOURQUAL3 ranking, the selection of publication outlets was restricted to 136 peer-reviewed journals, ranked in the categories A+, A or B and published in English. We used the Journal Quality List to account for international comparability. Thus, we evaluated our earlier selection and added eleven additional journals, which had received a high ranking in the rankings of the Journal Quality List. The final selection of publication outlets included 146 high-quality, peer-reviewed journals, which include among other high-quality outlets the AIS Senior Scholars' Basket of 8.

To cover all 146 selected journals, we built a meta-search engine based on different databases, such as EBSCO Business Source Complete, to conduct our search. We utilized an elaborate search string, consisting of three components: innovation, championing, and level of analysis. These three keyword components were derived from our aim of analyzing innovation actors in the digital age by taking a social network perspective. As illustrated in Table 2 each component was represented by specific search terms. With respect to the concept of innovation actors, a preceding literature search had shown that a multitude of terms was used with overlapping definitions to label innovation actors (see Section 2.3). In order to limit prepossessions on the research topic, we chose keywords for our literature search based on the underlying broad characterization of innovation actors and not based on the familiar roles or role labels. Thus, we consolidated a range of activities, such as brokering, championing, and boundary spanning, which characterize innovation actors (cf. keyword components 'actors'). This approach ensured a systematic search of existing research without making strict assumptions about innovation actors' labeling. Moreover, to account for our social network perspective, we included search terms that delineated the level of analysis, namely network or organization.

Based on these components and with the goal of covering our research topic comprehensively, we formed a search string depicting keywords as well related terms and corresponding adjectives and verbs (cf. Table 2). The resulting Boolean expression also specified that these search terms had to be present either in the title, abstract or subject terms. The literature search was limited to the timeframe 1995 to 2020. In 1995 the American National Science Foundation lifted the last

[2] We decided to focus on peer-reviewed journal publications only to ensure a high quality and maturity of the reviewed research.

Keyword components	Search terms
Innovation	("innovat*")
Actors	("champion*" OR "promot*" OR "boundary spann*" OR "broke*" OR "sponsor*" OR "corporate entrepreneur*")
Level of analysis	("organi?ation*" OR "network*")

Table 2: Search string

restrictions on the commercial use of the Internet (Harris & Gerich, 1996). We, therefore, chose this year as a starting point to honor the high importance of innovation actors in the digital age (Kawakami et al., 2015; van Laere & Aggestam, 2016) and to be able to identify the facets of digital technology in innovation actors' endeavor to promote innovation.

3.2 Selection of Relevant Papers

The search process resulted in 1428 potentially relevant papers. Two independent researchers manually reviewed the material based on four inclusion criteria: (1) provide a research methodology; (2) focus on innovation actors who promote innovation vigorously through the various stages of the development process against resistance by taking risks (Howell & Shea, 2001; Jervis, 1975; Maidique, 1980) (3) instantiate innovation actors as individuals or a group; (4) take a social network-related perspective on innovation actors. With respect to our focus on innovation actors, we included all papers that focused on actors that fit our definition. Thus, we also included other innovation, who took over roles as knowledge brokers (e.g., De Brentani & Reid, 2012), boundary spanners (e.g., Ebers & Maurer, 2014), and sponsors (e.g., Kawakami et al., 2015; Watts & Henderson, 2006) and who fit our definition of innovation actors by playing a key role in the innovation process. At the same time, we excluded actors, who were labeled as champions did not fit our definition, since they, for instance, focused on champions promoting the implementation of information technology (e.g., Bassellier et al., 2003; Beath, 1991).

In the first filtering step, the title, the abstract, and the keywords of each publication were manually reviewed based on the four inclusion criteria by two independent researchers. Articles where no decision could be reached remained in the sample of potentially relevant articles for the next filtering step. As illustrated in Figure 2, after this first filtering step 252 articles remained. In the second filtering step, the remaining research literature was screened again, whereby the same filtering criteria were applied to the complete text of the research article. After the second filtering step, 53 relevant research articles remained. The filtering was conducted by at least two authors, who resolved disagreement through repeated discussions. In order to exhaust all literature sources on innovation actors, a backward and forward search based on the procedure of Webster and Watson (2002) was conducted. After the backward search (i.e., reviewing older literature cited in the articles yielded from the keyword search) and forward search (i.e., reviewing additional sources that have cited the paper), 8 articles that yielded additional fruitful insights were selected. Overall, 61 papers across 30 high-tier journals were identified as relevant to our research topic, as illustrated in Table 6 in Appendix A.

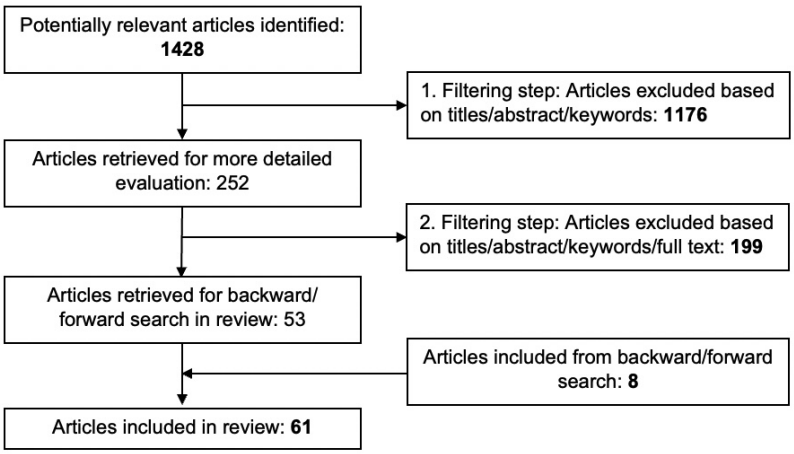


Figure 2: Filtering process

3.3 Coding and Review of Literature

Subsequently, all 61 research articles were categorized based on the research framework derived in Section 2.4 and by using the coding scheme shown in Table 10 in Appendix C. While the coding scheme had been developed by all authors, the coding was conducted by two authors. The two authors carefully and highlighted all findings and insights relevant to the review and its research focus on innovation actors' social network. They then extracted these findings as excerpts and included them in the coding table. With respect to innovation actors' social network, the authors first extracted excerpts that described innovation actors' activities or characteristics in their social network for each article. The authors coded these deductively by following the research framework as described in Section 2.4. Thus, innovation actors' activities were coded into the two categories: *creating social ties* and *using social ties*. Similarly, the two authors coded characteristics of innovation actors' social network into the two dimensions *structural embeddedness* and *relational embeddedness*. They then examined the research articles on a more granular level within each category and inductively derived emerging themes. Especially, with respect to innovation champions' activities, the authors derived subcategories by iteratively deriving categories, such as *scanning the environment* or *boundary spanning* (see analysis in Section 4.1).

For instance, Benbya and Leidner (2018) describe champions, who "act as connectors, suggesting contacts to ensure that ideas reach the people with appropriate and deployable capabilities and assets to develop them" (p. 150). These activities were coded into the category *creating social ties*, as this research article considered innovation champions from an actor-network perspective, and innovation champions conduct *boundary spanning* activities to connect different actors with the goal of enabling the creation of new ties. In contrast, Ebers and Maurer (2014) take a network-actor perspective by testing hypotheses, such as "Organizational boundary spanners' external relational embeddedness is positively associated with their organization's potential absorptive capacity" (p. 321). Accordingly, we coded the research article's findings for this hypothesis as *relational embeddedness*.

To understand the facets of information and digital technology in innovation actors' social network, the two authors conducting the coding also extracted excerpts revolving around these themes from the research article. These were then categorized depending on whether they described the context of the study (e.g. actors of digital innovation or IT innovation) or whether digital technology-enabled innovation actors to promote innovation (e.g., digital collaboration

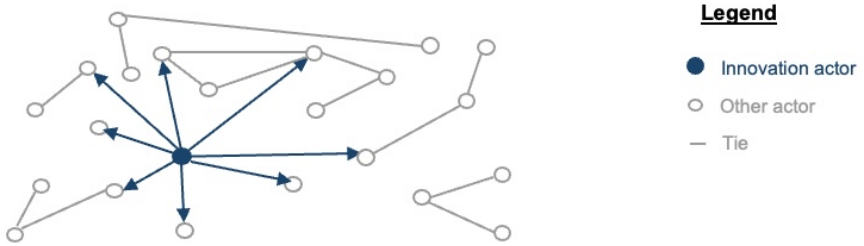
platform used by innovation actors) and with respect to the specific technology covered. Coding discrepancies were resolved in discussions among the two coding authors. In our analysis, we consider all types of studies, but point out if some results have mainly been put forward in conceptual papers and no empirical evidence has been provided.

4 Results of the Literature Review

In the following, we analyze innovation actors using the research framework that we developed based on social network theory and extant research on innovation actors (see Section 2.4). First, we analyze the literature by taking an actor-network perspective and exploring the activities of innovation actors in their social network. Second, we identify characteristics of innovation actors' social network and their implications for innovation actors' performance.

4.1 Actor – Network: Activities of Innovation Actors in Social Network

We approach the actor-network perspective from two perspectives. First, we analyze the activities that innovation actors use to change the topology of their social networks, activities related to *creating social ties.* Second, we identify innovation actors' activities aimed at altering the flows in their social network, activities related to *using social ties.* In the following, we outline the most frequently mentioned tie-related activities of innovation actors. Table 3 provides an overview of innovation actors' activities in the social network.



Creating social ties:	**Using social ties:**
▸ Forming social networks and coalitions ▸ Boundary spanning ▸ Scanning the environment	▸ Getting access to or obtaining resources ▸ Gaining the support of other people ▸ Brokering ▸ Sharing information and knowledge ▸ Drawing attention to the importance of information technology or digital technology

Table 3: Innovation actors' activities in the social network

4.1.1 Creating Social Ties

Existing literature has identified several activities, which innovation actors use to create social network ties. Innovation actors *form social networks and coalitions* to advance their innovation projects (e.g., Howell & Shea, 2006; Walter et al., 2011). One strand of the literature describes that innovation actors work on expanding their social network within the organization (e.g., Greene et al., 1999). Another strand of the literature emphasizes the role of relationship building with external actors outside the organization (e.g., Howell & Shea, 2001). In the literature on IT

innovation and digital innovation, especially the role of forming social ties with customers or users is emphasized (Heng et al., 1999; Tumbas et al., 2017).

Additionally, the importance of innovation actors' personal network characterized by strong social relationships has often been highlighted (Greene et al., 1999). However, innovation actors also heavily rely on weak ties with acquaintances they build and maintain by staying in contact with former colleagues and participating in volunteer services (Heng et al., 1999). Innovation actors purposefully join forces with other actors to form coalitions favoring the development of innovation (e.g., Anthony, 2012; Mansfeld et al., 2010). In doing so, innovation actors choose to reinforce or strengthen their connections with people in their network who possess complementary knowledge in order to form a team of innovation actors together with them (van Laere & Aggestam, 2016). Moreover, innovation actors also encourage others to expand their social network (Harryson, 2008; Watts & Henderson, 2006). This emphasis on building relationships can also be institutionalized if innovation actors promote organizational measures, such as job rotations (Watts & Henderson, 2006). Innovation actors are often described as *boundary spanning*, another activity related to creating social network ties (e.g., Benbya & Leidner, 2018; Obstfeld, 2005). Innovation actors span boundaries by interacting across internal organizational boundaries or between the organization and its external environment (e.g., De Brentani & Reid, 2012; Glaser et al., 2015). Concerning digitalization efforts, innovation actors' boundary spanning occurs between existing functional units to create a new digital initiative, a strategy named 'bridging' (Tumbas et al., 2018).

Research papers reveal that innovation actors *scan the environment* when performing boundary-spanning activities (e.g., Howell & Shea, 2001, 2006; Papadakis et al., 1998; Somech & Drach-Zahavy, 2013). Innovation actors draw attention to new ideas or trends that they notice while closely observing their surroundings and gathering information (Howell & Shea, 2001; Reid & de Brentani, 2004). Moreover, innovation actors actively sense the organizational environment to detect new digital technology and react to newly arising opportunities for digital innovation (Tumbas et al., 2017). Searching and scanning the environment may take place by attending conferences and informal meetings with external acquaintances (Ramirez & Dickenson, 2010). Innovation actors then channel the acquired information to others within the organization (Kandemir & Acur, 2012).

4.1.2 Using Social Ties

With respect to *using* existing social network ties, extant literature points to innovation actors' activities to *get access to or obtain resources* from their social network – information, knowledge, financial or technical resources (e.g., Greene et al., 1999; Howell & Shea, 2001; Markham et al., 2010). While some studies only provide limited details on the identification and procurement of resources (Howell & Shea, 2006; Mansfeld et al., 2010), others describe how innovation actors rely on social ties and the influence in their social network to gain access to resources (Hayton & Kelley, 2006; Jenssen & Jørgensen, 2004). In their effort to acquire resources, innovation actors do not shy away from conflict (Jenssen & Jørgensen, 2004) or using informal channels (Watts & Henderson, 2006). While the focus frequently lies on acquiring financial or human resources, some innovation actors focus on obtaining information technology as an enabler of innovation processes (Kawakami et al., 2015). Moreover, innovation actors may use their hierarchical influence to procure resources that enable them to build the capabilities necessary for digital innovation (Tumbas et al., 2017).

Extant literature also emphasizes the significant importance of non-material resources by outlining innovation actors' activities of *gaining the support*, motivation, and enthusiasm *of other people* (e.g., Hemmert et al., 2014; Howell & Boies, 2004; Janssen, 2005). Innovation champions build support within the organization by involving the right people (Howell et al., 2005), sharing their vision (e.g., Bammens, 2016; Fichter, 2009), and building trust by demonstrating honesty, openness, competence, benevolence, and reliability (du Chatenier et al., 2010). Innovation actors have been found to use a variety of influence tactics (Shim & Lee, 2001), but prefer the use of cooperative influence tactics over confrontational tactics when campaigning for support (Markham, 1998). Studying innovation actors of digital innovation, Arvidsson and Mønsted (2018) identify four specific tactics that innovation actors use to convince the organization of innovation and gain support: concealing, sequencing, anchoring, and propagating. For instance, the tactic of propagating, where innovation actors "marshal many applications synergistically" (p. 379), aligns innovation actors' efforts to gain support with the malleability of digital technology and the open-ended nature of innovation processes (Arvidsson & Mønsted, 2018).

Building support for innovation projects occurs on three levels: other employees, the management level, and other innovation actors. For instance, in innovation processes that are enabled by online user innovation communities, innovation actors help to achieve the support of users and encourage new users to join the community (Yan et al., 2018). Especially, the critical nature of obtaining management support has been shown to increase the likelihood that innovation development processes are successful (Abetti, 1997; Howell & Shea, 2001). Management support may not only result in resource allocation or formal support but also prevent interference in ongoing innovation projects (Badguerahanian & Abetti, 1995). Innovation actors frequently use a rationally motivated influence tactic by presenting the selling points of a new idea or innovation based on financial calculations in order to influence and obtain critical management support and resources (e.g., Jenssen & Jørgensen, 2004). In building support for an innovation project among senior management, innovation actors need to pay close attention to changes in the opinions of the management board by using formal and informal channels (van Laere & Aggestam, 2016). Innovation actors then match the perceptions of different stakeholders and adjust the strategy to convince management accordingly (van Laere & Aggestam, 2016). When building support among other innovation actors and inquiring about opportunities for collaboration, innovation actors use a combination of informal and formal channels. This tactic helps innovation actors to ensure that, on the one hand, other innovation actors are genuinely interested in the teamwork and, on the other hand, secures the possibility of a formal appointment (van Laere & Aggestam, 2016).

Not all innovation actors rely on management support to drive an innovation project. In contrast, some innovation actors purposefully forego formal approval and support by relying on bootlegging behavior (Globocnik & Salomo, 2015). In such cases, innovation actors' personal network still plays an important role in finding collaborators, but formal channels are bypassed completely. Innovation actors then use their own resources or rely on their personal ties to mobilize resources (Halme et al., 2012) .

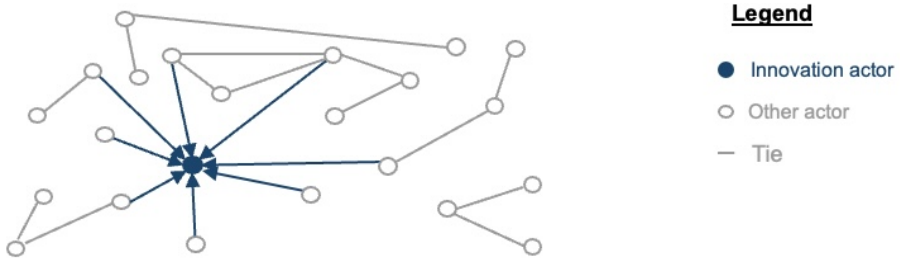
Further, innovation actors *share information and knowledge across* organizational and external boundaries (du Chatenier et al., 2010; Howell & Shea, 2001; Pollok et al., 2019). Thereby innovation actors exchange, share and merge their organization's knowledge stock with new information and knowledge from the environment across organizational boundaries (e.g., Reid & de Brentani, 2004). If innovation actors enable information sharing and knowledge exchange occurs between actors who are not linked to each other. innovation actors engage in *brokering* (e.g., Mascitelli, 2000; Obstfeld, 2005).

One specific position for sharing information and knowledge is occupied by lead users or leaders of user communities, who sometimes also take the role of innovation actors who promote innovation from outside the organization. They use their own knowledge and knowledge exchanged with others, such as problems detected and novel ideas for product improvement, to advance products or services (Colazo, 2014; Mahr & Lievens, 2012). To act as innovation actors, lead users rely on digital platforms and technologies to interact with the organization as well as communicate and collaborate with other users (Mahr & Lievens, 2012; Parmentier & Mangematin, 2014).

Innovation actors also *draw attention to the importance of information technology* (e.g., Kawakami et al., 2015; Peppard et al., 2011). They use information technology to support operational processes and typically raise the profile of information technology within the organization by 'selling' the idea that technology can potentially be leveraged to generate significant business value (Peppard et al., 2011). Thus, innovation actors encourage the use of information technology to improve the efficiency of innovation processes (Kawakami et al., 2015).

4.2 Network – Actor: Innovation Actors' Network Characteristics

We now turn to the network-actor perspective and analyze the literature on innovation actors with respect to two dimensions. First, we analyze innovation actors' *structural embeddedness* in order to understand the structure of innovation actors' social ties. Second, we consider innovation actors' *relational embeddedness* by studying the quality and character of innovation actors' ties in the social network. Table 4 outlines our results.



Structural embeddedness:	**Relational embeddedness:**
▸ High density in internal network, low density in external network ▸ Central network position ▸ High breadth of external network with other organizations ▸ Structural embeddedness in network with other innovation actors	▸ High level of trust in internal and external networks ▸ Character of network: informal vs. formal network; friendship vs. communication network ▸ Necessity to manage relational embeddedness throughout phases of innovation process ▸ Relational embeddedness with other innovation actors: division of labor vs. collective activities ▸ Changing relational embeddedness among innovation actors

Table 4: Innovation actors' network characteristics

4.2.1 Structural Embeddedness

In our analysis on innovation actors' structural embeddedness and its effect on innovation actors' performance, we found several contradictory findings. Researchers disagree on the role

of innovation actors' sparseness in social networks, the antonym of network density, depending on the nature of the networks. In an internal network, Obstfeld (2005) finds empirical evidence that the absence of structural holes, a characteristic of dense networks, is positively related to innovation actors' effectiveness, as actors benefit from collaboration and information exchange with other actors. In contrast, conceptual and empirical evidence exists suggesting the reverse relationship. Thus, De Brentani and Reid (2012) propose in their theoretical model that a higher level of non-redundant ties, which lead boundary spanners to occupy a structural hole, promotes boundary spanners' effectiveness. This relationship is supported by Ramirez and Dickenson (2010), who present empirical evidence that innovation actors' activities in sparse, distant external networks are beneficial for innovation actors' effectiveness as these networks might offer non-redundant information.

For innovation actors' position in the social network, extant literature suggests the benefits of innovation actors' central position in their social network. Thus, Wong and Boh (2014) find that performing ambassador activities while occupying a central network position is positively associated with innovation champions' effectiveness. This is congruent with the theoretical proposition by De Brentani and Reid (2012) that a more central position of the boundary spanner in the network promotes his or her effectiveness by enabling a faster and higher-quality information flow from outside the organization.

Turning to another dimension of structural embeddedness, De Brentani and Reid (2012) also suggest that a higher breadth of the external network enhances boundary spanners' effectiveness. This theoretical reasoning is echoed and confirmed by other research articles with empirical evidence. Thus, the existence of external relations with other firms' R&D units is positively associated with sponsors' effectiveness (Jenssen & Nybakk, 2009).

When analyzing innovation actors' network structure, another characteristic stands out in the literature: the existence of social ties among innovation actors, or the lack thereof. Innovation actors might promote innovations on their own as lone wolfs or lead a group of other actors in the organization in their pursuit (e.g., Greene et al., 1999; Howell et al., 2005). Alternatively, different innovation actors may form teams or communities to drive innovation success (e.g., Edmondson et al., 2001; van Laere & Aggestam, 2016).

The network among innovation actors can take different forms. Innovation actors may form small teams (Gupta et al., 2006; Hauschildt & Kirchmann, 2001) or entire 'innovation communities' among innovation actors across units or organizations in open innovation settings (Fichter, 2009). Literature is divided on whether complementarity in network structure among innovation actors is beneficial and may depend on the setting. While Klerkx and Aarts (2013) find that innovation champions may complement each other's network by relying on different network composition, Glaser et al. (2015) present evidence that boundary spanning is especially effective, if managers on different hierarchical levels share large parts of their networks.

4.2.2 Relational Embeddedness

For IAs' *relational embeddedness* in the social network, extant literature emphasizes the importance of trust in social relationships for innovation actors, as reputation and credibility may be prerequisites for the allocation of resources and the legitimacy of championing activities (Greene et al., 1999). Ebers and Maurer (2014) provide evidence to suggest that the level of innovation actors' relational embeddedness, measured as the level of trust in the ties in their internal and external social networks, is positively related to their effectiveness.

Moreover, with respect to the character of networks, both formal and informal channels play a significant role in innovation actors' endeavors to champion innovation (Howell & Boies, 2004) and form strategic linkages (Dougherty & Bowman, 1995). However, especially in interactions among multiple champions, the extent to which informal channels are used by champions needs to be carefully managed in order to avoid problems of coordination and function ambiguity among different innovation actors (Klerkx & Aarts, 2013). Further evidence of the importance of a network's character is provided in extant literature. Thus, a positive association between the communication network frequency, which measures the communication frequency in the network on the team level, and the likelihood of individuals to champion innovation exists (Donati et al., 2016). However, when considering friendship network density, a measure that expresses to what degree a network is based on friendship, no direct relationship with individuals' tendency to promote innovation projects can be found (Donati et al., 2016).

Especially studies focused on the IT industry find evidence that innovation actors may need to actively manage their relational embeddedness, as different types of social ties play a significant role throughout the different phases of the innovation process (Harryson, 2008). During the exploration phase, the corporate entrepreneur uses his large social network to establish a high number of weak ties to generate novel ideas. With the transition to the exploitation phase, the corporate entrepreneur gradually shifted his focus to a small number of strong ties to commercialize the innovation (Harryson, 2008). The importance of network management is echoed by literature that studies innovation actors at the intersection between organization and user community and emphasizes the need to balance opening up innovation processes to the community against the possibility of losing control (Parmentier & Mangematin, 2014).

Concerning innovation actors' social ties to other innovation actors (see Table 4), we observe differences in the relational embeddedness of these innovation actors. On the one hand, innovation actors may form teams of innovation actors to implement a division of labor (Gupta et al., 2006; Hauschildt & Kirchmann, 2001). For instance, Hauschildt and Kirchmann (2001) describe how innovation actors form dyads or troika with inventors. While the sponsor will drive promote innovation using hierarchical power, the boundary spanner will mediate between different stakeholders in the organization. This division of labor among two, or even three types of innovation actors, is positively associated with higher effectiveness in driving innovation and financial success (Hauschildt & Kirchmann, 2001). The division of labor may also take place with respect to the different types of networks, especially in networks of e-commerce organizations (Gupta et al., 2006). While one champion, called the network champion, builds relationships between organizations and acquires resources and knowledge in the B2B network, another champion focus on promoting innovation inside one organization.

On the other hand, the group of champions may also promote innovation as a team where championing forms a "complex performance of contextually dependent collective social interaction, varying over time" (van Laere & Aggestam, 2016, p.47). Multiple champions interact and perform championing behaviors, either by performing one championing behavior together or by combining multiple championing behaviors into a meaningful whole. In the studied information systems development project, the champions also switched roles over time, as they learned from their collective experience in championing innovation (van Laere & Aggestam, 2016).

Groups and communities of innovation actors may not remain fixed in their composition throughout the innovation process (Klerkx & Aarts, 2013; van Laere & Aggestam, 2016). Instead, the arrival and departure of innovation actors over time leads to a constant evaluation of the relationships among innovation actors and renegotiation of the division of labor and roles

(Klerkx & Aarts, 2013). The community of innovation actors then evolves into a multi-layered entity, where a primary innovation community composed of a core group of innovation actors orchestrates the innovation process and secondary innovation communities that exist only temporarily to promote certain aspects in the innovation process (Klerkx & Aarts, 2013).

5 Discussion

Digital technology has radically altered the nature of innovation and its development process (Lee & Berente, 2012; Yoo et al., 2010). Knowledge sharing and information exchange among innovation actors play a significant role for digital innovation, since these innovations are characterized by a recombination of highly heterogeneous and diverse knowledge (Nambisan et al., 2017; Yoo et al., 2012). To explore the role of innovation actors' social network in enabling knowledge sharing and collaboration, we conducted a comprehensive literature review and synthesized extant knowledge on innovation actors. We reviewed a broad literature base including four disciplines and starting with the onset of the digital era with the beginning of the internet's commercial use. In our analysis, we relied on a framework that we derived based on social network theory and extant research on innovation actors. In the following, we outline our most important findings and offer a research agenda for future research on innovation actors' social network.

5.1 State of Research on Innovation Actors' Social Network

Regarding innovation actors' activities in the social network, we find that innovation actors use three techniques to create novel social ties: (1) forming coalitions, (2) boundary spanning, and (3) scanning the environment. Subsequently, innovation actors then rely on these social ties to perform different activities that can be subsumed under five themes (1) getting access to resources, (2) gaining the support of other people, (3) brokering, (4) sharing information, and (5) drawing attention to the importance of information technology. Moreover, we also identified that digital technology acts as an enabler in this actor-network perspective by facilitating knowledge exchange or information sharing. In our analysis from an actors-network perspective we found digital technology to predominantly enable innovation actors' efforts to promote innovation. We discuss this finding and its implications for future research further in Section 5.2.1.

We also identified four main themes in the literature by taking a network-actor perspective and synthesizing research on innovation actors' structural embeddedness. When analyzing innovation actors' structural embeddedness, we find that, first, the density of innovation actors' network differs depending on the nature of the network (internal vs. external network). Second, innovation actors profit from a central position in their social network, as it enables faster information and knowledge exchange. Third, innovation actors benefit from a high breadth of their social ties with other organizations. Fourth, recent research shows that innovation actors increasingly build networks to champion innovation projects.

Moreover, studying literature on innovation actors' relational embeddedness in their network, we can identify five themes. First, innovation actors' social ties are characterized by a high level of trust. Second, extant literature explores the character of innovation actors' network and shows how the relational embeddedness diverges depending on the character and purpose of a network. Third, we found that literature identifies an increasing necessity for innovation actors to manage their relational embeddedness throughout the innovation process. Fourth, we identified the important role of social ties between innovation actors themselves. Here we

observe a shift in the literature that not only explores the roles of teams of innovation actors but also points to collective activities and co-championing among innovation actors. This shift is related to the fifth theme we identified in the literature, the changing composition of innovation actors in these innovation communities. The development towards innovation communities, where innovation actors collectively promote innovation projects, constitutes a radical shift in the analyzed literature and predominantly characterizes digital innovation. We discuss this development in depth and outline the research agenda for the future in Section 5.2.2.

5.2 Avenues for Future Research

In the following, we will discuss the implications of our analysis of innovation actors' social network for future research, especially by focusing on digital innovation and digital technology. First, we adopt an actor-network perspective in which digital technology is an enabler of innovation processes. Here we observe gradual shifts in innovation actors' activities in the social network. Second, we discuss innovation actors' role in digital innovation, where the novel nature of the innovation process has led to significant changes for innovation actors. After discussing changes and shifts we observed in the literature, we derive a research agenda for future research.

5.2.1 Actor - Network: Digital Technology as an Enabler

We found information and digital technology to trigger changes in degrees with respect to innovation actors' activities and characteristics. Thus, when analyzing innovation actors' activities, for instance, in Section 4.1 we find slight changes in how innovation actors create and use their social ties. Innovation actors may use their influence to obtain resources in order to build the capabilities necessary for digital innovation (Tumbas et al., 2017). Additionally, innovation actors may draw attention to the potential of using information technology (e.g., Kawakami et al., 2015; Peppard et al., 2011).

In our analysis, we also noticed that literature published in the last decade suggests an increasing heterogeneity of individuals, who can be considered innovation actors, as they promote an innovation vigorously through the various stages of the development process against potential resistance by taking risks. While earlier literature focused on clearly defined roles, such as innovation champion, boundary spanner, knowledge broker, or sponsor, who followed a structured process in promoting innovation (Jenssen & Jørgensen, 2004), we now see a shift towards a more nuanced spectrum of innovation actors. Thus, our definition of actors also applied to very motivated and assertive lead users. While they may not be able to take over the vibrancies that characterize innovation champions, they can still be placed on the championing spectrum. Our findings indicate that the digital innovation literature scarcely provides insights on how different, heterogeneous actors collaborate in the digital innovation process. Digital technology can provide opportunities to orchestrate activities among a group of actors. Moreover, innovation actors can employ digital platforms as a new way to work collaboratively during the digital innovation process (Benbya & Leidner, 2018; Yan et al., 2018). Yet, our literature review showed that not much is known about the facets of digital technology or platforms in enabling the collaboration of heterogeneous innovation actors.

Additionally, we still know very little about the changing nature of innovation actors' activities and characteristics due to the distinct attributes of digital technology. Arvidsson and Mønsted (2018) identify specific strategies that innovation actors use in digital innovation processes to align their actions with the specific nature of digital technology. However, in sum, the implications of

digital technologies' characteristics on innovation actors' strategies have been neglected so far. With the rise of autonomous tools, the innovation process can change fundamentally as humans and machines interact and work together to create new products (Seidel et al., 2019). Existing literature has explored the interaction of autonomous tools with designers, but the role of these tools for innovation actors who champion innovation is an avenue for future research.

5.2.2 Network – Actor: Innovation Actors and Digital Innovation

Early literature on innovation actors emphasized the outstanding role of one innovation actor. For instance, the innovation champion was characterized as a vibrant individual who takes the initiative to drive an innovation project forward (Howell & Higgins, 1990; Jervis, 1975; Schön, 1963). Innovation actors were predominantly described to act as lone wolfs when promoting their innovations (Howell et al., 2005; Shane et al., 1995). Simultaneously, the occurrence of groups of innovation actors who rely on a division of labor was explored in the literature on innovation champions early on (Chakrabarti & Hauschildt, 1989), but played a less dominant role. The idea of a division of tasks and responsibilities among different innovation actors resurfaced throughout the evolution of this literature stream (e.g., Hauschildt & Kirchmann, 2001). However, in the literature that focuses on digital innovation and/or emerged in recent years, we saw a shift to a different type of distributed agency (e.g., Klerkx & Aarts, 2013; van Laere & Aggestam, 2016) that is in line with other digital innovation literature (Nambisan et al., 2017). Thus, innovation champions act as a collective that co-performs championing behavior. The roles that each member of this championing collective performs may change at any time, as members may enter or depart the collective throughout the innovation process (Klerkx & Aarts, 2013; van Laere & Aggestam, 2016). Thus, a shift has occurred from innovation actors who predominantly act as lone wolfs or in teams, where each innovation actor performs a specialized role, to innovation collectives, who act as a meaningful whole (Fichter, 2009; Klerkx & Aarts, 2013).

Figure 3 illustrates this observation by depicting the two different layers of social network that innovation actors may possess. On the one hand, innovation actors are embedded in a network with other actors, such as employees or users (Howell & Boies, 2004). On the other hand, innovation actors form a network among themselves that they use to drive an innovation project together (Hauschildt & Kirchmann, 2001; van Laere & Aggestam, 2016).

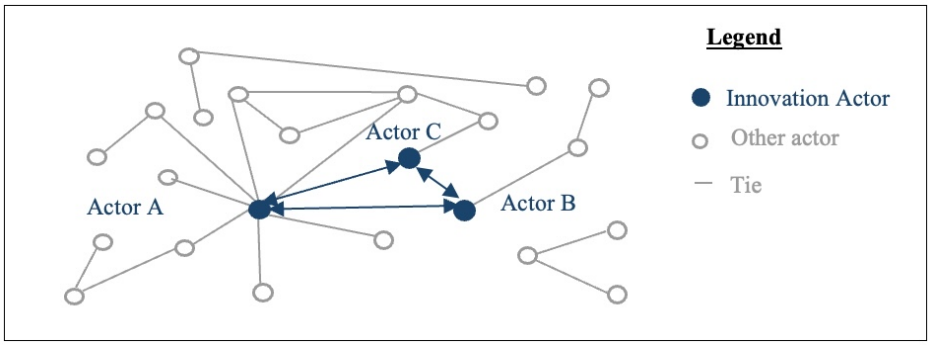


Figure 3: The social network layer of innovation actors

The observation in our literature review is in line with theoretical arguments in the digital innovation literature about the nature of innovation. The information systems literature has theoretically reasoned that agency has become more distributed and scattered in the digital innovation process (Nambisan et al., 2017; Yoo et al., 2012). This development can be traced to two characteristics of digital innovation: higher heterogeneity in required for digital innovation

(Barrett et al., 2012; Yoo et al., 2012) and a less bounded digital innovation process (Nambisan et al., 2017). Thus, the development of a digital artifact may require knowledge from different industries and unrelated bodies of knowledge. For instance, the implementation of an Industry of Things solution in an assembly line combines knowledge on sensors, manufacturing, IT infrastructure, and data science and requires a variety of stakeholders to be involved in this digital innovation.

Additionally, digital innovation are characterized by a high interdependency of innovation process and outcome (Nambisan et al., 2017). Traditional innovation had clear boundaries and the innovation process was completed with the launch of the product (Ulrich & Eppinger, 2011). In contrast, digital technology facilitates loose coupling between different stages or components of innovation (Wang et al., 2016; Yoo et al., 2010). For instance, different stages of the innovation process, such as the conception and development, can be split between various actors (Wang et al., 2016). As a result, digital products' and services' features can be altered after the release of the innovation (e.g., Hanseth & Lyytinen, 2010). Consequently, the boundary between innovation outcome and process has become blurred (Nambisan et al., 2017) and actors may join and leave the innovation process at any point in time.

Our literature review shows that a couple of research articles have started to explore the new phenomenon of distributed agency from different perspectives. However, the literature scarcely explores governance and orchestration mechanisms of these innovation communities in detail. Moreover, while we have learned much about the social and relational embeddedness of innovation actors with other actors, the network characteristics of innovation actors in a network with other innovation actors have been scarcely researched so far. We see this shift from innovation actors who act as lone wolves to innovation collectives as a radical change that calls for in-depth analyses in the future. Table 5 summarizes themes and research questions that could offer meaningful avenues for future research. In the following, we discuss these themes in more detail.

With the shift from innovation actors, who act as lone wolves to innovation collectives championing innovation, the role of the personal characteristics of the individual actors has lost in significance. Instead, the relationships between individual actors in these innovation collectives play a fundamental role in the failure or success of innovation projects. Moreover, the characteristics of the innovation team or collective as a whole form important factors in understanding (digital) innovation. Klerkx and Aarts (2013) offer some first insight into how difficult it may be to understand the character of these teams or communities overall, as they are subject to constant change as new innovation actors join and others decide to leave the community and different types of communities exist with different purpose and lifespan.

Moreover, the formation and continuing existence of these networks form another important avenue for future research. van Laere and Aggestam (2016) build an exception when outlining how innovation champions recruit co-champions. Yet, beyond that, literature provides no insights into the mechanisms and motivations that lead to the formation of an innovation collective among innovation actors. In a network among innovation actors, different roles and motives may interact. As a consequence, disagreement may arise on how to promote a digital innovation project. The mechanisms that enable these teams or communities to address and resolve conflicts could not be uncovered in our literature review. Information systems research on online communities (e.g., Kyriakou et al., 2017) or crowdsourcing (e.g., Zuchowski et al., 2016) could be a starting point when exploring communities of innovation actors further, as their characteristics may be similar to innovation communities.

Recommendation for future research	Possible research questions for future research
Digital Technology and Innovation Actors	▸ How can digital technology enable the collaboration of a wide spectrum of innovation actors? ▸ What is the function of digital technology in the formation of innovation teams and communities among innovation actors? ▸ How does the function of digital technology in enabling innovation actors' work change with the increasing sophistication of digital technology? ▸ How can autonomous tools be used in a meaningful way to support innovation actors?
Network among champions of digital innovation:	▸ What are the defining characteristics of communities of innovation actors? ▸ What characterizes networks among different innovation champions? ▸ How do innovation actors build networks among each other? How do innovation actors choose co-innovation actors? What are the goals and motivations? ▸ How do innovation actors work together in teams or innovation communities? How do networks of innovation actors deal with conflict? ▸ What characterizes the structural and relational embeddedness of the innovation actors in networks with other innovation actors?
Orchestration and governance of networks among actors of digital innovation	▸ How do innovation teams and innovation communities orchestrate their actions? ▸ Which dynamics influence the arrival or departure of innovation actors in innovation communities along the innovation process? ▸ How can organizations identify innovation actors in distributed teams or communities? ▸ What are suitable governance mechanisms for distributed innovation agency? ▸ How are conflicts among different innovation actors solved? ▸ How can organizations support the formation of innovation communities? ▸ How do organizations with innovation actors operating as lonely wolves shift to teams or communities of innovation actors, when undergoing a digital transformation? ▸ How can organizations react to changing actor compositions in the innovation community?

Table 5: Research agenda for future research on innovation champions

Organizational theory gives insights on what makes distributed agency, in the form of teams or communities of innovation actors, fundamentally different from innovation actors, who act as lone wolfs. Benkler (2006) outlines the growing importance of networks as an organizing element in the digital economy. Individuals organize themselves in loose networks or communities with other like-minded individuals without facing the constraints present in hierarchically organized organizations. The higher the uncertainty in the environment and the lower the degree of structure, the better suited a network organization will be (Benkler, 2006). As a result, network organizations will be better suited for the digital age, where new technologies change the innovation processes and outcomes fast. Yet, we still lack a clear understanding of the coordination mechanisms and dynamics in such network organizations. Moreover, future research would need to explore how and which governance mechanisms can facilitate innovation creation in such network organizations. Additionally, for incumbent organizations the question arises on how they first move to this different form of organizing and can then adapt their network structure to constantly changing requirements and tasks in the digital economy. While some actors are only part of peripheral network structures, others form the core that remains stable throughout an innovation project (Klerkx & Aarts, 2013). How can organizations handle

such fluid boundaries in their network structure? What characterizes the stable core network?

6 Theoretical and Practical Contribution

The contribution of our study is threefold. First, with this synthesis of the extant literature on innovation actors, we contribute to information systems research, which has called for an exploration of actors' interactions in digital innovation processes (Holmström, 2018; Lyytinen et al., 2016). Our literature review enables us to zoom into the phenomenon by focusing on specific actors in the innovation process. As such, we can add a more detailed understanding to actors of digital innovation by bringing together empirical and theoretical evidence presented in the literature on innovation actors. We identify the innovation actors' activities in creating and using social ties in their endeavor to promote innovation. Moreover, we pinpoint nine themes that extant literature focuses on when exploring innovation actors' structural and relational embeddedness. In doing so we can add valuable knowledge to digital innovation literature, which has so far mostly led this argumentation related to the distributed nature of agency on an abstract level. The multidisciplinary nature of our literature review enables us to understand the activities and characteristics of innovation actors' in general, while also identifying characteristics related to the nature of digital innovation. Thus, we find that innovation actors increasingly form innovation teams or and perform activities as an innovation collective, instead of acting as lone wolfs. This development is connected to the combination of heterogeneous expertise and knowledge necessary for digital innovation. Additionally, our literature review contributes to digital innovation literature that has called for a transdisciplinary perspective on digital innovation (Nambisan et al., 2020). Thus, we contribute to the literature by providing an in-depth understanding of the structure and flows of innovation actors' network by combining findings from four disciplines.

Moreover, we synthesize knowledge on the facets of digital technology in nurturing innovation actors' activities. Digital innovation literature has called for a deepened understanding of the use and implementation of digital technology for innovation activities in companies (Yoo et al., 2012). By relying on a social network perspective, we add a layer of understanding to the existing literature on innovating with digital technology. For instance, our analysis shows that one of the main themes in extant literature on innovation actors' activities in using social ties is that actors draw attention to the benefits of using digital technology in innovation processes. For practitioners, the literature review provides an in-depth understanding of innovation actors' social network that enables better support and identification of innovation actors. The shift towards more distributed agency of innovation makes it necessary for companies to take a different perspective when designing measures to support and identify innovation actors, than was the case in the past, when innovation actors predominantly acted as lone wolfs and stood out as such. Moreover, practitioners can use the findings to adapt the conditions prevailing in their organization to facilitate innovation actors' efforts to drive innovation projects.

Second, our perspective on innovation actors, among which the innovation champions take up a dominant role, contributes to information systems literature by providing a novel perspective on innovation actors. The role of the champion has been explored in the information systems in the last three decades (Beath, 1991). Yet, the focus has been predominantly on another type of champion, namely the information systems champions, who drive the adoption and diffusion of novel information systems (Lin et al., 2014). The perspective on innovation actors who drive innovation has mainly been limited to the field of innovation management, where the concept

of the champion also originated. In existing information systems literature, the two concepts of IT champion and innovation champion have not always been separated and the only existing literature review on champions in the field also lacks a clear differentiation between these two literature streams (Renken & Heeks, 2019). With the growing interest in exploring digital innovation and the interactions among stakeholders of the innovation process, our literature review and our conceptualization of innovation actors can add important insights. Especially, the focus on innovation champions' social network has been missing in existing literature reviews that cover innovation actors (Jenssen & Jørgensen, 2004; Renken & Heeks, 2019).

Third, based on the insights that we gain from synthesizing the literature on innovation actors' social network activities and characteristics in traditional innovation processes, we develop a research agenda that synthesizes important themes in the literature that have been less attention in existing research. We identify important gaps in the understanding of innovation actors' social network in the digital age and formulate questions for future research. We present four themes that can guide researchers interested in exploring innovation actors and their interplay with digital technology in the future.

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Wang, G., Henfridsson, O., & Nandhakumar, J. (2016). How do designers assemble representational practices to generate radical digital innovations ? *Proceedings of the 37th International Conference on Information Systems*, 1–19.
Watts, S., & Henderson, J. C. (2006). Innovative IT climates: CIO perspectives. *Journal of Strategic Information Systems*, *15*(2), 125–151.
Webster, J., & Watson, R. T. (2002). Analyzing the past to prepare for the future: Writing a review. *MIS Quarterly*, *26*(2), xiii–xxiii.
Wong, S. S., & Boh, W. F. (2014). The contingent effects of social network sparseness and centrality on managerial innovativeness. *Journal of Management Studies*, *51*(7), 1180–1203.
Yan, J., Leidner, D. E., & Benbya, H. (2018). Differential innovativeness outcomes of user and employee participation in an online user innovation community. *Journal of Management Information Systems*, *35*(3), 900–933.
Yoo, Y. (2010). Computing in everyday life: A call for research on experiential computing. *MIS Quarterly*, *37*(2), 357–370.
Yoo, Y., Boland, R. J., Lyytinen, K., & Majchrzak, A. (2012). Organizing for innovation in the digitized world. *Organization Science*, *23*(5), 1398–1408.
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Appendix A: Scientometrics

Our analysis shows that the 61 relevant research articles on innovation actors were published in 30 different journals. This large diversity of publication outlets also becomes apparent in Table 6, which portrays the number of all relevant articles in our sample by outlet. The Journal of Product Innovation Management accounts for the largest share, 19.7% of research articles on IAs. With a share of 6.6% each, International Journal of Innovation Management, Journal of Business Venturing and R&D Management are the second, third and fourth most important outlets. A share of 4.9% was published in Technovation and the practitioner-oriented MIS Quarterly Executive, respectively.

Journal	Absolute frequency
Journal of Product Innovation Management	12
International Journal of Innovation Management	4
Journal of Business Venturing	4
R&D Management	4
MIS Quarterly Executive	3
Technovation	3
Administrative Science Quarterly	2
Harvard Business Review	2
Journal of Information Technology	2
Journal of Management Studies (JMS)	2
Journal of Strategic Information Systems	2
Leadership Quarterly	2
Research Policy	2
Accounting, Management & Information Technology	1
California Management Review	1
Decision Support Systems (DSS)	1
Entrepreneurship: Theory and Practice (ET&P)	1
European Journal of Information Systems	1
European Journal of Work & Organizational Psychology	1
Group & Organization Management	1
Human Resource Management	1
IEEE Transactions on Engineering Management	1
Journal of Business Research	1
Journal of Management (JOM)	1
Journal of Management Information Systems	1
Journal of Occupational and Organizational Psychology	1
Research in the Sociology of Organizations	1
Small Business Economics	1
Technological Forecasting & Social Change	1
Technology Analysis & Strategic Management	1

Table 6: The relevant articles by outlet

With respect to the four disciplines that we included in our literature search (cf. Section 3), a concentration of the published innovation actor literature can be observed. As summarized in Table 7, almost half of all articles (34) were published in the discipline technology, innovation and entrepreneurship. The discipline information systems accounted for 12 articles. Literature in

business administration (9) as well as human resources and organization (8) made up similarly sized proportions of the literature included in the literature review.

Discipline of literature on innovation actors	Absolute frequency
Technology, innovation and entrepreneurship	34
Information systems	12
Business administration	9
Human resources and organization	8

Note: Some journals are assigned to more than one discipline.

Table 7: Disciplines of innovation-related research by number of publications

Over the time frame, the number of research articles published grew steadily. In the first ten years (1995-2004) 15 relevant research papers were published. This more than doubled to 32 research articles in the time frame 2005 to 2014. In the time frame 2015 to 2020, 13 additional papers that explore innovation actors from an organizational perspective have been published.

The research approach of the selected literature is quite diverse. While 38.2% of the research approaches were inductive and 5.5% of research articles used inductive and deductive approaches, the majority (56.4%) of research articles applied deductive approaches. Furthermore, significantly more articles relied on quantitative (61.8%) than on qualitative (38.2%) methods of data analysis.

As Table 8 illustrates, the largest proportion of articles (39.3%) collected data in surveys. Case studies and interviews account for the second and third largest shares with 24.6% and 14.8% respectively. Additionally, 9.8% of the publications are conceptual contributions and 6.6% of research articles draw on secondary data to conduct their analysis. Only a small share of the literature relies on a literature review (2 papers) or mixed methods of data collection (1 paper).

Methods of data collection	Count
Survey	24
Case Study	15
Interview study	9
Conceptual paper	6
Secondary data	4
Literature Review	2
Mixed methods	1

Table 8: Methods of data collection by number of publications

Appendix B: Overview of the Reviewed Literature

Paper	Innovation actor	Research approach	Research method	Facet of information/ digital technology	Categorization of network activity and characteristic	Theme – Social network activity	Theme - Social network characteristic
Abetti (1997)	Innovation Champion	Inductive & deductive	Interview study	IT innovation	Using social ties	Getting access to or obtain resources; Gaining support of other people	
Ansari and Munir (2010)	Innovaiton Champion	Inductive	Conceptual paper	IT as enabler; IT innovation	Using social ties	Sharing information and knowedge	
Anthony (2012)	Corporate entrepreneur	Inductive	Case Study	NA	Creating and using social ties	Getting access to or obtain resource; forming social networks and coalitions	
Arvidsson and Mønsted (2018)	Corporate entrepreneur	Inductive	Case Study	NA	Using social ties	Gaining the support of other people	
Badguerahanian and Abetti (1995)	Corporate entrepreneur	Inductive	Case Study	NA	Using social ties	Graining the support of other people	
Bammens (2016)	Corporate entrepreneur	Inductive	Conceptual paper	NA	Using social ties	Gaining the support of other people	
Benbya and Leidner (2018)	Innovation Champion, Sponsor	Inductive	Case Study	IT as enabler	Creating and using social ties	Boundary spanning; sharing information and knowledge	
De Brentani and Reid (2012)	Boundary spannner, knowledge broker	Inductive	Conceptual paper	NA	Creating and using social ties; structural embeddedness	Boundary spanning; Sharing information and knowledge, brokering	Low density in social network; central network position; high breadth of external network with other organizations
du Chatenier et al. (2010)	Champion; knowledge broker	Inductive & deductive	Case Study	NA	Creating and using social ties	Getting access to or obtaining resources; boundary spanning; broking; sharing information and knowledge; forming social networks and coalitions; gaining the support of other people	
Colazo (2014)	Innovaiton Champion	Deductive	Secondary Data	IT as enabler, IT innovation	Using social ties	Sharing information and knowedge	
Donati et al. (2016)	Corporate entrepreneur	Deductive	Survey	NA	Using social ties; relational embeddedness	Getting access to or obtaining resources; sharing information and knowledge; gaining the support of other people	Character of network: friendship vs. communication network
Dougherty and Bowman (1995)	Innovaiton Champion	Inductive	Interview study	NA	Using social ties; relational embeddedness	Getting access to or obtaining resources; gaining the support of other people	Character of network: informal vs. formal network
Ebers and Maurer (2014)	Boundary Spanner	Deductive	Survey	NA	Relational embeddedness		High level of trust in internal and external networks

Paper	Innovation actor	Research approach	Research method	Facet of information/ digital technology	Categorization of network activity and characteristic	Theme – Social network activity	Theme - Social network characteristic
Edmondson et al. (2001)	Champion	Inductive	Interview study	NA	Creating social ties; structural embeddedness	Forming social networks and coalitions	Structural embeddedness in network with other innovation actors
Fichter (2009)	Sponsor, Innovation Champion, boundary spanner	Inductive	Case Study	IT innovation	Using social ties; structural embeddedness	Getting access to or obtaining resources; gaining the support of other people; sharing information and knowledge	Structural embeddedness in network with other innovation actors
Flath et al. (2017)	Innovation Champion	Inductive	Secondary Data	IT as an enabler; Digital innovation	Using social ties	Sharing information and knowedge	
Glaser et al. (2015)	Boundary spanner, sponsor	Deductive	Survey	NA	Creating social ties; structural embeddedness	Boundary spanning	Structural embeddedness in network with other innovation actors
Globocnik and Salomo (2015)	Corporate entrepreneur	Deductive	Survey	NA	Using social ties	Getting access to or obtaining resources; sharing information and knowledge	
Greene et al. (1999)	Innovation Champion	Inductive	Literature Review	NA	Creating and using social ties; relational embeddedness	Forming social networks and coalitions; getting access to or obtaining resources; gaining the support of other people	High level of trust in internal and external networks
Gupta et al. (2006)	Champion, boundary spanner, sponsor	Inductive	Case Study	Digital innovaiton	Creating and using social ties; Structural and relational embeddedness	Forming social networks and coalitions; getting access to or obtaining resources; gaining the support of other people	Structural embeddedness in network with other innovation actors; Relational embeddedness with other innovation actors: division of labor
Halme et al. (2012)	Corporate Entrepreneur	Inductive	Interview study	NA	Using social ties	Getting access to or obtaining resources; sharing information and knowledge	
Harryson (2008)	Corporate entrepreneur	Inductive & deductive	Case Study	NA	Creating and using social ties; relational embeddedness	Forming social networks and colations, getting access to or obtaining resources, gaining the support of other people	Necessity to manage relational embeddedness throughout phases of innovation process
Hauschildt and Kirchmann (2001)	Innovation Champion, Sponsor	Deductive	Survey	NA	Structural and relational embeddedness		Structural embeddedness in network with other innovation actors; Relational embeddedness with other innovation actors: division of labor
Hayton and Kelley (2006)	Corporate entrepreneur	Inductive & deductive	Conceptual paper	NA	Creating and using social ties	Forming social networks and coaltions; boundary-spanning; gathering access to or obtaining resources	
Hemmert et al. (2014)	Innovation Champion	Deductive	Survey	NA	Using social ties	Gaining the support of other people	

Paper	Innovation actor	Research approach	Research method	Facet of information/ digital technology	Categorization of network activity and characteristic	Theme – Social network activity	Theme - Social network characteristic
Heng et al. (1999)	Innovation Champion	Inductive	Interview study	IT innovation	Creating and using social ties	Forming social networks and coalitions; boundary spanning; getting access to or obtaining resources; gaining the support of other people; sharing information and knowledge	
Howell and Boies (2004)	Innovation Champion	Deductive	Interview study	NA	Using social ties; relational embeddedness	Gaining the support of other people	Character of network: informal vs. formal network
Howell and Shea (2006)	Innovation Champion	Deductive	Survey	NA	Creating and using social ties	Forming social networks and coalitions; boundary spanning; scanning the environment; getting access to or obtaining resources; sharing information and knowledge	
Howell et al. (2005)	Innovation Champion	Inductive & deductive	Survey	NA	Using social ties	Gaining the support of other people	
Howell and Shea (2001)	Innovation Champion	Deductive	Survey	NA	Creating and using social ties	Forming social networks and coalitions; boundary spanning; scanning the environment; getting access to or obtaining resources; gaining the support of other people; brokering; sharing information and knowledge	
Janssen (2005)	Corporate entrepreneur	Deductive	Survey	NA	Using social ties	Getting access to or obtaining resources; gaining the support of other people	
Jenssen and Nybakk (2009)	Sponsor	Deductive	Survey	NA	Structural embeddedness		High breadth of external network with other organizations
Jenssen and Jørgensen (2004)	Innovaiton champoin	Inductive	Literature Review	NA	Creating social ties	Forming social networks and coalitions; gaining the support of other people; getting access to or obtainig resources	
Kandemir and Acur (2012)	Innovation Champion, knowledge broker	Deductive	Survey	NA	Creating and using social ties	Scanning the environment, sharing inforamtion and knowledge	
Kawakami et al. (2015)	Sponsor	Deductive	Survey	IT as enabler	Using social ties	Getting access to or obtaining resources; gaining the support of other people; drawing attention to the importance of information technology	
Klerkx and Aarts (2013)	Champion, Sponsor, Boundary Spanner	Inductive	Case study	NA	Structural and relational embeddedness		Structural embeddedness in network with other innovation actors; character of network: formal vs. informal; changing relational embeddedness among innovation actors

Paper	Innovation actor	Research approach	Research method	Facet of information/ digital technology	Categorization of network activity and characteristic	Theme – Social network activity	Theme - Social network characteristic
Mahr and Lievens (2012)	Champion	Deductive	Secondary Data	IT innovation; IT as enabler	Using social ties	Sharing information and knowedge	
Mansfeld et al. (2010)	Champion, Sponsor, Boundary Spanner	Deductive	Survey	NA	Creating and using social ties	Forming social networks and coalitions; getting access to or obtaining resources; gaining the support of other people: sharing information and knowledge	
Markham (1998)	Innovation Champion	Deductive	Survey	NA	Using social ties	Gaining the support of other people	
Markham et al. (2010)	Champion, Sponsor, Boundary Spanner	Deductive	Survey	NA	Creating and using social ties	Boundary spanning; getting access to or obtaining resources; gaining the support of other people	
Martin (2011)	Innovation Champion	Inductive	Case Study	IT innovation	Creating and using social ties	Forming social networks and coalitions; gaining the support of other peple	
Mascitelli (2000)	Sponsor	Inductive	Conceptual paper	NA	Creating and using social ties	Forming social networks and coalitions; sharing information and knowledge, brokering	
Obstfeld (2005)	Boundary Spanner	Deductive	Survey	NA	Creating and using social ties; structural embeddedness	Boundary spanning, brokering, sharing information and knowledge	High density in external social network
Papadakis et al. (1998)	Sponsor	Deductive	Survey	NA	Creating and using social ties	Scanning the environment, gaining the support of other people	
Parmentier and Mangematin (2014)	Champion	Inductive	Case Study	Digital Innovation; IT as enabler	Creating and using social ties; relational embeddedness	Boundary spanning; sharing information and knowledge	Necessity to manage relational embeddedness throughout phases of innovation process
Peppard et al. (2011)	Sponsor	Inductive	Case Study	IT innovation; IT as enabler	Using social ties	Gainig the support of other people; drawing attention to the importance of information technology	
Pollok et al. (2019)	Champion, Sponsor, knowledge broker	Inductive & deductive	Mixed methods	NA	Creating and using social ties	Boundary spanning, getting access to or obtaining resources, sharing information and knowledge	
Ramirez and Dickenson (2010)	Knowledge brokers; boundary spanner	Deductive	Survey	NA	Creating social ties; structural embeddedness	Scanning environment; forming social networks and coalitions	Low density in external social network
Reid and de Brentani (2004)	Boundary spanner, knowledge broker, champion	Inductive	Conceptual paper	NA	Creating and using social ties	Boundary spanning, scanning the environment, getting access to or obtaining resources, brokering, sharing information and knowledge	

Paper	Innovation actor	Research approach	Research method	Facet of information/ digital technology	Categorization of network activity and characteristic	Theme – Social network activity	Theme - Social network characteristic
Shane et al. (1995)	Innovation Champion	Deductive	Survey	NA	Using social ties	Gaining the support of other people	
Shim and Lee (2001)	Innovation Champion	Deductive	Survey	NA	Using social ties	Gaining the support of other people	
Smith (2007)	Sponsor (Godfather)	Inductive	Case Study	NA	Using social ties	Getting access to or obtaining resources, gaining the support of other people	
Somech and Drach-Zahavy (2013)	Innovation Champion	Deductive	Survey	NA	Creating and using social ties	Scanning the environment, sharing information and knowledge, getting access to or obtaining resources	
Tumbas et al. (2017)	Sponsor	Inductive	Interview study	Digital innovation	Creating and using social ties	Scanning the environment, forming social networks and coalitions, getting access to or obtaining resources	
Tumbas et al. (2018)	Corporate entrepreneur	Inductive	Interview study	Digital innovation	Creating social ties	Boundary spanning	
van Laere and Aggestam (2016)	Innovation Champion	Inductive	Case Study	IT innovation	Creating and using social ties; Structural and relational embeddedness	Forming social networks and coaltions, gaining the support of other people	Structural embeddedness in network with other innovation actors; relational embeddedness with other innovation actors: collective activities; changing relational embeddedness among innovation actors
Vessey et al. (2014)	Innovation Champion	Deductive	Case Study	NA	Using social ties	Getting access to or obtaining resources, gaining the support of other people	
Walter et al. (2011)	Innovation Champion	Deductive	Survey	NA	Creating social ties	Forming social networks and colations, getting access to or obtaining resources, gaining the support of other people	
Watts and Henderson (2006)	Sponsor	Inductive & deductive	Interview study	IT as an enabler, IT innovation	Creating and using social ties	Forming social networks and coalitions, sharing information and knowlede, gaining the support of other people; getting access to or obtaining resources	
Wong and Boh (2014)	Boundary spanner	Deductive	Survey	NA	Creating and using social ties; structral embeddeness	Getting access to or obtaining resources, scanning environment, gaining support from other people	Central network position
Yan et al. (2018)	Innovation champion	Deductive	Secondary Data	IT as an enabler	Creating and using social ties	Sharing information and knowledge, gaining the support of other people	

Appendix C: Research Method Details

Category	Sub-category: description	Coding
Research article	**Title**	Free text
	Author	Free text
	Year	Free text
	Journal	Free text
Filtering criteria	**Methodology**: clearly stated methodology, no editorial	Binary (yes/no)
	Focus on innovation actors: individuals who promote innovation vigorously through the various stages of the development process against resistance by taking risks (Howell & Shea, 2001; Jervis, 1975; Maidique, 1980)	Binary (yes/no)
	Innovation actors on the individual or group level	Binary (yes/no)
	Focus of constructs related to social network perspective	Binary (yes/no)
Focus and findings of article	**Research gap/ research questions**	Free Text
	Proposition/ hypotheses	Free Text
	Findings	Free Text
	Contribution	Free text
Innovation actor	**Definition and scope of innovation actor:** Excerpt of innovation actors' definition and description in research article	Free Text
	Innovation actor categorization: champion (Howell & Shea, 2001; Jervis, 1975; Maidique, 1980); boundary spanner (Ebers & Maurer, 2014; Tushman & Scanlan, 1981); knowledge broker (Burt, 2004; Kirkels & Duysters, 2010); sponsor (Hayton & Kelley, 2006; Tushman & Nadler, 1986); corporate entrepreneur (Sharma et al., 1999)	Categorical
Information technology and digital technology	**Information and digital technology:** Excerpt of facet of information and digital technology in research article	Free text
	Context includes IT/digital technology	Binary (Yes/No)
	Digital technology as enabler of innovation actors	Binary (Yes/No)
	Type of technology	Free text
Methodology	**Research approach:** inductive, deductive, inductive & deductive, abductive	Categorical
	Research method: concept, literature review, survey, interview study, case study, experiment, secondary data, mixed methods (Palvia et al., 2003)	Categorical
	Unit of analysis: Individual, team/group, organization, mixed	Categorical
Actor - network	**Network Activity:** Excerpts of innovation actors' activities in social network	Free text
	Categorization of network activity (framework)	Categorical
	Sub-categorization of network activity	Categorical
Network - actor	**Network Characteristic:** Excerpts of innovation actors' characteristics in social network	Free text
	Categorization network characteristic (framework)	Categorical

Table 10: Coding scheme

Part II

Evaluating the Impact of Champions at the C-Level

Paper V

Risk and Return of Chief Digital Officers' Appointment
An Event Study

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Proceedings of the 40th International Conference on Information Systems, Munich, Germany, 2019
https://aisel.aisnet.org/icis2019/general_topics/general_topics/14/

Paper VI

CDOs' Managerial Power: Market Reactions to Chief Digital Officer Appointments

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CDOs' Managerial Power: Market Reactions to Chief Digital Officer Appointments

Abstract

Prior literature has shown that companies may benefit from chief digital officers (CDOs) who drive digital strategy and create business value through digital initiatives. Yet, research that empirically quantifies CDOs' effect on organizational performance is scarce. We apply event study methodology to analyze how stock markets react to CDO appointments based on a comprehensive global sample of companies issuing press releases in the timeframe 2009 to 2020. We find an overall significant positive market reaction for CDO appointments to newly created positions. However, the reaction can turn to negative when considering CDOs' structural, prestige, and expert power. Thereby, we show the empirical significance of expert and prestige power, two power dimensions that have received little attention to date. Additionally, we demonstrate that the overall positive market reaction to CDO appointments contrasts with market reactions to chief information officer (CIO) appointments in recent years, underscoring the distinct nature of both roles empirically.

Keywords: chief digital officer, CDO, managerial power, digital transformation, strategic signal, event study, expert power, prestige power, market reaction

1 Introduction

Over twenty years ago, Chatterjee et al. (2001) showed that stock prices react positively to companies' appointment of newly created chief information officer (CIO) positions, especially if the companies are characterized by high levels of IT-driven transformation (Chatterjee et al., 2001). While CIO positions have been established in companies, and their positive impact on business value and future cash flows has been studied for several decades (e.g., Chatterjee et al., 2001; Leidner et al., 2010; Liu & Preston, 2021), companies have more recently started to establish chief digital officers (CDOs) as executives to drive digital strategy, especially to meet transformation urgency and coordination needs in the company (Firk et al., 2021). In the following paragraphs, we will argue that the role of the CDO is not just a modern version of the CIO role but profoundly different, and accordingly, reactions of the stock market (in the following briefly referred to as market reactions) to the creation of CDO positions will differ from those of CIO positions. Further, we nowadays face situations where companies exhibit both CIO and CDO positions, which is an unprecedented situation and unchartered territory for investigation, warranting the assumption of diverse market reactions to CDO positions. We, therefore, argue that, following the changing role of IT in companies, stock markets will demand somewhat different characteristics from CDOs.

With digital transformation and digital innovation, the role of IT for organizations has shifted, leading to changes in companies' senior management and governance mechanisms (Bharadwaj et al., 2013; Tumbas et al., 2018). Digital transformation is "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies" (Vial, 2019, p. 118). Digital transformation affects every aspect of an organization and thus goes far beyond pure IT-enabled organizational transformation (Wessel et al., 2021). Since the strategic responsibility for digital transformation initiatives is now frequently assigned to the new position of the CDO and not the CIO, the

CDO has increasingly gained influence in organizations (Singh et al., 2020; Tumbas et al., 2018). This development is traced by recent research into the role of CDOs and the range of tasks included in their role, ranging from the orchestration of digital initiatives across business units to the development of digital technologies (Singh & Hess, 2017; Tumbas et al., 2018). The new appointment of executives on the C-level can signal organizational change, such as strategic renewal, and evoke positive market reactions (Chatterjee et al., 2001; Gangloff et al., 2016). Prior research into market reactions to senior management changes also indicates that these reactions often depend on executives' individual characteristics (e.g., Bandodkar & Grover, 2022; Chatterjee et al., 2001). Generally, extant research finds that C-level executive appointments, including CIO appointments, are overwhelmingly perceived as positive by investors (e.g., Bandodkar & Grover, 2022; Chatterjee et al., 2001; Huson et al., 2004).

However, there are several reasons why CDO appointments may not necessarily be perceived as positive, leading to deviations from prior findings on CIOs. First, extant research has identified exceptions to the rule that the stock market generally reacts positively to C-level executive appointments. For example, Gangloff et al. (2016) found a negative market reaction to the appointment of an interim CEO following financial misrepresentation. Similarly, other studies found no reaction to the appointment of insiders (Worrell et al., 1993), corporate sustainability executives with broad rather than focused responsibilities (Arora et al., 2020), and executives with a very low or very high degree of internationalization (Schmid & Dauth, 2014).

Second, we argue that market reactions to CDO appointments depend on the profile of managerial power. Managerial power is defined as "the capacity of individuals to exert their will" (Finkelstein, 1992, p. 506), that is, the ability of managers to follow through with their plans. Namely, we argue that market reactions to CDO appointments are influenced by CDOs' prestige and expert power as signaled by respective statements in the announcements, which may play a prominent role and may be even more relevant than structural power due to the wide range of responsibilities assigned to CDOs (Singh & Hess, 2017; Tumbas et al., 2018). While structural power derived from a formal hierarchical position is inarguably important, managerial power theory stresses the importance of further forms of power, namely prestige and expert power, characterized as a greater influence due to personal status or relevant knowledge and experience, respectively. Although managerial power theory encompasses several power dimensions, extant research applying this theoretical lens focuses predominantly on structural power (e.g., Chen et al., 2010; Chen et al., 2021; Feng et al., 2021; Taylor & Vithayathil, 2018) (see Table 7 and 8 in Appendix A for an overview), which might be more relevant for studying CIO positions rather than for CDO positions. Therefore, we pose the following research questions:

RQ1: How are CDO appointments related to market reactions?

RQ2: What characterizes the power profile of CDOs whose appointment leads to positive market reactions?

To address these research questions, we study market reactions to company press releases announcing a CDO appointment through the lens of managerial power (Finkelstein, 1992). We argue that three types of managerial power[1] – structural, prestige, and expert – must be considered to identify the CDO's power profile that investors perceive as contributing to successful digital

[1]Finkelstein (1992) additionally considers a fourth type of power, ownership power, defined as the extent to which an executive possesses the capacity to act as an agent of stakeholders' interests. We do not consider CDOs' ownership power for two reasons. First, press releases, our data source for CDO appointments and the effects we measure, rarely report on ownership power. Second, while CEOs typically have ownership power (Daily & Johnson, 1997), other C-level executives typically do not.

transformation. Investors pay close attention to changes in the top management team and their implications for a company's future prospects. The appointment of CDOs and whether they are perceived as influential and competent due to their power profile leads investors to decide to buy or sell stock based on this information. Accordingly, we apply event study methodology, an approach that has been widely used in extant IS research to measure how events influence expected business value and future cash flows (Bandodkar & Grover, 2022; Bose & Leung, 2019; Chatterjee et al., 2001) to validate our research model empirically. Our analysis is based on a comprehensive global sample of 307 press releases announcing unique CDO appointments in the period 2009 to 2020.

Overall, we find a statistically significant positive market reaction to newly created CDO positions, as opposed to significant negative market reactions to CDO successions. Underlining our argument that CDO positions are perceived differently by the stock market, we can contrast this finding to chief information officer appointments, where in our sample market reaction in recent years is significantly negative for both appointments to newly created and existing positions. We only identify this negative effect for CIO appointments to newly created positions in recent years, while for earlier time periods we find, in line with Chatterjee et al. (2001), a positive market reaction to CIO appointments. We attribute this observation to changing investor attitudes towards IT-related executives over time. Our results indicate that research on CIOs is not automatically transferable to CDOs and that the stock market values CDO and CIO appointments differently.

Furthermore, we show that the overall market reaction to newly created CDO positions might turn from positive to negative depending on CDOs' power profile regarding structural and expert power. Namely, we find that CDOs' expert power based on an interdisciplinary background in both business and computer science is positively valued by the stock market, while a sole focus on one area is perceived as negative. Similarly, overall market reactions to CDO succession appointments turn from negative to positive for CDOs with high structural, prestige, and expert power.

In sum, we demonstrate that the predominant focus of earlier studies on structural power neglects the empirical significance of expert power and, to a smaller extent, prestige power. With respect to expert power, we extend earlier findings by Lim et al. (2013), one of the few studies that considers both expert and structural power, by emphasizing the need to differentiate between different aspects of expert power and by demonstrating that, for CDOs, higher expert power may not be derived from greater depth of knowledge, but rather from interdisciplinary and company-external knowledge. Based on our findings, we introduce a theory of CDO impact, identifying structural, prestige, and expert power as moderators of CDOs' influence on organizational performance.

2 Theoretical Foundation and Hypotheses Development

In the following, we present the theoretical foundation, the theory of managerial power based on Finkelstein (1992), and outline related literature. Subsequently, we develop hypotheses to explore the link between CDO appointments and market reactions.

2.1 Theoretical Foundation: Managerial Power

Managerial power (also referred to simply as power) is attained by top managers who can deal with internal and external uncertainty, both due to their ability and position (Finkelstein, 1992; Thompson, 1967). Focusing on strategic decision-making power, Finkelstein (1992) differentiates between structural, prestige, and expert power, for which he develops measurements and demonstrates their reliability and validity. *Structural power* is defined as executives' authority derived from the position within the organization's formal structure. This hierarchical authority allows executives to control their subordinates' actions (Finkelstein, 1992; Hambrick, 1981). *Prestige power* is the influence that results from an executive's personal prestige or status. Stakeholders see executives with high standing or personal relationships with influential people as having a higher ability to manage uncertainty because they can, for example, use their influential network to obtain relevant information about environmental contingencies early on (Finkelstein, 1992). *Expert power* is defined as executives' ability to cope with environmental contingencies by drawing on their relevant knowledge and experience (Finkelstein, 1992; Hambrick, 1981).

2.2 Related Literature: Managerial Power

When studying functional top managers, such as chief marketing, technology, or information officers, with power theoretical arguments, research has frequently taken a non-specific conceptual and measurement perspective on power and has not differentiated among different dimensions (Baker et al., 2019; Collins et al., 2018; Feng et al., 2015). Several labels (e.g., theory of managerial discretion, power theory, and strategic leadership literature) have been used to refer to this theoretical lens in extant literature. Many studies focus on structural power only (Chen et al., 2010; Feng et al., 2021; Taylor & Vithayathil, 2018), as illustrated in Table 7 and 8 in Appendix A. Lim et al. (2013) is a rare exception in information system literature, in that it considers both structural and expert power. The authors find that a CIO's structural power and IT-related expert power are positively associated with public recognition of the company's IT capability. Another differentiated perspective on managerial power from innovation management research finds that a CTO's structural power is positively related to the TMT's commitment to innovation, but a negative relationship exists between a CTO's expert power and multifunction power, a measure of power breadth, and the TMT's commitment to innovation (Garms & Engelen, 2019).

With respect to CIOs, most IS research using variables measuring power has either focused on structural power only (six studies in our overview of related literature in Table 7) or taken another theoretical perspective but included variables measuring power (seven studies in Table 7). Studies that fall into the first category have, for instance, identified a positive relationship between CIOs' level of structural power and the quality of IT governance (Bradley et al., 2012), the level of sophistication of electronic medical records (Smith et al., 2013) or demand-side leadership (Chen et al., 2010), and forward-looking company performance (Feng et al., 2021). Recent studies have strongly emphasized the significant role of structural power for CIOs' effectiveness for long-term company performance (Feng et al., 2021) and illustrate the significance of CIOs' structural power as a moderator of the influence of CIOs' effectiveness in selling issues on digital innovation outcomes (Chen et al., 2021). In the second category, studies implicitly accounted for CIOs' structural or expert power by studying these functional executives, for example, with the theoretical perspective of resource- and knowledge-based theory (Armstrong & Sambamurthy, 1999), Porter's typology of strategic positioning (Banker et al., 2011), or social capital theory (Karahanna & Preston, 2013). A detailed overview of all related studies, their measures of managerial power or related constructs and their data sources can be found in Table

7 and 8 in Appendix A.

2.3 Hypotheses Development

2.3.1 CDO Appointment and Market Reactions

In this section, we develop hypotheses regarding our first research question: *How are CDO appointments related to market reactions?* Generally, extant research agrees that the announcement of C-level appointments, especially newly created positions, is recognized as an essential signal of change by investors and stockholders (e.g., Gangloff et al., 2016; Worrell et al., 1993). However, extant literature also shows that such appointments can be perceived as positive or negative, depending on several mitigating factors. As illustrated in Figure 1 below, we hypothesize about the market reaction to CDO appointments by differentiating between CDOs who are appointed to a new position and CDOs who take over an existing position (succession).

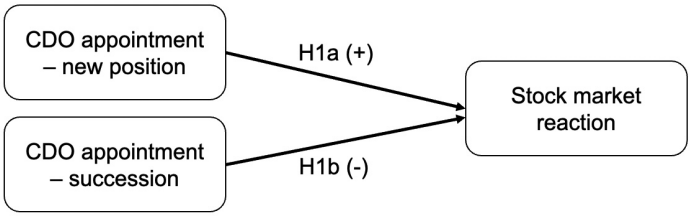

Figure 1: Research model - CDO appointment and market reaction

On the positive side, Chatterjee et al. (2001) show that the market reacts positively to companies appointing newly created chief information officer positions, especially if the companies are characterized by high levels of IT-driven transformation. This is in line with a recent paper by Bandodkar and Grover (2022) that investigates the link between the human and relational capital of C-level IT experts, such as CIOs,and the stock market's reaction. By creating the new chief digital officer position, companies send stakeholders and investors a strategic signal that they are promoting digital initiatives. To set themselves apart from established IT roles, such as the CIO, CDOs create and communicate what Tumbas et al. (2018) refer to as a digital logic of action, which they enact through distinct strategies, such as grafting, bridging, and decoupling. By acting as entrepreneurs, digital evangelists, and coordinators, CDOs can be of key significance for the orchestration and governance of companies' digital transformation and digital initiatives, but typically do not take over a functional IT responsibility (Singh & Hess, 2017). As digital accelerators, CDOs promote digital innovation by experimenting with digital technologies, while existing IT leaders provide the necessary infrastructure (Tumbas et al., 2017). Thus, by appointing a CDO to a newly created position, companies work towards implementing a viable digital business strategy by taking their organizational setting into account and addressing varying aspects of digital transformation (Singh et al., 2020; Tumbas et al., 2017).

The costs associated with appointing a CDO include the executive's compensation and the resources the CDO requires to promote digital innovation and drive the company's digital transformation (Tumbas et al., 2018). At the same time, press releases of publicly listed companies are subject to public and legal scrutiny, which discourages companies from dishonest signaling (Zmud et al., 2010). Thus, only companies that expect the benefits of appointing a CDO to outweigh the costs associated with the role will make and communicate this strategic decision accordingly. We argue that by appointing a CDO to a newly created position, companies send a credible strategic signal of their intention to focus on the challenges of digital transformation. This may

be perceived as an essential indicator of the company's future financial performance, which will the stock price will reflect. We thus hypothesize:

Hypothesis 1a: A CDO appointment to a newly created position is associated with positive market reactions.

On the negative side, some extant research finds no or even negative market reactions following the appointment of an executive to an already existing position. Beatty and Zajac (1987) employ an event study and investigate CEO succession announcements and their effects on stock prices. In the case of CEO successions, "the market perception of a CEO change in which little information is given is typically a negative one" (Beatty & Zajac, 1987, p. 313), pointing to such announcements as being perceived as disruptive and unanticipated events with potentially negative consequences (Beatty & Zajac, 1987). Acknowledging CEO succession as a disruptive event, recent research shows that this disruption might be even amplified and lead to more pronounced negative consequences if CEO succession goes along with gender change (Zhang & Qu, 2016). Along the same lines, Reinganum (1985) find negative effects of CEO succession on stock prices, except for external appointments in small firms. Similar to these findings, investors may perceive CDO succession appointments as negative. We hypothesize:

Hypothesis 1b: A CDO appointment to an existing position (succession) is associated with negative market reactions.

2.3.2 CDO's Power Profile and Market Reactions

In this section, we develop hypotheses regarding our second research question: *What characterizes the power profile of CDOs whose appointment leads to positive market reactions?* We argue that the direction of the market reaction to a CDO appointment depends on investors' perceptions of whether the appointed CDO's power profile fits his or her role and will enable him or her to execute digital initiatives and lead the company's digital transformation. CDOs' power profile can impact the market reaction of CDO appointments to both new and existing positions. For new positions, the power profile may emphasize the potential of the appointed CDO in driving the digital transformation and financial success of a company, which amplifies the positive perception by investors, and vice versa. For successions, we hypothesize a negative market reaction. However, the description of the power profile in an announcement may counteract this effect and lead investors to value a CDO succession appointment positively. As outlined in Appendix A, we focus on three aspects of power: structural, prestige, and expert power. Our research model is depicted in Figure 2.

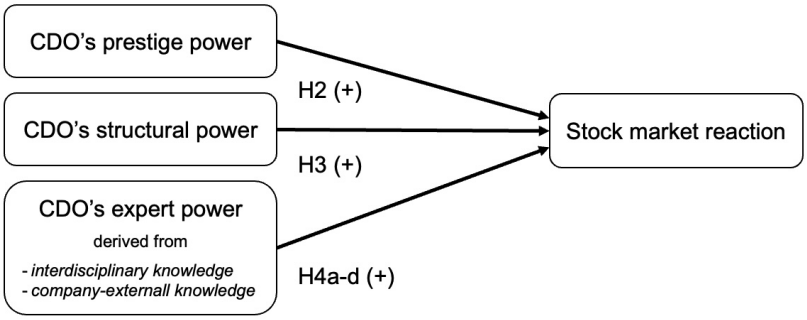

Figure 2: Research model - CDO's power profile and market reaction

CDO's Structural Power and Market Reactions. Executives' structural power derives from the hierarchical authority stemming from their function (Finkelstein, 1992; Hambrick, 1981). Extant literature finds that many CDOs focus on establishing their own legitimacy and carving out their own area of responsibility by underscoring the differences between digital and IT logic (Tumbas et al., 2018), but neglects CDOs' structural power. Drawing on extant literature on other C-level positions, especially CIOs, we argue that positioning CDOs at a high hierarchical level and providing them with the resources they require to promote digital innovation and drive digital transformation will strengthen their sphere of influence. Extant literature on chief information officers identifies structural power as an essential success factor for their strategic decision-making authority and effectiveness (Chen et al., 2010; Preston et al., 2008a). Studies show that CIOs with high structural power are well positioned to build potent relationships with other TMT members and company stakeholders, providing them with more opportunities to drive strategic activities (Carter et al., 2011). CIOs' level of structural power has also been linked to higher organizational performance through its positive effect on IS strategic alignment (Preston & Karahanna, 2009), better long-term performance (Feng et al., 2021), the quality of IT governance (Bradley et al., 2012), the level of information system sophistication (Smith et al., 2013), and companies' perceived IT capability (Lim et al., 2013). Building on these findings, we argue that higher structural power of chief digital officers is associated with higher organizational performance, leading investors to perceive the appointment of a CDO with a higher level of structural power as positive. Therefore, we hypothesize:

Hypothesis 2: An appointed CDO's structural power is associated with positive market reactions.

CDO's Prestige Power and Market Reactions. Prestige power denotes the influence that results from an executive's personal prestige or status (Finkelstein, 1992). For external stakeholders, such as investors, the competencies of a company's TMT are not readily observable. D'Aveni (1990) argues that stakeholders assess the quality of a company's TMT by evaluating the TMT members' prestige as evidenced, for example, by whether they earned degrees from prestigious universities. Stakeholders perceive executives with high standing or strong personal relationships with influential people as having a higher ability to manage uncertainty because they can, for example, use their influential network to obtain relevant information about environmental contingencies early on (Finkelstein, 1992). At the same time, prestigious TMT members have been shown to form relationships with influential external stakeholders more easily, which is linked to higher organizational performance (Higgins & Gulati, 2003; Stuart et al., 1999). Based on these arguments, we argue that investors will perceive a CDO's prestige power positively and therefore hypothesize:

Hypothesis 3: An appointed CDO's prestige power is associated with positive market reactions.

CDO's Expert Power and Market Reactions. Expert power is defined as executives' ability to cope with environmental contingencies by drawing on their relevant knowledge and experience (Finkelstein, 1992). When a CDO acts as a digital harmonizer and/ or coordinator, he or she must possess a broad understanding of the company's business to align different business units and functions, weaken organizational silos, and drive and successfully implement digital initiatives across the organization (Singh & Hess, 2017; Tumbas et al., 2017). Investors may evaluate a newly appointed CDO's expert power based on an interdisciplinary educational background as proof of his or her ability to share and integrate different types of knowledge and collaborate across functions and business units. This aligns with the knowledge-based view that individuals need to share a common language or base their communication on common knowledge to enable

successful knowledge integration and favorable business outcomes (Grant, 1996; Kearns & Sabherwal, 2006). Furthermore, high levels of business understanding help CDOs interpret business challenges and requirements, which positively influences organizational performance (Wagner et al., 2014).

Concerning chief information officers, literature shows that an extensive IT background combined with business orientation leads to a higher quality relationship between CIO and CEO or TMT (Feeny et al., 1992; Preston et al., 2008a). Moreover, several studies emphasize the advantage of IT professionals with business competence, and vice versa (Bassellier & Benbasat, 2004; Bassellier et al., 2003). Additionally, companies pay significant compensation premiums for IT professionals with an MBA compared to other degrees (Mithas & Krishnan, 2008). Accordingly, we argue that appointing a chief digital officer with an interdisciplinary educational background may send a positive strategic signal to investors. Therefore, we hypothesize:

Hypothesis 4a: An appointed CDO's expert power derived from interdisciplinary knowledge is associated with positive market reactions.

CDOs appointed from the outside are equipped with another type of expert power, because they have collected extensive knowledge and experience regarding digital transformation in other contexts and may have demonstrated their ability to lead digital initiatives. Moreover, executives hired from the outside can judge the organization's current state more objectively than insiders with political and personal loyalties and agendas (Chatterjee et al., 2001; Hambrick & Finkelstein, 1987). Extant research on executive appointments finds external hires to be positively associated with strategic change (Schepker et al., 2017), an essential aspect of digital transformation, where companies face changing competitive landscapes due to the disruptive nature of digital technology (Bharadwaj et al., 2013; Vial, 2019). Accordingly, we put forth the following hypothesis:

Hypothesis 4b: An appointed CDO's expert power derived from company-external knowledge is associated with positive market reactions.

3 Methodology – Event Study

To test our research model empirically, we adopted an event study methodology to measure the short-term impact of announcing the appointment of a CDO on a company's equity on the stock market. The event study methodology has been a well-established method in the finance discipline (Binder, 1998; MacKinlay, 1997) since it was introduced by Fama et al. (1969) more than 50 years ago. It has also been widely used in IS literature and applied in various contexts, such as the adoption of identity theft countermeasures (Bose & Leung, 2019), the establishment of a new CIO position (Chatterjee et al., 2001), the appointment of a CIO to the board of directors (Bandodkar & Grover, 2022), and transformational IT investments (Dehning et al., 2003). By conducting an event study, we can isolate and measure the effect of an unexpected event based on changes in stock price (Fama, 1970; McWilliams & Siegel, 1997). We closely followed the approach of earlier event studies (Bose & Leung, 2019; Chatterjee et al., 2001; Dehning et al., 2003; Yang et al., 2012) and tok existing guidelines for conducting event studies into account (McWilliams & Siegel, 1997).

In conducting the event study, we undertook several steps as outlined in the following and in Appendix B: retrieving the events' announcements, filtering announcements, collecting stock prices and other data, constructing the market model, estimating abnormal returns, coding explanatory and control variables, and conducting regression analyses.

3.1 Estimation Method

The underlying idea behind the event study methodology is a comparison between the observed, actual stock market return around an event and the estimated common return on the stock market for a hypothetical scenario where the event did not occur (MacKinlay, 1997). Thus, we compared stock return in the event of appointing a CDO (five-day event window) with a hypothetical, estimated case where a company does not appoint a CDO (estimation window). The five-day event window encompasses the day of the announcement (day 0), two days before (days -1 and -2), and two days after (days +1 and +2), following established guidelines for event studies (MacKinlay, 1997; McWilliams & Siegel, 1997). For the estimation window, we relied on stock price data of 255 trading days starting on t=-300 and ending on t=-45 prior to the event observed (t=0) to ensure that the observed event cannot influence the market model estimates and following the lead of earlier studies in IS literature, most of which use the same estimation window (e.g., Chatterjee et al., 2001; Dehning et al., 2003). We calculated the daily abnormal return by comparing the observed market return of the event window with the estimated return of the estimation window. Daily abnormal return was then averaged across all companies and cumulated over the event window to measure the average effect of an event across the entire length of the event window.

We then evaluated the statistical significance of the market reaction to an event, using both a parametric and non-parametric test, as suggested by McWilliams and Siegel (1997), to control for the possibility of outliers or violations of the normality assumption. The described approach to derive the CAR and to test the statistical significance of the market reaction follows the procedure employed in previous event studies in IS (e.g., Bose & Leung, 2019; Dehning et al., 2003; Yang et al., 2012)[2] and is described in detail in Appendix B.

3.2 Data

Announcements of CDO appointments from 2009 to 2020 were retrieved via LexisNexis, a database for periodical articles and press releases. Our comprehensive search used the keyword "chief digital officer" and alternative position titles, such as "vice president digital" or "head digital" as well as abbreviations, such as "CDO", along with keywords such as "appoint", "create", "establish", "name" or "new" that indicate an appointment. In selecting our keywords, we followed the lead of other event studies that explore the announcement of managerial positions (e.g., Chatterjee et al., 2001). We included different CDO position titles to account for differences in titles across companies and covered the period January 1, 2009 to December 31, 2020. Our initial search resulted in 7,014 announcements. A comprehensive filtering process and quality checks (see Appendix B for details) led to a final sample of 334 CDO appointment announcements.

Next, we coded the press releases to retrieve detailed information about the CDO's characteristics and the organization (see following subsection). We then matched all remaining announcements with daily stock price data for the respective company. We retrieved stock price data, prices of market indices and company characteristics from Refinitiv Eikon. In this step, we filtered out 27 announcements of companies for which stock price data was missing. Our final sample contained 307 CDO appointment announcements.

[2] For a detailed description of the event study methodology, including the formula for the calculation of the cumulative abnormal return and the test statistics see also Bose and Leung (2019). We followed their approach closely.

To connect with extant research, we also collected data on chief information officer appointments for the timeframes (1) 1987-1998, the period also used by Chatterjee et al. (2001) and (2) 2011-2020, a period comparable to our sample of CDO appointments. We provide detailed information on the collected data in Appendix C. The corresponding findings are shortly presented in Section 4.1.3 and 4.2.4 and described in more detail in Appendix C.

3.3 Variables

3.3.1 Dependent Variable

Cumulative abnormal return (CAR), a measure of the market reaction in the five days surrounding the event (day -2 through day +2), is our dependent variable. CAR denotes the difference between a company's observed stock market return at the event and the expected return in the absence of an event, cumulated across the five days surrounding the event (see Appendix B for details).

3.3.2 Independent Variables

To explain the cumulative market reaction during the event window, we derived explanatory variables from the press releases, taking a power theory perspective. First, we reviewed categories in existing research to assess executives' structural, prestige, and expert power (e.g., Banker et al., 2011; Feng et al., 2021; Feng et al., 2015; Finkelstein, 1992) and adopted categories that could be derived from the information in the press releases. Additionally, we scanned a random sample of twenty press releases to identify additional information signaling structural, prestige, and expert power among CDOs. The resulting coding framework represents indicators of CDOs' structural, prestige, and expert power as well as control variables and was used to code all press releases.

We took several steps to ensure a high quality, consistency, and intercoder reliability of the coding process[3]. First, all categories of the coding framework were defined and described in detail beforehand. Second, two researchers conducted a pilot coding by first coding a sample of ten press releases independently and discussing different coding outcomes until consensus was reached. After repeating this approach two times and intercoder reliability of 94% across the variables was achieved and the researchers continued to code the remaining sample independently. Third, during the coding process, regular meetings took place to discuss questions and coding disagreements. For the principal analysis all explanatory variables were derived exclusively from information provided in the press releases, because these represent observable signals for investors. Table 1 summarizes the variables.

Structural power. We used established measures of structural power in this study, such as reporting distance to the CEO, TMT membership, and title rank (e.g., Banker et al., 2011; Feng et al., 2021; Smaltz et al., 2006). Additionally, we included the resource endowment of CDOs with a team or business unit as an additional variable to measure structural power because these resources facilitate exerting influence.

Prestige Power. Following Finkelstein (1992), we used elite education to measure a CDO's prestige power. A degree from an elite university provides executives with a personal network with other people in powerful positions who attended the same elite institution with them (Finkelstein, 1992). More recent studies have also considered executives with work experience in large IT companies to carry prestige (Pollock et al., 2010), since they can be expected to have personal ties

[3]Due to length restrictions, we did not include sample sets of announcements and their coding in the manuscript. However, we will gladly provide them upon request.

to stakeholders and access to valuable information about these companies (Burton et al., 2002). Start-up experience also carries prestige, signaling entrepreneurial spirit and more virtue than established companies (Gamez-Djokic et al., 2022).

Expert Power. Prior IS literature has emphasized the importance of interdisciplinary education and competencies for business and IT professionals (Bassellier & Benbasat, 2004; Bassellier et al., 2003; Mithas & Krishnan, 2008). Accordingly, we included the interdisciplinary nature of CDOs' educational background, measured as at least one degree in both business and IT, as a dimension of their expert power. Earlier literature has also argued that externally hired executives introduce new perspectives and knowledge and challenge existing assumptions and beliefs (e.g., Chatterjee et al., 2001), leading us to consider external experience (outside) as a measure of expert power. Additional measures were considered in the robustness checks (see Appendix E).

Table 1: Description and measurement of variables

Type of variable	Variable name	Description	Measure
Dependent variable	CAR_i	Average cumulative abnormal return for company i over event window -2 to +2 (e.g., Bose & Leung, 2019; McWilliams & Siegel, 1997)	CAR_i
Structural power	**Title Rank**	Indicator of hierarchical rank based on job title for appointed CDO (based on Feng et al., 2015; Garms & Engelen, 2019)	President/CxO = 6, Executive Vice President = 5, Senior Vice President = 4, Vice President = 3, other title = 2, no executive title = 1, no information = 0
	TMT	Indicator of CDO's membership in company's TMT (based on Bandodkar & Grover, 2022; Feng et al., 2021; Smaltz et al., 2006)	CDO is member of top management team = 1; Otherwise = 0
	Team	Indicator of whether appointed CDO has a team or business unit at his/her disposal (OM)	CDO has a team/business unit to drive digital transformation = 1; Otherwise = 0
	Reporting Line CEO	Indicator of direct reporting line between appointed CDO and CEO (based on Banker et al., 2011; Smith et al., 2013)	Direct reporting line CDO-CEO = 1; Otherwise = 0
Prestige power	**Elite Education**	Indicator of degrees from elite universities that appointed CDO received (based on Finkelstein, 1992)	Number of elite degrees that CDO received; Otherwise = 0
	Experience Start-up	Indicator of CDO's start-up working experience prior to appointment (OM)	CDO worked in start-up prior to appointment = 1; Otherwise = 0
	Experience Big Tech	Indicator of CDO's work experience in one of the largest information technology companies in the world (OM)	CDO worked in Global Fortune 500 IT company prior to appointment = 1; Otherwise = 0
Expert power	**Outside**	Indicator of externally hired CDO (Chatterjee et al., 2001; Karimi et al., 1996)	Externally hired CDO = 1; Otherwise = 0
	Interdisciplinary	Indicator that CDO possesses an educational degree in business and computer science (OM)	CDO with educational degree in both business and computer science = 1; Otherwise = 0
	Business Degrees	Indicator of depth of CDO's business knowledge (based on Armstrong & Sambamurthy, 1999; Smaltz et al., 2006) derived from CDO's educational background in business and/or management	Number of business or management degrees (max. 3); Otherwise = 0
	Computer Science Degrees	Indicator of depth of CDO's IT knowledge (based on Armstrong & Sambamurthy, 1999; Smaltz et al., 2006) derived from CDO's educational background in computer science (based on Lim et al., 2013)	Number of computer science degrees (max. 3); Otherwise = 0
	Other Degrees	Indicator of depth of CDO's non-IT/non-business knowledge based on CDO's educational background in areas other than computer science and business (OM)	Number of other degrees (max. 3); Otherwise = 0

Table 1: Description and measurement of variables

Type of variable	Variable name	Description	Measure
Control variables	**Profile Business Unit**	Indicator for CDOs responsible for driving digital initiatives in one business unit, but not across the entire organization (OM)	CDO responsible for digital initiatives in one business unit = 1; Otherwise = 0
	Profile Functional	Indicator for CDOs with functional role profile (e.g., responsibility for digital marketing, sales, or innovation) (OM)	CDO with functional role profile = 1; Otherwise = 0
	Technology Responsibility	Indicator for CDOs with responsibility for IT (e.g., IT architecture, cost-effective IT services) (OM)	CDO with responsibilities for IT = 1; Otherwise = 0
	Mixed Responsibility	Indicator for CDOs with mixed responsibility for both information technology infrastructure and digital initiatives/transformation (OM)	CDO with responsibilities for IT and digital transformation = 1; Otherwise = 0
	US	Country dummy indicating whether the announcing company is based in the US (Jacobs & Müller, 2020)	US = 1; Otherwise = 0
	Female	Indicator of appointed CDO's gender (e.g., Zhang & Qu, 2016)	Female = 1; Male = 0
	New position/ Succession	Indicator of whether the CDO appointment was a succession or newly created role, based on Chatterjee et al. (2001)	CDO appointment to new position where no CDO or CIO position previously existed = New position; Otherwise = Succession

General Notes: All measures of CDOs' power were derived from extant literature on CIOs or other C-level executives or constitute own measurements (OM). In line with our event study methodology, we coded the presence of information regarding a power dimension as 1, while we coded the absence of information as 0.
Elite education: For the US, undergraduate and graduate schools were considered to constitute elite universities, if they appeared in the U.S. News & World Report Historical Liberal Arts College and University Rankings in the top 20 at least once in the period 1985-2020 (Reiter, 2021). For non-US undergraduate and graduate schools a comparable measure was created based on the QS World University Rankings ("QS World University Rankings", 2021).
Experience Big Tech: We used historical data on the Global Fortune 500 companies ("Fortune Global 500", 2021) in the period 2009-2020 to identify the largest IT companies, as which we categorized companies in the industrial subsectors "Computer Software", "Computers, Office Equipment", "Information Technology Service", "Semiconductors and Other Communications Equipment", "Network and Other Communications Equipment", and "Internet Services and Retailing".
Role Profile: Please note that the control variables describing CDOs' role profile can overlap, since a CDO can, for instance, be responsible for marketing (functional) for one product segment (business unit).

New position. We split our sample when analyzing the market reaction to CDO appointments by differentiating between two types of positions: new positions and succession. We considered CDO appointments to constitute a new position if no CDO or CIO existed in the company or during the appointment. Adopting this approach, we can eliminate the possibility that a CIO position was renamed to create a CDO position. This approach also allows us to compare our results with Chatterjee et al. (2001), who only studied newly created positions during a timeframe when CIOs constituted novel C-level executives. All CDO appointments in companies where a CDO or CIO previously existed were considered successions.

3.3.3 Control Variables

We included control variables in the regression analysis and robustness checks (see Appendix E). Extant research has identified different role profiles for CDOs, ranging from role profiles with overarching responsibility for all digital initiatives to specialized role profiles, with a focus on digital innovation or digital marketing only (Singh & Hess, 2017; Tumbas et al., 2017). At the same time, CDOs may not be responsible for driving digital initiatives across the entire organization but only for a specific business unit. Accordingly, we used control variables to identify CDOs with responsibility for one business unit, CDOs with a functional role profile, e.g., on marketing or innovation, CDOs with mixed responsibility for IT and business, and CDOs with responsibility for IT infrastructure only (see Table 1 for details). Additional control variables are described in Table 1 and Table 17 in Appendix E.

3.3.4 Regression Analysis

To test our hypotheses, we used the CAR over the event windows (day -2 to day +2) as the dependent variable in a multivariate OLS regression, following earlier IS studies (e.g., Bose & Leung, 2019; Chatterjee et al., 2001). We included explanatory variables to explain the CAR in the event window, taking a managerial power theory perspective. These explanatory variables represent indicators for CDOs' structural, prestige, and expert power. In the following, we show the results of different models to study CDOs' power profile. The regression equation reflects the consolidated model with controls for CDO succession appointments (see Table 5, Models III to IV):

$$CAR_i = \beta_0 + \beta_1 TMT_i + \beta_2 Team_i + \beta_3 ReportingLineCEO_i + \beta_4 EliteEducation_i + \beta_5 ExperienceStartup_i + \beta_6 Outside + \beta_7 Interdisciplinary_i + \beta_8 BusinessDegree_i + \beta_9 ComputerScienceDegree_i + \beta_{10} OtherDegree_i + Controls + u_i$$

In addition to the regression analyses reported in the following sections, we also conducted several robustness checks using alternative event windows, different estimation windows and additional control variables (see Appendix E).

4 Results

4.1 Market Reactions to CDO Appointments

In the following, we analyze the market reaction separately for CDOs appointed to a newly created position and CDOs succeeding a CIO or CDO in the company. We then compare the results to findings for CIO appointments.

4.1.1 CDO Appointments to Newly Created Positions

Table 2 illustrates the cumulative abnormal return for CDOs appointed to newly created positions for companies where no CDO or CIO position previously existed[4]. We depict different configurations of the event window and report the corresponding z-score and p-value of the parametric and non-parametric tests. Our analysis identifies a positive market reaction to the announcement of CDO appointments for newly created positions. This effect is statically significant according to the Patell test for the event window [-2;2] and [0;2] (p-value < 0.01).

Event window	Obs.	Mean	Patell z-score	Patell p-value	Sign test z-score	Sign test p-value
$[-2; 2]$	90	0.57%	2.52***	0.01	0.42	0.92
$[-2; 0]$	90	0.09%	0.71	0.48	0.63	0.60
$[0; 2]$	90	0.49%	2.76***	0.01	0.63	0.60
$[-1; 1]$	90	0.22%	0.74	0.46	0.21	0.92
Note: *, **, *** = statistically significant at the 10%, 5% and 1% level, respectively, in a two-tailed test.						

Table 2: Cumulative abnormal return - CDO new position

[4]This restrictive definition of a new position allows us to filter out companies, which may have renamed their CIO position to a CDO position, without changing the appointed executive's responsibilities.

Considering the event window [-2; 2], the value of the stock increases by an average of 0.57% after a company's announcement to appoint a CDO, which is a sizeable effect size that is comparable to other event studies (e.g., Bose & Leung, 2019; Han & Chang, 2012). To illustrate the effect size, consider the example of a company like General Electric (GE), with an average market capitalization of approximately USD 190 bn across our sample period 2009-2020. An increase of 0.57% against the market index would have resulted in a gain of, on average, approximately USD 1.08 billion in market capitalization in five days for GE.

We also observe some heterogeneity in the market reaction. We identify we observe a positive but statistically insignificant market reaction for the specific event windows [-2;0] and [-1;1]. Such heterogeneity of effects across event days and windows is in line with earlier event studies that report different event windows (e.g., Han & Chang, 2012; Yang et al., 2012). The sign test indicates no statistical significance for all event windows.[5]

Hypothesis 1a states that announcements of CDO appointments to new positions are associated with a positive market reaction. Overall, the results presented in Table 2 show support for this hypothesis.

4.1.2 CDO Appointments to Existing Positions

Table 3 depicts the cumulative abnormal return for CDO succession appointments. We find a negative and statistically significant effect of announcing the appointment of a CDO succession on the cumulative abnormal return in all event windows according to both the Patell and sign test, except for the event window [-1;1], where the non-parametric sign test could detect no statistical significance. Considering the event window [-2; 2], the value of the stock decreases by an average of 0.76% (p-value < 0.01) after a company's announcement to appoint a succeeding CDO, an effect greater in size than the average positive market reaction to CDO appointments to new positions. Hypothesis 1b states that announcing a CDO appointment for a succession is associated with a negative market reaction. As illustrated in Table 3, our results show strong support for this hypothesis.

Event window	Obs.	Mean	Patell z-score	Patell p-value	Sign test z-score	Sign test p-value
[−2; 2]	217	-0.76%	-4.93***	0.00	-2.65***	0.01
[−2; 0]	217	-0.57%	-4.43***	0.00	-1.97*	0.06
[0; 2]	217	-0.46%	-3.96***	0.00	-2.51**	0.01
[−1; 1]	217	-0.50%	-3.97***	0.00	0.07	1.00
Note: *, **, *** = statistically significant at the 10%, 5% and 1% level, respectively, in a two-tailed test.						

Table 3: Cumulative abnormal return - CDO succession

4.1.3 Comparison to Findings for CIO Appointments

Our study's results for CDO appointments to newly created positions for recent years align with findings by Chatterjee et al. (2001) on announcements of chief information officers' appointment to newly created positions in the timeframe 1987-1998, which are associated with significant

[5]A closer analysis showed that this difference in the test statistics for the parametric and non-parametric test is not driven by outliers but can be attributed to the mechanisms of the non-parametric test. Thus, the sign test examines whether the number of announcements that are followed by a positive market reaction significantly differs from the number of announcements with a negative market reaction. While the number of announcements does not differ significantly, positive market reactions are on average larger in size leading to the observed effect.

positive market reactions. To ensure the consistency of our methodological approach with earlier event studies and to analyze the persistence of these findings until today, we also analyzed market reactions to CIO appointments during the period 1987-1998 and the recent period 2011-2020, as shown in Appendix C. Our results in Table 12 in Appendix C show that CIO appointments during the more recent period 2011-2020 elicited a negative market reaction for both new positions and succession. The observed negative effect is comparable in size to the market reaction of chief digital officer succession appointments in our study and is highly statistically significant.

4.2 Regression Results for CDOs' Managerial Power

In the following, we present the results of a multivariate regression of the cumulative abnormal return on the stock market in a five-day event window [-2;2] using different explanatory variables describing CDOs' power profile. While Table 4 shows the result of the multivariate regression for CDO appointments to new positions, Table 5 depicts the regression analysis for CDO succession appointments. Model I shows the combined effect, Model II represents a consolidated model[6], and Models III and IV include control variables. As we illustrate in further analysis and robustness checks in Appendix E, the identified effects observed for structural, prestige and expert power are robust to the inclusion of a wide range of control variables on the individual, organizational and industry level as well as other event and estimation windows.

4.2.1 Regression Results for CDOs' Structural Power

Hypothesis 2 argues that the abnormal return following a company's announcement to appoint a CDO is positively associated with the CDO's structural power. For CDO appointments to new positions, Models I to IV in Table 4 illustrate that CDOs' title rank, membership in the TMT, and endowment with a subordinate team or business unit do not influence the market reaction. Surprisingly, we find a statistically significant negative effect for a direct reporting line between CDO and CEO, but no statistically significant effect for other reporting structures (see Appendix E). The negative effect for the CDO-CEO reporting line is robust to the inclusion of control variables, as shown in Models III and IV.

Our results therefore indicate no support for hypothesis 2 for CDO appointments to new positions. Instead, we find a negative effect for CDOs' reporting line to the CEO, an effect we explore in depth in a post-hoc analysis (see Appendix D). Moreover, we observe that frequently used variables of structural power, such as CDOs' title rank and membership in the TMT show non-significant and non-sizeable effects in our analysis.

For CDO succession appointments, Models I to IV in Table 5 show that CDOs' title rank and membership in the TMT do not influence the market reaction. Yet, announcements of CDO appointments with a subordinate team or business unit are perceived as positive by the stock market, with an average return of 3.24% (Model I). This effect is statistically significant at the 10% level for Model I only. Surprisingly, we again find a statistically significant negative effect for a direct reporting line between CDO and CEO, but no statistically significant effect for other reporting structures (see Appendix E). This negative effect is statistically significant in Models I to IV (p-value < 0.1). In combination, the effects for both significant structural power variables lead to a slight positive effect for CDO succession appointments.

[6] We use a consolidated model in order to increase the statistical power of the provided regression analysis to an acceptable level. This is necessary due to the sample size for the CDO appointments to new positions.

Regression models	Complete model	Consolidated model	Model (II) with controls	Model (II) with controls
	(I)	(II)	(III)	(IV)
Constant	-0.0117	0.0004	-0.0065	0.0034
	(0.0473)	(0.0168)	(0.0217)	(0.0176)
Title Rank	0.0025			
	(0.0088)			
TMT	0.0230	0.0310	0.0270	0.0300
	(0.0271)	(0.0237)	(0.0251)	(0.0254)
Team	0.0254	0.0229	0.0189	0.0202
	(0.0242)	(0.0231)	(0.0222)	(0.0232)
Reporting Line CEO	-0.0461**	-0.0454**	-0.0403**	-0.0469**
	(0.0209)	(0.0197)	(0.0216)	(0.0200)
Elite Education	-0.0016			
	(0.0193)			
Experience Big Tech	-0.0115			
	(0.0183)			
Experience Start-up	0.0299			
	(0.0482)			
Outside	0.0249	0.0269	0.0294	0.0265
	(0.0216)	(0.0205)	(0.0204)	(0.0210)
Interdisciplinary	0.0850*	0.0844**	0.0835*	0.0840*
	(0.0441)	(0.0409)	(0.0435)	(0.0439)
Business Degrees	-0.0334*	-0.0354**	-0.0311*	-0.0337**
	(0.0190)	(0.0174)	(0.0185)	(0.0168)
Computer Science Degrees	-0.0420***	-0.0424***	-0.0390***	-0.0428***
	(0.0155)	(0.0119)	(0.0138)	(0.0104)
Other Degrees	-0.0047			
	(0.0214)			
Control Variables	*No*	*No*	*Profile*	*Responsibility, US, Gender*
Sample size	90	90	90	90
R-squared	13.00%	11.79%	14.56%	14.07%
Adjusted R-squared	0.00%	4.26%	3.74%	3.20%

Note: *, **, *** = statistically significant at the 10%, 5% or 1% level, respectively. Robust standard errors are given in brackets

Table 4: Regression analysis – CDO new position

Overall, our results for CDO succession appointments indicate no support for hypothesis 2. While one structural power variable, CDOs' team endowment, supports our hypothesis in one model, we find a stable, negative effect for CDOs' reporting line to the CEO, an effect that we explore in depth in a post-hoc analysis (see Appendix D). Our regression analysis shows that CDOs' title rank and membership in the TMT show non-significant and non-sizeable effects in our regression analysis.

Regression models	Complete model	Consolidated model	Model (II) with controls	Model (II) with controls
	(I)	(II)	(III)	(IV)
Constant	-0.0099	0.0305***	-0.0354***	-0.0299***
	(0.0190)	(0.0094)	(0.0123)	(0.0100)
Title Rank	-0.0043			
	(0.0035)			
TMT	0.0110	0.0088	0.0094	0.0111
	(0.0106)	(0.0107)	(0.0105)	(0.0117)
Team	0.0324*	0.0301	0.0308	0.0295
	(0.0193)	(0.0184)	(0.0188)	(0.0188)
Reporting Line CEO	-0.0253*	-0.0280**	-0.0264*	-0.0281*
	(0.0148)	(0.0143)	(0.0143)	(0.0144)
Elite Education	0.0258*	0.0243*	0.0243*	0.0244*
	(0.0140)	(0.0142)	(0.0140)	(0.0142)
Experience Big Tech	0.0004			
	(0.0168)			
Experience Start-up	0.0099	0.0093	0.0118	0.0076
	(0.0122)	(0.0108)	(0.0112)	(0.0110)
Outside	0.0251**	0.0270**	0.0261**	0.0274**
	(0.0114)	(0.0112)	(0.0116)	(0.0113)
Interdisciplinary	-0.0070	-0.0050	-0.0041	-0.0068
	(0.0179)	(0.0166)	(0.0186)	(0.0162)
Business Degrees	-0.0120	-0.0100	-0.0109	-0.0107
	(0.0093)	(0.0093)	(0.0095)	(0.0092)
Computer Science Degrees	0.0079	0.0069	0.0090	0.0088
	(0.0096)	(0.0071)	(0.0078)	(0.0075)
Other Degrees	-0.0339**	-0.0338**	-0.0311**	-0.0325**
	(0.0135)	(0.0138)	(0.0134)	(0.0136)
Control Variables	*No*	*No*	*Profile*	*Responsibility, US, Gender*
Sample size	217	217	217	217
R-squared	9.16%	8.58%	8.90%	8.89%
Adjusted R-squared	3.81%	4.15%	3.08%	3.06%

Note: *, **, ***= statistically significant at the 10%, 5% or 1% level, respectively. Robust standard errors are given in brackets

Table 5: Regression analysis – CDO succession

4.2.2 Regression Results for CDOs' Prestige Power

Hypothesis 3 suggests that abnormal returns in response to CDO appointments are positively associated with CDOs' prestige power. For CDO appointments to new positions, the regression analysis on the market reaction to CDOs' prestige power, depicted in Model I in Table 4, indicates no statistically significant effects. Even though CDOs' experience in a start-up has a positive and sizeable coefficient, it is statistically insignificant. The coefficients for CDOs' elite education and experience in big tech companies are close to zero or negative and statistically insignificant. Thus, for newly created CDO positions, we find no support for hypothesis 3.

Next, we analyze the market reaction associated with CDOs' prestige power for succession appointments, which is depicted in Models I to IV in Table 5. All models show a statistically significant effect of CDOs' elite education. On average, stocks rise by 2.43% (Model II, p-value < 0.1) if a CDO with a degree from an elite university is appointed to a CDO succession position. In contrast, experience in big tech companies has no statistically significant effect on investors'

reaction. Overall, and in contrast to CDO appointments to new positions, we find support for hypothesis 3 for CDO succession appointments.

4.2.3 Regression Results for CDOs' Expert Power

Hypothesis 4a suggests that abnormal returns in response to CDO appointments are positively associated with CDOs' expert power derived from interdisciplinary knowledge (a combination of business and IT knowledge). The regression results of Models I to IV in Table 4 show strong support for this hypothesis (p-value < 0.1). This contrasts with the regression results for the number of degrees in either business or computer science, where a statistically significant negative effect exists. The combined effect for the appointment of a CDO with one degree in business or management and another degree in computer science leads, on average, to a stock price increase of 0.66%[7] (Model II).

For CDO succession appointments, we find no statistically significant effect for CDOs' expert power derived from interdisciplinary knowledge, as Models I to IV in Table 5 illustrate. Therefore, hypothesis 4a is not supported for CDO succession appointments. Yet, our analysis in Table 5 shows that investors sanction the appointment of CDOs with degrees in engineering and/ or humanities (other degrees).

Hypothesis 4b argues that the abnormal return following a company's announcement to appoint a CDO is positively associated with the CDO's expert power derived from external knowledge. When analyzing the market reaction for CDO appointments to new positions, Models I to IV in Table 4 show that CDOs with company-external knowledge, measured by CDOs' external hiring status (outside), are perceived as positive by investors, but the coefficient is statistically insignificant. Thus, we find no support for hypothesis 4b.

When we turn to CDO succession appointments, Models I to IV in Table 5 illustrate that CDOs hired externally are also perceived as positive by investors. On average, a company announcing the appointment of a CDO from outside the company can ceteris paribus expect a cumulative increase of 2.70% (Model II) of its stock, an effect that is highly statistically significant at the 5% level and robust to the inclusion of controls. Thus, we find strong support for hypothesis 4b for CDO succession appointments.

4.2.4 Comparison to Results for CIO Appointments

Our analysis in Table 13 in Appendix C shows different results for investors' reactions to chief information officers' power profiles following their appointments in the timeframe 2011-2020, compared to investors' reactions to chief digital officer appointments. Only the positive market reaction of CIOs' expert power derived from business knowledge is statistically significant. In contrast, structural power and other expert power variables exhibit no statistically significant association with the market reaction following CIO appointments. These findings are presented and discussed in detail in Appendix C.

4.3 Post-hoc Regression Analysis

The negative market reaction for CDOs with a direct reporting line to the CEO contrasts with the positive effects identified in earlier literature for CIOs reporting to the CEO (Bradley et al.,

[7] This effect is calculated by summing up the value of the coefficients for "Interdisciplinary", "Business Degrees" and "Computer Science Degrees".

2012; Chen et al., 2010; Preston et al., 2008a). To gain a deeper understanding of this result, we carried out a post-hoc analysis driven by extant literature pointing to the diversity of roles taken over by CDOs (Singh & Hess, 2017; Tumbas et al., 2017) as well as the emphasis that both centrally and decentrally positioned CDOs drive digital transformation (Singh et al., 2020). For both new positions and successions, we find that the negative market reaction to the direct reporting line CDO-CEO is driven by a negative perception of this reporting line when combined with a CDO responsible for one business unit only or, to a smaller extent, a CDO taking care of both digital transformation and IT infrastructure or responsible for IT infrastructure only. The post-hoc regression analysis is presented in detail in Appendix D.

5 Discussion

In this paper, we raised two research questions to explore the link between CDO appointments and companies' financial performance. In the following, we discuss our results.

5.1 New Position vs. Succession of CDO Appointments

Regarding our first research question, which analyzes how CDO appointments are related to market reactions measured by abnormal returns, we find that on average – and without accounting for other influences – investors react negatively to CDO succession appointments. This negative market reaction to CDO succession appointments is in line with prior literature on CEO successions, which has generally found succession announcements to form unexpected and disrupting events, which are met with an adverse market reaction (Beatty & Zajac, 1987). However, we also identify exceptions, where the provided information regarding CDOs' power profile counteracts the negative perception. Thus, succession appointments of CDOs with company-external knowledge, elite university degrees or CDOs endowed with a team or business unit are, after all, perceived as positive by investors.

In contrast to successions, CDOs appointed to a newly created position are perceived as positive by investors, in line with findings on chief information officers appointments to newly created positions (Chatterjee et al., 2001) in the timeframe 1987-1998. To analyze the persistence of these findings until today, we conducted an additional analysis on the market reactions to chief information officer appointments in two different periods (1987-1998 and 2011-2020). In line with Chatterjee et al. (2001), we also identify a positive market reaction for earlier CIO appointments to new position using data from 1987 to 1998. However, using data from 2011 to 2020, a period similar to our analysis of CDO appointments, we find that in this more recent timeframe, investors react negatively to companies appointing a CIO to new and existing positions (see Appendix C).

The diverging effects identified for newly created CIO and CDO positions in recent years could be caused by investors' perception of two alternative notions of novelty. On the one hand, the creation of a new position in a company – regardless of the competitive environment – may be perceived as positive by investors since it signals a change in the company's strategic direction toward digital initiatives. On the other hand, C-level appointments to newly created positions may be valued by investors, if these appointments are new to the company and new across industries. Thus, the appointing companies signal their leadership in the industry. While CIO positions were still reasonably new across industries during the period studied by Chatterjee et al. (2001), this novelty has vanished in recent years. Therefore, we assume that the market reaction is positive, if the CDO or CIO position is newly created at a company and, at the same

time, constitutes a relatively new position across industries. This reasoning is in line with extant literature showing that proactive investments have positive market externalities which lead to a more positive market reaction (Kwon & Johnson, 2014). Therefore, we argue that thirty years ago the appointment of a CIO signaled organizations' strategic action towards the innovative use of IT (Chatterjee et al., 2001). Today, the importance of IT investment and the widespread use of IT in organizations for business value is firmly established (Melville et al., 2004). Thus, a CIO appointment itself may no longer be decisive for investors in evaluating an organization's future prospects.

In addition to the novelty argument, market reaction to newly created CDO positions may be positive due to the distinct nature of the CDO, as perceived by investors. Extant literature offers some evidence for this possible explanation. For example, Tumbas et al. (2018) explore how CDOs establish their own jurisdiction and use distinct strategies to enact this logic to differentiate themselves from the established IT function and the CIO. Our findings on different market reactions for CIOs and CDOs further indicates of the strategically distinct nature of both executives.

5.2 CDOs' Managerial Power

Our second research question explores the power profile of CDOs whose appointment leads to positive abnormal returns. We find that the overall negative market reaction can turn positive for CDO succession appointments with strong structural, prestige, and expert power. In contrast, the overall positive market reaction for CDO appointments to new positions may turn negative for CDOs with weak structural and expert power. Earlier studies using power theoretical arguments have frequently taken non-specific conceptual and measurement perspectives on power by using power-related concepts or variables without explicitly relating to power theory or, if using a power lens, predominantly focused on structural power only. In contrast, we took a more comprehensive approach to studying the impact of CDOs' power profile on abnormal returns by considering structural, prestige, and expert power. Our findings add to existing knowledge on executives' power in the following ways.

First, we find that CDOs with high levels of structural power measured by their endowment with a team or business unit are perceived as positive by investors when appointed to an existing position. This finding is in line with extant knowledge on the importance of executives' structural power (Bradley et al., 2012; Feng et al., 2021). At the same time, we also move beyond existing knowledge by showing that we need to differentiate conceptually between distinct types of structural power. In the case of CDOs, it is not structural power derived from the hierarchical position, such as CDOs' membership in the TMT or title rank. Instead, structural power derived from resource endowment determines investors' positive perception of CDO appointments. This positive perception of structural power is limited to CDO succession appointments.

Second, in a post-hoc analysis, we further show that the surprising negative reaction to CDOs with a reporting line to the CEO, another measure of structural power, is mainly driven by CDOs responsible for a specific business unit (business unit profile, instead of a corporate profile) or mixed responsibility for both IT infrastructure and digital transformation. This finding corresponds to Preston et al. (2008b). When studying different CIO roles and reporting lines, they argue that CIOs with a low level of both strategic effectiveness and strategic decision-making authority (IT Mechanic CIOs) are associated with the lowest contribution of IT to organizational performance. Most of these IT Mechanic CIOs do not report to the CEO and

their position "may reflect an intentional decision on the part of top management teams to limit or neutralize the risk of investing in IT resources and in developing a strategic CIO" (Preston et al., 2008b, p. 63). Similarly, we argue that the appointment of a CDO responsible for driving digital transformation in one specific business unit signals a risk-averse strategy toward digital transformation. The provision of the same CDO with a direct reporting line to the CEO, which emphasizes the significant importance of the digital transformation for the organization, forms a contradiction. In a similar vein, the appointment of a CDO who simultaneously takes on the role of CIO and is thus responsible for both IT infrastructure and digital transformation does not signal that the organization sees digital transformation as a high priority worth its own managerial position. Again, this contradicts the direct reporting line of the CDO to the CEO. This is similar to Karpovsky and Galliers (2013), who hypothesize a negative relationship between formal hierarchical CIO power and an undefined IS strategy. Overall, such CDO appointments give rise to a negative market reaction due to incongruent signals, which have previously been identified as the cause for negative market reactions surrounding situations of organizational misconduct (Paruchuri et al., 2021).

Third, we demonstrate that the predominant focus of earlier studies on structural power neglects the empirical significance of other types of power. We provide evidence that expert power, and – to a lesser extent – prestige power constitute essentialdimensions of CDOs' power profiles that influence investors' perceptions of CDO appointments. While for CDO succession appointments we identify significant positive market reactions to appointments of CDOs with a high level of prestige and expert power, the pattern is more complex for CDO appointments for new positions. Investors only value expert power derived from interdisciplinary knowledge. In contrast, investors perceive in-depth knowledge in one domain is perceived as negative by investors. Additionally, prestige power plays no significant role in the market reaction of CDO appointments to new positions. Apart from Lim et al. (2013) and Preston et al. (2008a), who include expert and structural power in their study, the power dimensions of prestige and expert power – to our knowledge – have been largely overlooked by extant research. Our findings indicate the importance of a more nuanced perspective on CDOs' power profile covering structural, prestige, and expert power for short-term financial performance. Thus, we see our study as a vital contribution to a better understanding of the different dimensions of functional executives' managerial power and their significance in explaining short-term financial performance.

Fourth, we identify and demonstrate the importance of new conceptual dimensions of expert power. We differentiate between expert power derived from different sources and show that these different types have significant but partly diverging effects on investors' perception of the appointed CDO. For CDO appointments to new positions, the level of expert power derived from business and IT knowledge are associated with negative and statically significant market reactions. In contrast, expert power derived from interdisciplinary knowledge leads to significant positive market reactions. Investors appear not to perceive the depth of knowledge as beneficial for CDOs. In contrast, the knowledge of how to align business and IT in a company, measured as CDOs' interdisciplinary educational background, is perceived as a success factor for CDOs appointed to new positions. For CDO succession appointments, we further find that expert power derived from knowledge acquired outside the appointing company is perceived as positive by investors. Power derived from interdisciplinary and company-external knowledge comprise new dimensions of expert power. We show that future research should consider these new dimensions of prestige and expert power to understand executives' power profiles and their effect on financial performance. Moreover, identifying the optimal and combined level of IT and business knowledge adds to our understanding of CDOs' role.

Fifth, we show that different types of power are relevant for CDO appointments to new positions compared to successions. Whereas for CDO appointments to new positions only expert power derived from interdisciplinary knowledge impacts market reactions, for CDO succession appointments structural and prestige power and expert power derived from company-external knowledge influence investors' reactions. This can be attributed to the different situations and responsibilities of the appointed CDO. CDOs appointed to new positions may focus on analyzing the company's current situation and creating a digital transformation roadmap. These are tasks where broad and interdisciplinary knowledge can be helpful. In contrast, CDOs appointed to succeed a CDO or CIO may predominantly need to focus on implementing an already existing vision of digital transformation for the appointing company. To execute and lead such a vision, especially prestige and structural power can be beneficial power dimensions because they allow for faster implementation due to the appointed CDOs' broad network of contacts (prestige power) or authority (structural power).

Table 6 highlights our research contribution to extant literature.

Table 6: Summary of findings and contributions to literature

RQ	Extant C-level executive research	Our findings
RQ1: How are CDO appointments related to market reactions?	Predominantly positive market reactions to appointment of C-level executives (Chatterjee et al., 2001; Huson et al., 2004) except for situations of organizational turmoil (Gangloff et al., 2016)	For succession, overall negative market reaction to Chief Digital Officer appointments. In contrast, for new positions, overall positive market reaction to CDO appointments. Depending on the power profile of the appointed CDO, these market reactions may turn into the opposite reaction.
	Positive market reaction to Chief Information Officer appointments to new positions during the timeframe 1987 to 1998 (Chatterjee et al., 2001)	Shift of market reaction to Chief Information Officer appointments to new positions (and successions) from positive to negative over time (1987-1998 vs. 2011-2020); Positive market reaction to CDO appointments to new positions may be explained by novelty of executive position across industries Identification of diverging market reaction for CIO and CDO appointements Empricial evicence of distinct roles, as perceived by investors
RQ2: What characterizes the power profile of CDOs whose appointment leads to positive market reactions?	Research studying functional top managers (e.g., CIO, CFO, CMO) predominantly takes on a non-specific conceptual and measurement perspective towards power by not differentiating between dimensions (e.g., Baker et al., 2019; Collins et al., 2018; Feng et al., 2015) or focuses on structural power only (e.g., Bradley et al., 2012; Chen et al., 2010; Feng et al., 2021) although Finkelstein (1992) suggests several types of power	In contrast to other C-level managers, for CDO appointments additional power dimensions need to be considered due to distinct role. We find, prestige and expert power constitute important dimensions of power – besides structural power – for CDO appointments; prestige power is perceived as positive by investors for CDO succession appointments; expert power is, depending on its source, perceived as positive or negative by investors for CDO succession and new position appointments.

Table 6: Summary of findings and contributions to literature

RQ_	Extant C-level executive research	Our findings
	Chief Information Officers' structural power derived from hierarchical authority is positively associated with measures of CIO leadership effectiveness and organizational performance (e.g., Bradley et al., 2012; Lim et al., 2013) Predominantly congruent effect of different dimensions of structural power (e.g., Bradley et al., 2012; Feng et al., 2021)	For Chief Digital Officer measures of hierarchical authority play no significant role. Instead, based on press releases identification of a new conceptual dimension of structural power derived from resource endowment, which is associated with a positive market reaction for CDO succession appointments. Incongruence between CDO reporting line and profile leads to negative market reaction Negative perception of incongruent signals by investors (Paruchuri et al., 2021)
	Chief Information Officers' IT-related expert power is positively related to public recognition for company's IT capability (Lim et al., 2013); Negative association of expert and multifunction power on TMT's commitment to innovation (Garms & Engelen, 2019)	For Chief Information Officers, expert power derived from business knowledge perceived as positive by investors. For Chief Digital Officer new position appointments, domain-specific expert power is perceived as negative by investors, whereas investors react positively to expert power derived from interdisciplinary knowledge, a newly identified dimension of expert power For Chief Digital Officer succession appointments, expert power derived from company-external knowledge as well as prestige power perceived as positive

6 Limitations, Future Research, and Implications

6.1 Limitations and Future Research

Our event study based on secondary data delivers valuable implications for research and practice but is also limited in some ways. First, we only included companies in our sample that issued a press release announcing the appointment of a CDO. Even though we applied an extensive keyword search to extract announcements of all companies appointing a CDO, we may have missed CDO appointment announcements. In addition, if CDOs are not part of the TMT, there are no legal reporting obligations.

Second, some investors may have expected the company to appoint a CDO, such that the press release did not provide investors with new information. However, in this case our results would be biased towards zero and the abnormal return would be even larger than the reported effects. To account for possible leakages of information, as observed by Chatterjee et al. (2001), we also estimated abnormal returns for two days preceding the event.

Third, the event study methodology allows us to isolate and estimate the causal effect of an event on abnormal returns on the stock market. At the same time, the nature of the methodology also limits the implications that can be drawn from our analysis of short-term effects on the stock market. Therefore, we encourage scholars to employ other research strategies to explore the significance of CDOs' role by taking an alternative perspective or exploring long-term effects. A starting point for future research could be the unfolding theory, which we outline in the

following section.

6.2 Theoretical and Practical Implications

From a practical perspective, our findings also provide valuable insights for practitioners, especially organizations who seek to appoint a CDO in the future. Our research identifies the conditions under which the appointment of a CDO will more likely lead to positive reactions by investors and increase a company's equity value. Therefore, we indicate when and how the appointment of a CDO can send shareholders a credible signal of strategic change in a company. At the same time, we also suggest that the appointment of a CDO is not without dangers if companies appoint a CDO with an inadequate power profile.

From a theoretical perspective, we propose an unfolding CDO impact theory (CDO IT) for further studies on CDOs' impact on financial performance, as depicted in Figure 3. Whereas Finkelstein (1992) argued that structural, prestige, and expert power form independent dimensions of executives' power profile and extant research shows direct links between some of these power dimensions and performance variables, we propose, based on our findings, that all three dimensions of CDOs' power should be considered in concert, rather than in isolation. In addition, a distinction in the market reaction to CDO appointments is needed for new and succession positions, as our results illustrate.

Further, we propose power dimensions as moderators of the impact of CDOs' presence on financial performance, based on our evidence that for new positions (successions), the positive (negative) direct effects of CDO presence on financial performance can turn to negative (positive) when considering power dimensions. According to Baron and Kenny (1986, p. 1174), a moderator is a "variable that affects the direction and/or strength of the relation between an independent or predictor variable and a dependent or criterion variable". In our case, the independent variable is a CDO's presence, and the dependent variable is financial performance. The observed relation between these variables reverses when power variables are considered. Thus, the effect of a CDO's presence depends on the interaction of power dimensions (Frazier et al., 2004).

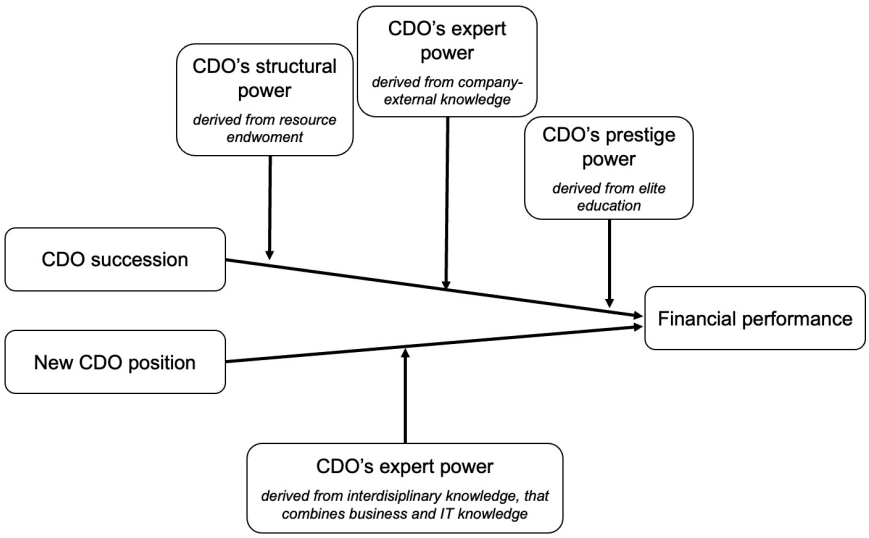

Figure 3: Unfolding CDO impact theory

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Appendix A: Theoretical Foundation and Related Literature

Table 7: Related literature on CIOs' managerial power in information systems

Study	Theoretical foundation	Measure of managerial power	Measure of related constructs	Findings on managerial power or related constructs	Data source
Armstrong and Sambamurthy (1999)	Resource-based and knowledge-based theory		Knowledge: CIO's IT and business knowledge; System of knowing: CIO's participation in TMT, hierarchical distance CIO-CEO, informal interaction CIO-TMT	CIOs' business and strategic IT knowledge significantly enhance companies' IT assimilation. CIOs' business and strategic IT knowledge are associated with their systems of knowing.	Survey data
Banker et al. (2011)	Porter's strategic positioning		Reporting line: CIO reporting structure (CIO-CEO vs. CIO-CFO)	Differentiators with a CIO–CEO reporting structure and cost leaders with a CIO–CFO reporting structure outperform companies with misaligned configuration.	Secondary data
Bradley et al. (2012)	Resource-based view theory	**Structural power**: CIO reporting level, CIO–TMT membership		CIOs' structural power has a significant positive influence on the quality of IT governance in hospitals.	Survey data
Chen et al. (2010)	Strategic leadership theories	**Structural power:** reporting distance CIO-CEO, TMT membership of CIO	Human capital: organizational tenure, IT work experience, level of education	Positive association between CIO human capital and CIO supply-side leadership. Positive association between CIO structural power CIO demand- side leadership.	Survey data
Chen et al. (2021)	Issue selling theory	**Structural power**: reporting distance CIO-CEO, TMT membership of CIO	Business and IS Intelligence: CIO IT-related strategic knowledge	CIO IT-related strategic knowledge forms antecedent of CIO issue selling effectiveness. CIO's structural power positively moderates impact of CIO issue selling on digital innovation outcome.	Survey data
Feng et al. (2021)	Managerial power theory	**Structural power:** CIO presence in the TMT, CIO relative compensation and pay rank in TMT, CIO tenure		CIO structural power is positively related to company performance, an association that is especially strong under great market turbulence, high industry IT intensity, and great operating efficiency	Secondary panel data
Karahanna and Preston (2013)	Social capital theory		Structural CIO-TMT social capital: reporting distance CIO-CEO, TMT membership of CIO	Structural CIO-TMT social capital positively influences cognitive CIO-TMT social capital. No influence of structural CIO-TMT social capital on the IS-business strategy alignment.	Survey data
Karimi et al. (1996)	Miles and Snow typology	Power/Rank of IT leader: hierarchical distance IT leader-CEO	Status of IT leader: external/internal hire	IT leaders' rank (when combined with status) is significantly related to companies' competitive strategy.	Survey data
Lim et al. (2013)	Institutional theory, (managerial power theory)	**Structural power**: title **IT-related expert power**: education, employment, industry experience		IT executives with greater structural power or IT-related expert power are more likely to attract public recognition for their company's IT capability.	Secondary panel data
Preston et al. (2008a)	Theory of managerial discretion	**Structural power:** TMT membership, reporting level **Expert power:** CIO strategic effectiveness		A higher level of CIO's structural power is positively associated with CIO's level of strategic decision-making authority.	Survey data

Table 7: Related literature on CIOs' managerial power in information systems

Study	Theoretical foundation	Measure of managerial power	Measure of related constructs	Findings on managerial power or related constructs	Data source
Preston and Karahanna (2009)	IS strategic alignment, upper echelon theory		CIO-TMT shared domain knowledge: CIOs' business knowledge Structural systems of knowing: TMT membership, formality of interaction, hierarchical distance CIO-CEO	Shared domain knowledge and structural systems of knowing influence the development of shared understanding between CEO and TMT, which is a significant antecedent of IS strategic alignment.	Survey data
Smaltz et al. (2006)	Mintzberg's managerial roles, upper echelon theory		CIO capability: strategic IS and business knowledge TMT-CIO engagements: hierarchical level of CIO, TMT membership	Significant positive relationship of CIO capabilities with CIO role effectiveness. TMT-CIO engagements do not directly impact CIO role effectiveness.	Survey data
Smith et al. (2013)	Upper echelon theory	Power: direct reporting line CIO-CEO		Positive association between CIO-CEO reporting line and level of sophistication of EMR and higher performance.	Secondary panel data
Taylor and Vithayathil (2018)	Executive power & compensation	**Structural power:** TMT membership of technology leader		Higher levels of company output in short and long term for companies that include technology leader in TMT.	Secondary panel data

Discipline	Study	CxO	Theoretical foundation	Measure of managerial power	Findings on managerial power or related constructs	Data source
Finance	Baker et al. (2019)	CFO		**Power:** pay share in sample top quartile, member of the board	Accruals earnings management (real earnings management) is greater when the CEO (CFO) is powerful relative to the CFO (CEO).	Secondary data
Finance	Beck and Mauldin (2014)	CFO		**Expert and Referent power:** Tenure	Significant positive relationship between audit fee reductions and CFOs' power.	Secondary data
Finance	Collins et al. (2018)	CFO	Managerial power theory, theory of self-focus	**Power index:** composed of three measures: membership on the board of directors, tenure, and the number of titles held	Powerful CFOs use their power to negotiate shorter incentive pay duration to maximize the present value of their performance.	Secondary data
Innovation Mgmt.	Garms and Engelen (2019)	CTO	Upper echelon, managerial power	**Structural power:** compensation, title rank, board membership **Expert power**: Technical education **Multifunction power**: Non-R&D and innovation responsibility	Significant positive relationship between structural power and TMT's commitment to innovation. Significant negative relationship between expert power/ multifunction power and TMT's commitment to innovation. Negative moderation effect of multifunctional power with structural power and positive moderation effect of multifunctional power with expert power on TMT's commitment to innovation.	Secondary data
Marketing	Feng et al. (2015)	CMO	Managerial power	**Marketing department power:** department's representational power, rewards, highest hierarchical level, cumulative hierarchical level, responsibilities	Significant positive relationship between marketing department's power and company performance.	Secondary data
Marketing	Nath and Mahaja (2011)	CMO	Intraorgani-zational power, resource dependence	**CMO Power in TMT**: percentage with higher title	Non-significant relationship between power of CMO in TMT and company performance.	Secondary data

Table 8: Related literature on managerial power in other disciplines

Appendix B: Additional Information About Methodology

In the following we provide detailed information on the estimation method, the filtering process used during data collection, a country-wise description of the sample data and the parametric and non-parametric test used to evaluate our results.

B.1 Estimation Method – Market Model

In this event study, we compare stock return in the event of appointing a CDO (event window) with a hypothetical case where a company does not appoint a CDO (estimation window). For the estimation window, we use data on the company's daily market return (i.e., changes in the company's stock price on one day) and the daily return of the market index (i.e., changes in the price of the overall market portfolio containing all assets available for trading on the stock market) for a period preceding the announcement of a CDO appointment. To estimate how a company's stock market return relates to the return of the market portfolio on a daily basis prior to the event, we estimate:

$$R_{i,\tau}=\alpha_i + \beta_i * R_{m,\tau} + \epsilon_{i\tau}$$

where $R_{i,\tau}$ is the return for stock i on day τ, $R_{m,\tau}$ is the rate of return on a market portfolio m (e.g., S&P 500) on day τ, α_i is the intercept, β_i is the systematic risk of stock i and $\epsilon_{i\tau}$ is the error term. To retrieve the coefficients ($\widehat{\alpha_i}$ and $\widehat{\beta_i}$), we rely on stock price data for an estimation window of 255 trading days starting on t=-300 and ending on t=-45 prior to the event observed (t=0), to ensure that the observed event cannot influence the market model estimates and following the lead of earlier studies in IS literature, most of which use the same estimation window (e.g., Chatterjee et al., 2001; Dehning et al., 2003). Thus, we use this estimation window to calculate the correlation between the return of a company's stock and the return of the market portfolio in the absence of a CDO appointment based on the equation above. To verify the robustness of our results we also calculate the coefficients for two other estimation windows: [-300; -20] and [-350; -45]. Earlier studies frequently relied on the S&P 500 index as the market index (Chatterjee et al., 2001). In contrast, we follow the approach of Bose and Leung (2019) to account for heterogeneity in our global sample and match each stock with a market index that represents the company's market capitalization in the respective country. We thereby consider multiple market indices for a particular stock and select the market index with the highest explanatory power, measured by R^2.

For the event window, we derive the estimated daily abnormal return, which expresses the difference between the company's observed stock market return at the event and the expected return in the absence of an event following earlier research. Using the estimated coefficients ($\widehat{\alpha_i}$ and $\widehat{\beta_i}$), we derive the daily abnormal return $AR_{i,\tau}$ for stock i on day τ based on the following equation:

$$\mathrm{AR_{i,\tau}= R_{i,\tau} - \left(\widehat{\alpha_i} + \widehat{\beta_i} * R_m, \tau\right)}$$

$\widehat{\alpha_i}$ and $\widehat{\beta_i}$ are the ordinary least square estimates of a regression of $R_{i,\tau}$ on $R_{m,\tau}$ over the estimation window. The daily abnormal return indicates the deviation of a company's observed return from the estimated return. Thus, we compare the stock return in the event that a company appoints a CDO with the hypothetical case that the company does not appoint a CDO. We observe market reactions to the new information in a five-day event window, the day of the announcement (day 0) and two days before (days -1 and -2) and two days after (days +1 and +2) the announcement. Accordingly, we can account for leaked information prior to the event day as well as possible

lags in the market reaction, without running the risk of false inferences that can be caused by long event windows (McWilliams & Siegel, 1997). Event study analysis can be sensitive to outliers. Following a standard approach, we adjust our sample to ensure that our results are not driven by individual observations. Thus, we adapt the widely applied winsorization approach by setting all variables in the bottom and top one percentile to the values of the variables at the 1st and 99th percentiles (Dewan et al., 2007).

B.2 Filtering Process and Quality Checks of Press Releases

We filtered our initial search results encompassing 7,014 announcements of CDO appointments in four screening steps. First, we disregarded announcements that were irrelevant, i.e., press releases mentioning CDOs but not reporting on their appointment or other uses of the abbreviation "CDO" (e.g., collateralized debt obligation). Second, we disregarded announcements that referred to appointments in non-listed companies, subsidiaries, or local branches of stock-listed companies. These two screening steps reduced our sample to 1,356 announcements. After disregarding duplicate announcements (e.g., press releases containing the same or similar news), our sample included 424 announcements. Third, in order to eliminate confounding factors, we filtered out announcements that coincided with other announcements of the company within a confounding window of five days (two days before and after the announcement). As suggested by McWilliams and Siegel (1997) and adopted by recent IS studies (Bose & Leung, 2019; Yang et al., 2012), we excluded 63 announcements that coincided with other news relevant to the company's future prospects, such as the declaration of dividends, unexpected earnings, signing of major government contracts, filing of lawsuits, and upcoming mergers or acquisitions. Fourth, we screened the sample for companies that issued more than one press release about different CDO appointments within 18 months. To ensure consistency in our estimations, we included only the first of multiple appointments made by the same company within this time period, resulting in the exclusion of 27 appointments. Overall, the filtering approach reduced our sample to 334 appointment announcements.

B.3 Country-Wise Description of Sample Data

Table 9 shows a country-wise description of the sample data.

As described in Section B.1 each stock was matched with country-specific indices to derive the abnormal return. Additionally, we used the following regional indices to match the stocks depending on countries' classification: MSCI Frontier Markets Index, MSCI Emerging Markets Index, MSCI Emerging Markets Latin America Index, MSCI Emerging Markets EMEA Index, MSCI Emerging Markets Asia Index. Additionally, all stocks were matched with the MSCI World Index and S&P 500 index. Then the market index with the highest explanatory power, measured by R^2, was selected und used to derive the abnormal return.

Our international sample covers 27 different countries across 6 continents. The United States (48.21%), the United Kingdom (9.12%), and France (5.21%) make up the largest proportions of announcements.

Continent	Country	Country indices	Obs.
Africa	South Africa	JALSH, JASIN, JBANK, JFINA	2
Asia	Hong Kong	HSI, HSCI, HSNF	2
Asia	India	BSE100, BSESN, BSEBANK	11
Asia	Japan	KQ11, N225, TOPX, TOPX100, TOPX500, TRXFLDJPPBANK, TRXFLDJPPFIN	2
Asia	Singapore	FTFSTAS, STI, FTFSTAS30	4
Asia	South Korea	KS11, KS200, KS200FNCL, TRXFLDKRPFIN, TRXFLDKRPBANK	1
Asia	Sri Lanka	CSE	1
Asia	Thailand	SETB, SETF, SETI	1
Asia	United Arab Emirates	ADI, TRXFLDAEPF11, TRXFLDAEPFIN	4
Asia/Europe	Russia	IRTS, IMOEX, MOEXFN	2
Australasia	Australia	AORD, AXBAKD, AXDFKD, AXKO	12
Australasia	New Zealand	NZ50, NZCI, NZFK	5
Europe	Belgium	BCSH, BEFIP, BFX	2
Europe	Denmark	CX3010GI, CX3010PI, OMXC20, OMXCPI	4
Europe	Finland	OMXH25, OMXHPI, TRXFLDFIPFIN, TRXFLDFIPF11	15
Europe	France	FCHI, FRFIN, PAX, TRXFLDFRPBANK, TRXFLDFRPFIN	16
Europe	Germany	CXPBX, CXPVX, GDAXHI, GDAXI	14
Europe	Italy	FTITLMS, FTMIB, TRXFLDITPBANK, TRXFLDITPFIN	1
Europe	Netherlands	AAX, AEX, NLFIN	4
Europe	Norway	OBX, OBXP, OSEAX, TRXFLDNOPFIN TRXFLDNOPF11	3
Europe	Spain	TRXFLDESPBANK, TRXFLDESPFIN, IBEX	2
Europe	Sweden	OMXS30, SX3010PI, SX30PI	4
Europe	Switzerland	C8300T, C8700T, SSMI	11
Europe	United Kingdom	FTLC, FTSE, FTUB3010, FTUB3020	28
North America	Canada	GSPTSE, SPTTFS, TRXFLDCAPF11, TRXFLDCAPFIN	7
North America	United States	IXIC, NDX, SPSY, SPX, SPXBK	148
South America	Peru	SPBLPGPT, SPBL25PT	1

Table 9: Country-wise description of sample data

B.4 Parametric and Non-parametric Test

We used both a parametric and non-parametric to evaluate the statistical significance of investors' reaction to an event, following earlier studies (e.g., Bose & Leung, 2019; Chatterjee et al., 2001). The test statistic is based on the cumulative standardized abnormal return (CSAR), which is calculated by computing the standardized abnormal return (SAR) using the formula $SAR_{it}=\frac{AR_{it}}{\sqrt{Var(AR_{it})}}$ and then aggregating all SARs: $CSAR=\frac{1}{N}\sum_{i=1}^{N}\sum_{t=S_1}^{S_2}\frac{SAR_{it}}{\sqrt{S_2-S_1+1}}$.

To evaluate the statistical significance of investors' reaction to an event, we used the parametric Patell or Standardized Residual Test by calculating the following Z-statistic:

$$Z=\frac{1}{\sqrt{N}}CSAR$$

In addition, we also compute the test-statistic of the Generalized Sign Test, a commonly used non-parametric test in event studies (MacKinlay, 1997), to test whether number of positive abnormal returns during the event day or estimation window was different from the number of positive abnormal returns during the estimation window. Here we use the following test statistic that follows a standard normal distribution:

$$Z_t=\frac{p_t-Ns}{\sqrt{N\,(1-s)\,s}}$$

Where p_t denotes the number of positive abnormal returns on day t across all announcements, N is the number of announcements, s forms the share of positive abnormal returns in the estimation period.

Appendix C: Market Reaction to CIO Appointments

The significant negative market reaction following Chief Digital Officer appointments contrasts with the observed positive market reaction to Chief Information Officer appointments (Chatterjee et al., 2001). In order to understand this result better, we collected data on announcements of CIO appointments in two time periods: (1) 1987-1998, the time period also used by Chatterjee et al. (2001) and (2) 2011-2020, a time period comparable to our sample of CDO appointments, for companies based in the US. We followed a similar approach for CIO announcements, as the one outlined for CDO announcements earlier. Thus, we also retrieved announcements from Lexis-Nexis by relying on an extensive key word search, which included the terms "chief information officer" and alternative position titles, such as "vice president information technology" or "head information technology", along with keywords, such as "appoint", "create", "establish", "name" or "new", that indicate an appointment. We filtered search result in four screening steps, as described earlier. The number of announcements, the screening steps and the final sample size are summarized in Table 10

Step	**Time period 1987-1998**	**Time period 2011-2020**
Initial search results	2,132	23,771
Announcements filtered out that: – use the abbreviation "CIO" with other meaning – share generic news on CIO but do not mention appointment – refer to private firms, local branches, or subsidiaries	(1,728)	(18,385)
Announcements filtered out because they were duplicates	(361)	(4,979)
Announcements filtered out due to missing stock market data	(24)	(51)
Announcements filtered out due to confounding factors	(39)	(80)
Final sample	**110**	**276**

Table 10: Filtering process leading to the final sample

Table 11 depicts the cumulative abnormal returns in response to announced CIO appointments in the timeframe 1987-1998 and the timeframe 2011-2020. We report different configurations of the event window as well as the corresponding z-score and p-value of the Patell test. For the timeframe 1987-1998, we find a positive effect of announcing the appointment of a CDO on the cumulative abnormal return. For the event windows [-2;0] and [-1;1] – the latter was used by Chatterjee et al. (2001) – the identified positive market reaction is statistically significant at the 5% level. Considering the event window [-1; 1], the stock market increases by an average of 0.49% after a company's announcement to appoint a CIO. These results are also robust even when taking into account whether the CIO was appointed to a newly created position or succeeded an existing one (analysis not shown). In comparison, we observe significant negative market reactions for the timeframe 2011-2020 for CIO appointments. For instance, in the event window [-1;1], the stock of a company announcing the appointment of a CIO decreases by 0.45% on average, a highly statistically significant effect (p-value < 0.01). This result lends credibility to our results for CDO appointments, which may seem surprising compared to earlier literature, but may arise due to changes in investors' sentiment towards executives surrounding digital and information technology (see *Discussion*).

	Timeframe 1987-1998				Timeframe 2011-2020			
Event window	**Obs.**	**Mean**	**Patell z-score**	**Patell p-value**	**Obs.**	**Mean**	**Patell z-score**	**Patell p-value**
[−2; 2]	110	0.12%	0.23	0.82	276	-0.40%	-4.24***	0.00
[−2; 0]	110	0.21%	2.14**	0.03	276	-0.33%	-4.63***	0.00
[0; 2]	110	0.14%	-0.79	0.43	276	-0.19%	-2.66***	0.01
[−1; 1]	**110**	**0.49%**	**2.28****	**0.02**	**276**	**-0.45%**	**-5.84*****	**0.00**
*, **, *** statistically significant at the 10%, 5% or 1% level, respectively, in two-tailed test.								

Table 11: Cumulative abnormal returns for CIO appointments – Comparison of timeframes

Table 12 splits the sample of CIO appointments for the timeframe 2011-2020 into CDO appointments to new positions and successions and reports the overall market reaction and Patell test statistics. For both new positions and successions, we find significant negative market reactions. For instance, for the event window [-1;1] stock markets on average decrease by 0.45% (p-value < 0.1) for CIO new position appointments and by 0.41% for CIO succession appointments (p-value < 0.01). The lower level of statistical significance might be attributable to the small sample size of CIO appointments to new positions.

	New position				Succession			
Event window	**Obs.**	**Mean**	**Patell z-score**	**Patell p-value**	**Obs.**	**Mean**	**Patell z-score**	**Patell p-value**
[−2; 2]	34	-0.65%	-1.83*	0.07	242	-0.37%	-3.86***	0.00
[−2; 0]	34	-0.25%	-1.11	0.27	242	-0.34%	-4.51***	0.00
[0; 2]	34	-0.32%	-1.11	0.27	242	-0.18%	-2.44***	0.00
[−1; 1]	34	-0.45%	-1.91*	0.06	242	-0.41%	-5.52***	0.00
*, **, *** statistically significant at the 10%, 5% or 1% level, respectively, in two-tailed test.								

Table 12: Cumulative abnormal returns for CIO appointments – New position vs. succession – Timeframe 2011-2020

Table 13 shows the results of a multivariate regression for the cumulative abnormal return on the stock market in a five-day event window [-2;2] for CIO appointments. Models I and II assess the influence of structural power characteristics on the market reaction to CIO appointments, Model III depicts the influence of expert power on investors' perception of CIO appointments, Model IV shows the combined effect of structural and expert power, and Model V includes controls for the CIOs' profile. Models I and II identify no statically significant effect of structural power on the market reaction to CIO appointments. A similar analysis for CIO appointments to new positions in the timeframe 1987-1998 reveals similarly no statistically significant role of structural power on abnormal returns (not shown).

Models III to V reveal a positive and statistically significant influence of CIOs' business knowledge on cumulative abnormal returns. Thus, on average stocks rise by 0.57% (Model III, p-value < 0.05) for each business degree that the appointed CIO has earned. This effect is robust to the inclusion of structural power characteristics and controls. Since the constant indicates a strong negative baseline effect of 1.12% (Model III, p-value < 0.01), an appointed CIO would have needed to earn three degrees in business in order to be positively perceived by investors overall.

In summary, our analysis shows that investors predominantly do not perceive most structural and expert power characteristics to influence their perception of CIO appointments. Once exception forms expert power derived from a business knowledge, which leads to a positive

Regression models	Structural power		Expert power	Structural & expert power	IV with controls
	(I)	(II)	(III)	(IV)	(V)
Constant	*0.0078*	*-0.0048***	*-0.0112****	*-0.0117****	*-0.0115***
	(0.0102)	*(0.0023)*	*(0.0040)*	*(0.0041)*	*(0.0049)*
Title Rank	*-0.0021*				
	(0.0018)				
TMT	*0.0003*				
	(0.0041)				
Team	*0.0058*	*0.0069*		*0.0062*	*0.0063*
	(0.0065)	*(0.0064)*		*0.0065)*	*(0.0067)*
Reporting Line CEO	*0.0014*	*0.0033*		*-0.0001*	*-0.0000*
	(0.0060)	*(0.0059)*		*(0.0059)*	*(0.0059)*
Reporting Line CFO	*0.0021*	*0.0038*		*0.0022*	*0.0023*
	(0.0060)	*0.0058)*		*(0.0057)*	*(0.0057)*
Outside			*0.0066*	*0.0061*	*0.0064*
			(0.0043)	*(0.0043)*	*(0.0042)*
Interdisciplinary			*-0.0151*	*-0.0159*	*-0.0159*
			(0.0123)	*(0.0124)*	*(0.0124)*
Business Degrees			*0.0057***	*0.0053***	*0.0053**
			(0.0028)	*(0.0028)*	*(0.0029)*
Computer Science Degrees			*0.0091*	*0.0093*	*0.0093*
			(0.0091)	*(0.0093)*	*(0.0093)*
Other Degrees			*0.0044*	*0.0047*	*0.0047*
			(0.0039)	*(0.0039)*	*(0.0040)*
New Position	*-0.0034*	*-0.0026*	*-0.0049*	*-0.0046*	*-0.0046*
	(0.0069)	*(0.0070)*	*(0.0066)*	*(0.0068)*	*(0.0068)*
Focus Mixed					*-0.0003*
					(0.0048)
Focus Technology					*-0.0008*
					(0.0053)
Sample size	*276*	*276*	*276*	*276*	*276*
R-squared	*1.12%*	*0.67%*	*3.25%*	*3.58%*	*3.59%*
Adjusted R-squared	*0.00%*	*0.00%*	*1.35%*	*0.73%*	*0.07%*

Note: *, **, *** = statistically significant at the 10%, 5% or 1% level, respectively. Robust standard errors are given in brackets.

Table 13: Regression analysis – CIO appointment

market reaction. In extant literature structural power has been shown to form a significant characteristic of CIOs, which influences, among other outcomes, the quality of IT governance (Bradley et al., 2012), demand-side leadership (Chen et al., 2010), and forward-looking company performance (Feng et al., 2021). These studies have focused long-term performance measures. In contrast, this paper measures the short-term influence, and more specifically the perception of the power profile for companies' future prospect. Accordingly, given the presented findings, we put forward a complementary view which can extend our understanding of extant literature. While structural power forms a significant characteristic for CIO success in the long-term, this is not the case for the short-term and investors' perceptions. Instead, only CIOs' expert power derived from business knowledge positively influences abnormal returns following CIO appointments.

Appendix D: Post-hoc Regression Analysis

The negative market reaction for CDOs with a direct reporting line to the CEO contrasts with the positive effects identified in earlier literature for CIOs (Bradley et al., 2012; Chen et al., 2010; Preston et al., 2008a). To gain a deeper understanding of this result, we carried-out a post-hoc analysis driven by extant literature pointing to the diversity of roles taken over by CDOs (Singh & Hess, 2017; Tumbas et al., 2017) as well as the emphasis that both centrally and decentrally positioned CDOs drive digital transformation (Singh et al., 2020). Since the negative effect exists for CDO succession and new position appointments, we carried out a combined regression analysis for all announcements with an explanatory variable for new positions, depicted in Table 14. Model I shows the regression analysis with all structural, expert and prestige power variables, while Model II shows a consolidated model and Models IIII to VI explore combined effects. Similar to the findings in Table 4 and 5, we find that stock markets react negatively to this reporting structure with average negative abnormal return of 2.92% (Table 14, Model I, p-value < 0.05).

In Models I and II, we control for CDOs' different role profiles, namely business unit responsibility, functional focus (e.g., marketing or innovation) and a mixed focus on both digital transformation and IT infrastructure. The negative reaction to the direct reporting line CDO-CEO remains stable even when controlling for these different CDO profiles. In Model III to VI, we study the combined effects between the reporting line CDO-CEO and the distinct role profiles. We find that the negative market reaction to the direct reporting line between CDO and CEO is driven by a negative perception of this reporting line when combined with a CDO responsible for one business unit only (Model III) or, to a smaller extent, a CDO taking care of both digital transformation and IT infrastructure (Model V) or responsible for IT infrastructure only (Model VI). We observe a statistically significant (p-value < 0.05) and sizeable negative effect of 6.02% for CDOs with a business unit profile and a direct reporting line to the CEO.

Controlling for this combined effect also reduces the direct effect of the reporting line CDO-CEO on the market reaction leaving it statistically insignificant and, at the same time, increases the variance that can be explained. The effect is similar, but not as pronounced for Model V and VI, since the negative, direct effect of the reporting line remains statistically significant. In contrast, Model IV shows that only the direct reporting line CDO-CEO, but not the combination of a functional role profile and the direct reporting line, is perceived negatively. Compared to Models III and V, this illustrates that investors may perceive only the combination of certain role profiles with a direct reporting line CDO-CEO as negative. In order to ensure that the effects are not driven by some other dimension of managerial power or contextual factor, we also controlled for other combined effects (not shown) but found no significant effects explaining the negative market reaction to the reporting line CDO-CEO.

Regression models	All power dimensions & profile		All power dimensions & profile		Reporting Line to CEO & Profile/Focus	
	(I)	(II)	(III)	(IV)	(V)	(VI)
Constant	*-0.0253*	*-0.0343****	*-0.0344****	*-0.0280****	*-0.0279****	*0.0288****
	(0.0219)	*(0.0106)*	*(0.0100)*	*(0.0097)*	*(0.0083)*	*(0.0091)*
Title Rank	*-0.0021*					
	(0.0037)					
TMT	*0.0114*					
	(0.0101)					
Team	*0.0277**	*0.0254**	*0.0260**	*0.0258**	*0.0253**	*0.0263**
	(0.0143)	*(0.0135)*	*(0.0136)*	*(0.0139)*	*(0.0138)*	*(0.0138)*
Reporting Line CEO	*-0.0292***	*-0.0293***	*-0.0174*	*-0.0342***	*-0.0234**	*-0.0225**
	(0.0121)	*(0.0117)*	*(0.0117)*	*(0.0144)*	*(0.0126)*	*(0.0130)*
Elite Education	*0.0191**	*0.0170*	*0.0171*	*0.0187*	*0.0174*	*0.0176*
	(0.0109)	*(0.0110)*	*(0.0114)*	*(0.0112)*	*(0.0112)*	*(0.0112)*
Experience Big Tech	*-0.0012*					
	(0.0133)					
Experience Start-up	*0.0190*	*0.0210*	*0.0173*	*0.0214*	*0.0190*	*0.0199*
	(0.0166)	*(0.0167)*	*(0.0171)*	*(0.0166)*	*(0.0169)*	*(0.0167)*
Outside	*0.0241***	*0.0250***	*0.0285****	*0.0243***	*0.0245***	*0.0256****
	(0.0104)	*(0.0100)*	*(0.0100)*	*(0.0097)*	*(0.0097)*	*(0.0097)*
Interdisciplinary	*0.0207*	*0.0181*	*0.0180*	*0.0213*	*0.0180*	*0.0204*
	(0.0246)	*(0.0243)*	*(0.0247)*	*(0.0244)*	*(0.0252)*	*(0.0248)*
Business Degrees	*-0.0135*	*-0.0115*	*-0.0128*	*-0.0124*	*-0.0113*	*-0.0123*
	(0.0082)	*(0.0082)*	*(0.0080)*	*(0.0082)*	*(0.0084)*	*(0.0080)*
Computer Science Degrees	*-0.0123*	*-0.0124*	*-0.0083*	*-0.0135*	*-0.0148*	*-0.0123*
	(0.0128)	*(0.0129)*	*(0.0138)*	*(0.0132)*	*(0.0134)*	*(0.0133)*
Other Degrees	*-0.0236***	*-0.0220***	*-0.0199**	*-0.0233***	*-0.0255***	*-0.0239***
	(0.0110)	*(0.0109)*	*(0.0113)*	*(0.0109)*	*(0.0115)*	*(0.0114)*
New Position	*0.0224***	*0.0219***	*0.0214***	*0.0225***	*0.0232***	*0.0224***
	(0.0105)	*(0.0104)*	*(0.0103)*	*(0.0105)*	*(0.0104)*	*(0.0105)*
Profile Business Unit	*0.0152*	*0.0169*	*0.0220**			
	(0.0164)	*(0.0158)*	*(0.0126)*			
Profile Functional	*0.0081*	*0.0086*		*0.0048*		
	(0.0102)	*(0.00100)*		*(0.0101)*		
Focus Mixed	*0.0146*	*0.0163*			*0.0206*	
	(0.0154)	*(0.0142)*			*(0.0139)*	
Focus Technology	*-0.0136*	*-0.0135*				*0.0120*
	(0.0163)	*(0.0158)*				*(0.0116)*
Reporting Line to CEO and Profile Business Unit			*-0.0602***			
			(0.0305)			
Reporting Line to CEO and Profile Functional				*0.0109*		
				(0.0234)		
Reporting Line to CEO and Focus Mixed					*-0.0547***	
					(0.0262)	
Reporting Line to CEO and Focus Technology						*-0.0429**
						(0.0244)
Sample size	*307*	*307*	*307*	*307*	*307*	*307*
R-squared	*11.03%*	*10.65%*	*11.60%*	*10.04%*	*10.86%*	*10.58%*
Adjusted R-squared	*5.79%*	*6.37%*	*7.99%*	*6.37%*	*7.22%*	*6.93%*

Note: *, **, *** = statistically significant at the 10%, 5% or 1% level, respectively. Robust standard errors are given in brackets.

Table 14: Regression analysis – Ex-post analysis reporting line

Appendix E: Descriptive Analysis and Robustness Checks

Table 15 depicts the descriptive statistics for all variables that we used in the subsequent regression analysis. Table 16 shows the correlation matrix for all variables included in the regression analysis. The maximum correlation is 0.46, a value well below the threshold usually considered for issues of multicollinearity.

Variables	Mean	SD	Min	Max
Abnormal Return	-0.07%	2.04%	-7.84%	7.80%
Title Rank	4.80	1.45	2	6
TMT	0.24	0.42	0	1
Team	0.15	0.35	0	1
Reporting line CEO	0.20	0.40	0	1
Elite Education	0.15	0.45	0	2
Experience Start-up	0.07	0.26	0	1
Experience Big Tech	0.18	0.38	0	1
Outside	0.70	0.46	0	1
Interdisciplinary	0.09	0.29	0	1
Business Degrees	0.27	0.59	0	3
Computer Science Degrees	0.08	0.31	0	2
Other Degrees	0.14	0.41	0	2
New Position	0.29	0.46	0	1

Table 15: Descriptive statistics

To check the robustness of our results we conducted numerous additional analyses. Table 17 summarizes all variables used for these robustness checks. A selection of these analyses is shown in Table 18 and 19. These tables depict the regression estimations for alternative event windows and estimation windows for CDO appointments to new positions (Table 18) and CDO succession appointments (Table 19). Moreover, we control for additional characteristics of appointed CDOs as well organizational or industry level variables in Table 20 (new position) and Table 21 (succession). Overall, we observe – with minor limitations – that our results for market reactions to CDO appointments and structural, prestige, and expert power are robust to the inclusion of these control variables and different settings.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) Abnormal Return (in %)	1.00													
(2) Title Rank	-0.03	1.00												
(3) TMT	-0.01	0.14	1.00											
(4) Team	0.06	0.02	-0.14	1.00										
(5) Reporting line CEO	-0.06	0.23	0.10	0.04	1.00									
(6) Elite Education	0.01	0.03	-0.02	-0.02	0.01	1.00								
(7) Experience Start-up	0.05	-0.01	0.08	0.02	-0.02	0.01	1.00							
(8) Experience Big Tech	0.02	-0.03	0.01	0.17	0.04	0.00	0.12	1.00						
(9) Outside	0.07	-0.08	0.03	0.01	0.05	0.04	0.11	0.16	1.00					
(10) Interdisciplinary	0.02	-0.06	0.01	0.00	-0.08	0.35	0.04	0.00	0.04	1.00				
(11) Business Degrees	-0.02	-0.09	0.08	0.03	-0.03	0.46	-0.07	0.03	0.03	0.45	1.00			
(12) Computer Science D.	0.01	0.02	-0.01	-0.07	-0.07	0.13	0.09	0.11	0.16	0.36	0.14	1.00		
(13) Other Degrees	-0.04	0.03	0.07	0.00	-0.01	0.44	-0.11	-0.05	-0.01	0.43	0.16	-0.01	1.00	
(14) New Position	0,15	0,04	-0,10	0,14	0,05	0,08	0,03	-0,05	0,02	0,08	-0,06	0,08	0,02	1.00

Table 16: Correlation matrix

Variable name	Description	Data source	Measure
Reporting Line CxO	Indicator of direct reporting line between appointed CDO and CxO (based on Banker et al., 2011; Smith et al., 2013)	Press release	Direct reporting line CDO-CxO = 1Otherwise = 0
No. Different Positions	Indicator of number of different positions held by the CDO inside and outside the company prior to appointment (based on Finkelstein, 1992)	Press release	Number of different positionsOtherwise = 0
Experience CIO	Indicator of whether appointed CDO has experience working as a CDO in an organization	Press release	Prior CDO experience = 1; Otherwise = 0
Experience CDO	Indicator of whether appointed CDO has experience working as a CIO in an organization	Press release	Prior CIO experience = 1; Otherwise = 0
Experience Digital Transf.	Indicator of whether the appointed CDO has prior experience in driving digital transformation, following Finkelstein's (1992) measurement of critical expertise	Press release	Prior digital transformation experience = 1; Otherwise = 0
Business Experience	Indicator of whether the appointed CDO has prior business experience, following Finkelstein's (1992) measurement of critical expertise	Press release	Prior business experience = 1; Otherwise = 0
IT Experience	Indicator of whether the appointed CDO has prior IT experience based on Lim et al. (2013) and following Finkelstein's (1992) measurement of critical expertise	Press release	Prior IT experience = 1; Otherwise = 0
Tobin's Q	Measure of a company's market value divided by the book value. Widely used indicator of future growth options associated with R&D and IT spending (e.g., Bardhan et al., 2013; Bharadwaj et al., 1999)	Refinitiv Eikon	Market value/book value
Company Size	Company size measured as the log of market capitalization following earlier research (based on Bharadwaj et al., 1999; Lim et al., 2013)	Refinitiv Eikon	ln (market capitalization)
Company Age	Indicator of company's age measured as difference between founding year and year 2020, used in earlier research (based on Pollock et al., 2010)	Refinitiv Eikon	ln (company age)
Industry Classification	Dummy variables indicating a company's industry classification in sectors: manufacturing, finance, information technology, communication services, according to the Global Industry Classification Standard (GICS) sector code	Refinitiv Eikon	Manufacturing = 1 if GICS 20; Finance = 1 if GICS 40; Information Technology = 1 if GICS 45; Communication Services= 1 if GICS 50; Otherwise = 0

Table 17: Description and measurement of control variables

As illustrated in Table 18 and Table 19, the presented effects for CDO appointments to new positions and successions are robust to the use of alternative estimation windows. For the two alternative estimation windows [300; 20] and [350;45], we observe effects that are similar with respect to size, direction and level of statistical significance. The analyses further illustrate the effects for different event windows. We observe no differences in the direction of the effects, but slight variations for the size of the effects and the level of statistical significance across the different event windows. This leads us to conclude that a complete consideration of the five days surrounding the event is necessary to fully observe the market reaction to CDO appointments.

Regression models	Consolidated model	Estimation window [300;20]	Estimation window [350;45]	Event window [0;2]	Event window [-2;0]
	(I)	(II)	(III)	(IV)	(V)
Constant	*0.0004*	*-0.0015*	*-0.0014*	*0.0041*	*-0.0046*
	(0.0168)	*(0.0172)*	*(0.0172)*	*(0.0161)*	*(0.0110)*
TMT	*0.0310*	*0.0288*	*0.0299*	*0.0053*	*0.0347**
	(0.0237)	*(0.0228)*	*(0.0229)*	*(0.0150)*	*(0.0180)*
Team	*0.0229*	*0.0252*	*0.0264*	*0.0142*	*0.0125*
	(0.0231)	*(0.0242)*	*(0.0241)*	*(0.0153)*	*(0.0157)*
Reporting Line CEO	*-0.0454***	*-0.0470***	*-0.0469***	*-0.0150*	*-0.0406****
	(0.0197)	*(0.0200)*	*(0.0204)*	*(0.0145)*	*(0.0142)*
Outside	*0.0269*	*0.0297*	*0.0282*	*0.0128*	*0.0212*
	(0.0205)	*(0.0212)*	*(0.0212)*	*(0.0165)*	*(0.0140)*
Interdisciplinary	*0.0844***	*0.0810**	*0.0830***	*0.0581**	*0.0750*
	(0.0409)	*(0.0414)*	*(0.0416)*	*(0.0304)*	*(0.0508)*
Business Degrees	*-0.0354***	*-0.0343***	*-0.0348***	*-0.0191*	*-0.0410****
	(0.0174)	*(0.0171)*	*(0.0171)*	*(0.0130)*	*(0.0133)*
Computer Science Degrees	*-0.0424****	*-0.0414****	*-0.0411****	*-0.0263****	*-0.0260***
	(0.0119)	*(0.0128)*	*(0.0127)*	*(0.0096)*	*(0.0115)*
Sample size	*90*	*88*	*88*	*90*	*90*
R-squared	*11.79%*	*11.90%*	*11.93%*	*5.67%*	*15.31%*
Adjusted R-squared	*4.26%*	*4.19%*	*4.22%*	*0.00%*	*8.08%*

Note: *, **, *** = statistically significant at the 10%, 5% or 1% level, respectively. Robust standard errors are given in brackets.

Table 18: Robustness check – CDO appointment to new position – Other estimation and event windows

Table 20 and Table 21 show the robustness checks with respect to additional control variables. For CDO appointments to new positions, we observe that all effects are robust to the inclusion of variables describing CDOs' characteristics, such as CDOs' role profile or experience (Table 20, Models I to III). Moreover, all effects remain stable and statistically significant with inclusion of control variables on the organizational and industrial level (Table 20, Models IV to VI). With the inclusion of dummy variables for industry classifications the effects become larger in size and the level of statistical significance increases. Moreover, we observe a statistically significant positive effect for CDOs' expert power derived from company-external knowledge (Table 20, Model VI).

For CDO succession appointments, our analysis also shows that all effects are robust to the inclusion of variables describing CDOs' characteristics, such as CDOs' role profile or experience (Table 21, Models I to III). As shown in Table 20, the inclusion of organizational and industry level controls leads to a variance for the statistical significance for the market reaction to CDOs with other degrees. It is important to note that the effect for CDOs' other degrees is just barely no longer statistically significant in Models IV to VI. One explanation could be that a correlation may exist between these organizational and industry level characteristics and the selection process for CDOs with a fitting educational background. Companies with higher earnings or market capitalization are likely to have human resource practices in place that allow them to better pick CDOs with the knowledge advantageous when performing their roles.

Regression models	Consolidated model	Estimation window [300;20]	Estimation window [350;45]	Event window [0;2]	Event window [-2;0]
	(I)	(II)	(III)	(IV)	(V)
Constant	*-0.0305*** (0.0094)*	*-0.0291*** (0.0094)*	*-0.0290*** (0.0094)*	*-0.0278*** (0.0082)*	*-0.0155** (0.0080)*
TMT	*0.0088 (0.0107)*	*0.0061 (0.0107)*	*0.0061 (0.0106)*	*0.0022 (0.0086)*	*0.0128 (0.0091)*
Team	*0.0301 (0.0184)*	*0.0272 (0.0187)*	*0.0272 (0.0185)*	*0.0184 (0.0147)*	*0.0221* (0.0127)*
Reporting Line CEO	*-0.0280** (0.0143)*	*-0.0304** (0.0143)*	*-0.0299** (0.0143)*	*-0.0161 (0.0118)*	*-0.0116 (0.0100)*
Elite Education	*0.0243* (0.0142)*	*0.0215 (0.0144)*	*0.0209 (0.0143)*	*0.0026 (0.0098)*	*0.0252** (0.0105)*
Experience Start-up	*0.0093 (0.0108)*	*0.0111 (0.0106)*	*0.0106 (0.0106)*	*0.0373*** (0.0107)*	*-0.0060 (0.0144)*
Outside	*0.0270** (0.0112)*	*0.0301*** (0.0112)*	*0.0303*** (0.0112)*	*0.0257*** (0.0089)*	*0.0055 (0.0089)*
Interdisciplinary	*-0.0050 (0.0166)*	*-0.0094 (0.0175)*	*-0.0087 (0.0172)*	*-0.0140 (0.0256)*	*0.0048 (0.0245)*
Business Degrees	*-0.0100 (0.0093)*	*-0.0075 (0.0089)*	*-0.0075 (0.0089)*	*0.0002 (0.0060)*	*-0.0108 (0.0077)*
Computer Science Degrees	*0.0069 (0.0071)*	*0.0044 (0.0076)*	*0.0045 (0.0074)*	*0.0053 (0.0087)*	*0.0039 (0.0179)*
Other Degrees	*-0.0338** (0.0138)*	*-0.0354** (0.0155)*	*-0.0350** (0.0153)*	*-0.0114 (0.0101)*	*-0.0229** (0.0115)*
Sample size	*217*	*208*	*209*	*217*	*217*
R-squared	*8.58%*	*9.67%*	*9.65%*	*8.19%*	*4.95%*
Adjusted R-squared	*4.15%*	*5.09%*	*5.09%*	*3.73%*	*0.34%*

Note: *, **, *** = statistically significant at the 10%, 5% or 1% level, respectively. Robust standard errors are given in brackets.

Table 19: Robustness check – CDO succession appointment – Other estimation and event windows

Regression models	Control variables – Individual level		Control variables – Organizational level		Industry controls	
	(I)	(II)	(III)	(IV)	(V)	(VI)
Constant	*0.0064*	*0.0004*	*0.0250*	*-0.0798*	*-0.0272*	*-0.0125*
	(0.0199)	*(0.0170)*	*(0.0241)*	*(0.1191)*	*(0.0317)*	*(0.0185)*
TMT	*0.0310*	*0.0303*	*0.0353*	*0.0407**	*0.0390*	*0.0421*
	(0.0238)	*(0.0245)*	*(0.0239)*	*(0.0245)*	*(0.0250)*	*(0.0265)*
Team	*0.0222*	*0.0228*	*0.0200*	*0.0216*	*0.0202*	*0.0137*
	(0.0238)	*(0.0233)*	*(0.0243)*	*(0.0249)*	*(0.0247)*	*(0.0252)*
Reporting Line CEO	*-0.0468***	*-0.0455***	*-0.0423***	*-0.0439***	*-0.0429***	*-0.0496***
	(0.0205)	*(0.0203)*	*(0.0196)*	*(0.0201)*	*(0.0201)*	*(0.0206)*
Outside	*0.0272*	*0.0253*	*0.0251*	*0.0261*	*0.0241*	*0.0426***
	(0.0205)	*(0.0214)*	*(0.0207)*	*(0.0223)*	*(0.0211)*	*(0.0203)*
Interdisciplinary	*0.0871***	*0.0736**	*0.0774**	*0.1010***	*0.0961***	*0.1353****
	(0.0431)	*(0.0424)*	*(0.0402)*	*(0.0409)*	*(0.0416)*	*(0.0419)*
Business Degrees	*-0.0356***	*-0.0336**	*-0.0353***	*-0.0394***	*-0.0401***	*-0.0549****
	(0.0180)	*(0.0184)*	*(0.0180)*	*(0.0181)*	*(0.0173)*	*(0.0192)*
Computer Science Degrees	*-0.0437****	*-0.0432****	*-0.0311***	*-0.0425****	*-0.0413****	*-0.0459****
	(0.0140)	*(0.0135)*	*(0.0150)*	*(0.0105)*	*(0.0112)*	*(0.0111)*
Reporting Line CxO	*-0.0183*					
	(0.0170)					
No. Different Positions	*-0.0015*					
	(0.0054)					
Experience CIO		*0.0178*				
		(0.0210)				
Experience CDO		*0.0024*				
		(0.0317)				
Experience Digital Transformation			*-0.0213*			
			(0.0164)			
Business Experience			*-0.0264*			
			(0.0203)			
IT Experience			*-0.0085*			
			(0.0215)			
Tobin's Q				*0.0007*	*0.0030*	
				(0.0066)	*(0.0080)*	
Company Size				*0.0035*		
				(0.0049)		
Company Age					*0.0066*	
					(0.0067)	
Industry Dummies	*No*	*No*	*No*	*No*	*No*	*Yes*
Sample size	*90*	*90*	*90*	*85*	*85*	*75*
R-squared	*12.49%*	*12.05%*	*13.76%*	*13.18%*	*13.44%*	*22.62%*
Adjusted R-squared	*2.64%*	*2.16%*	*2.84%*	*2.76%*	*3.05%*	*9.11%*

Note: *, **, *** = statistically significant at the 10%, 5% or 1% level, respectively. Robust standard errors are given in brackets.

Table 20: Robustness check – CDO appointments to new positions - Control variables

Regression models	Control variables – Individual level		Control variables – Organizational level		Industry controls	
	(I)	(II)	(III)	(IV)	(V)	(VI)
Constant	-0.0379***	-0.0310***	-0.0393***	-0.1203**	-0.0404*	-0.0374***
	(0.0112)	(0.0095)	(0.0113)	(0.0597)	(0.0211)	(0.0136)
TMT	0.0089	0.0086	0.0099	0.0128	0.0118	0.0157
	(0.0113)	(0.0106)	(0.0106)	(0.0107)	(0.0105)	(0.0107)
Team	0.0295	0.0294	0.0311	0.0282	0.0314*	0.0329*
	(0.0181)	(0.0192)	(0.0191)	(0.0193)	(0.0187)	(0.0191)
Reporting Line CEO	-0.0292**	-0.0267*	-0.0297**	-0.0302**	-0.0305**	-0.0324**
	(0.0145)	(0.0141)	(0.0142)	(0.0143)	(0.0147)	(0.0148)
Elite Education	0.0237*	0.0242*	0.0252*	0.0223*	0.0233*	0.0260*
	(0.0141)	(0.0142)	(0.0140)	(0.0131)	(0.0127)	(0.0133)
Experience Start-up	0.0085	0.0087	0.0057	0.0056	0.0073	0.0103
	(0.0114)	(0.0112)	(0.0122)	(0.0105)	(0.0118)	(0.0129)
Outside	0.0271**	0.0280**	0.0263**	0.0198*	0.0208*	0.0222*
	(0.0113)	(0.0117)	(0.0117)	(0.0109)	(0.0107)	(0.0116)
Interdisciplinary	-0.0044	-0.0042	-0.0087	-0.0018	-0.0004	-0.0007
	(0.0172)	(0.0180)	(0.0148)	(0.0176)	(0.0172)	(0.0186)
Business Degrees	-0.0109	-0.0101	-0.0125	-0.0125	-0.0129	-0.0085
	(0.0093)	(0.0093)	(0.0091)	(0.0082)	(0.0081)	(0.0091)
Computer Science Degrees	0.0068	0.0066	0.0121	0.0089	0.0074	0.0092
	(0.0072)	(0.0074)	(0.0087)	(0.0075)	(0.0072)	(0.0091)
Other Degrees	-0.0348***	-0.0348**	-0.0371***	-0.0176	-0.0183	-0.0202
	(0.0134)	(0.0141)	(0.0136)	(0.0130)	(0.0128)	(0.0124)
Reporting Line CxO	0.0016					
	(0.0167))					
No. Different Positions	0.0050					
	(0.0036)					
Experience CIO		0.0080				
		(0.0156)				
Experience CDO		-0.0119				
		(0.0162)				
Experience Digital Transformation			-0.0007			
			(0.0133)			
Business Experience			0.0184*			
			(0.0112)			
IT Experience			-0.0006			
			(0.0133)			
Tobin's Q				0.0074	0.0083*	
				(0.0047)	(0.0048)	
Company Size				0.0038		
				(0.0027)		
Company Age					0.0009	
					(0.0043)	
Industry Dummies	No	No	No	No	No	Yes
Sample size	217	217	217	200	200	196
R-squared	9.25%	8.82%	9.85%	9.96%	8.88%	8.83%
Adjusted R-squared	3.91%	3.45%	4.07%	4.18%	3.03%	1.78%

Note: *, **, *** = statistically significant at the 10%, 5% or 1% level, respectively. Robust standard errors are given in brackets.

Table 21: Robustness check – CDO succession appointments - Control variables

Paper VII

Information Systems Executives
A Review and Research Agenda

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Part III

Enabling Employees as Champions

Paper VIII

A Work Model for Employee Driven Innovation in Public Organizations

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Proceedings of the 27th European Conference on Information Systems, Stockholm & Uppsala, Sweden, 2019
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Paper IX

Tapping into the Wealth of Employees‘ Ideas
Design Principles for a Digital Intrapreneurship Platform

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Part IV

Understanding Champions' Context – Digital Innovation and Transformation

Paper X

The Current State and Future Opportunities of Digital Innovation

A Literature Review

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Paper XI

Digital Innovation...and the Cross-section of Stock Returns

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Digital innovation...and the cross-section of stock returns

Abstract

Based on validated word lists from the Information Systems literature, we use the MD&A section of annual firm reports to construct a text-based measure of digital innovation. In our sample period from 1996 to 2020, we find that firms with a high level of digital innovation are systematically different from low-level firms along several key characteristics like valuation, sales growth, and profitability. A digital innovation factor, which is long (short) stocks with high (low) digital innovation, earns an equally weighted (value-weighted) monthly six-factor alpha of 0.92% (0.50%) per month, both statistically significant at 1%. Differences in firm characteristics and abnormal returns are not explained by industry affiliation. Additional tests suggests that digital innovation is a priced risk factor, which should be added to existing asset pricing models.

Keywords: Digital innovation, asset pricing, factors, market efficiency, textual analysis

1 Introduction

"There is no alternative to digital transformation. Visionary companies will carve out new strategic options for themselves – those that don't adapt, will fail. – Jeff Bezos

In recent years, firms have been under pressure to transform digitally by reconsidering their business model, devising new digital business strategies, and using digital technologies to innovate (Vial, 2019). Against this backdrop, recent studies in Information Systems indicate that increasing digitalization blurs industrial boundaries and challenges the separation of firms along traditional industrial categories. These industrial boundaries are blurring because digital innovation shift the focus from single products towards connected products, integrate heterogeneous areas of knowledge, and require companies to find ways to access and recombine knowledge rooted in different industries and contexts (Seo, 2017; Yoo et al., 2012). Moreover, the editable and reprogrammable nature of digital technology enables the development and deployment of digital innovation across organizations and industries (Kallinikos et al., 2013). Thus, digital innovation transcend established industrial boundaries (Porter & Heppelmann, 2014) and lead to a convergence of products and service offerings (Nambisan et al., 2017). Hence, firms are increasingly forced to defend their market against firms from other industries (Hopp et al., 2018; Seo, 2017). For example, Microsoft has been competing with telecommunication companies, since its acquisition of Skype (Yoo et al., 2010). Thus, digital innovation may bring together firms in product markets across classic industry boundaries and make them competitors. At the same time, these firms share similar characteristics such as expertise in digital technology, digital devices, and digital services.

Considering these arguments, digital innovation might have unexplored consequences for capital markets. For example, because digital innovation is a cross-industry phenomenon, it seems increasingly inaccurate to classify companies solely based on their industry affiliation. The heterogeneity in terms of digital innovation rather suggests the need for a digital innovation factor in addition to established industry classifications. Because digital transformation affects the entire economy, one may also argue that the ability to digitally innovate is not only a useful firm characteristic to differentiate between firms, but also reflects a systematic digital risk factor that requires a return compensation. Accordingly, this study identifies systematic differences

in firm characteristics and financial performance depending on firms' engagement with digital innovation. Moreover, we explore whether the rise of digital innovation across companies has led to the existence of a new asset pricing factor.

Our study makes two contributions to the literature. First, we propose the construction of such a firm-specific measure of digital innovation using textual data from the MD&A section of annual firm reports. We rely on the MD&A section, since it is not audited and reflects the management's thoughts and opinions. Our methodology is similar to earlier work, like Loughran and McDonald (2011), Hoberg and Phillips (2010, 2016), and Hillert et al. (2014), e.g. to derive sentiment from text. Specifically, to obtain a measure of digital innovation for each firm, we follow a bag of words approach to parse the 10-Ks and derive vectors of words and word counts. Our digital innovation dictionary is based on validated word lists from the Information Systems literature. It measures the extent to which a firm creates and uses digital innovation using word lists of four dimensions: device, network, service and content layer.

As pointed out by Loughran and McDonald (2016), the dictionary approach is easy to understand and easy to replicate. Nevertheless, despite its simplicity, our measure is well able to explain important differences between firms beyond industry affiliation. Our analyses show that firms with a high level of digital innovation have a significantly higher valuation, significantly higher sales growth, and significantly lower profitability compared to firms with a low level of digital innovation. In line with our expectations, firms with a high level of digital innovation are also significantly younger and have a significantly higher (market) risk.

While our measure of digital innovation is thus able to describe firm heterogeneity across important dimensions, it is also a variable, which we cannot easily account for by other characteristics. Multivariate regressions to explain the digital innovation of a firm show low R^2 values ranging between 1% and 3%, even though these regressions contain explanatory variables like firm size, firm age, or Nasdaq membership, among others, which seem naturally linked to a firm's digital innovation. We conclude that our text-based measure of digital innovation is a unique variable to describe a firm's level of digital innovation, which is not captured by other characteristics.

The second contribution of our paper is to study the relation between digital innovation and stock returns. To this end, we construct a digital innovation factor (denoted DI factor in the following) which is long (short) firms in the highest (lowest) digital innovation quintile. The equally weighted monthly return of this quintile (5) minus quintile (1) strategy is 0.69% with a t-statistic of 2.48. This effect is not driven by the smallest and most illiquid firms, because we restrict the analysis to all firms with a market capitalization above the second NYSE size decile. Doing so, we address critical assessments from earlier research (e.g., Fama & French, 2008; Green et al., 2017; Hou et al., 2020) that most anomalies are concentrated in stocks with limited economic importance.[1]

The six factor alpha of the equally weighted portfolio, which controls for exposure to momentum and the five factors of Fama and French (2015) is higher at 0.92% per month and it has a much higher statistical significance with a t-statistic of 6.51. Firms with a high DI factor have a high negative exposure against the profitability factor *RMW* and the *HML* value factor for Fama and French. These relations are consistent with the fact that firms with a high level of digital innovation have a lower profitability and a higher valuation, and can explain why the alpha of

[1]Hou et al. (2020, p.2) point out that "microcaps represent only 3.2% of the aggregate market capitalization but 60.7% of the number of stocks." Green et al. (2017) advocate the exclusion of micro-caps below the second NYSE size decile to identify return drivers with high economic importance. We follow this procedure.

the strategy is substantial above its raw return. We observe a statistically significant six factor alpha also if we form a value-weighted long-short portfolio (0.50% per month; t-statistic: 4.22).

To account for industry effects, we also use industry-adjusted returns that are calculated as the stock's return minus its industry return. To this end, we rely on two different industry classifications, namely the 48 industries of Fama and French (1997), denoted as FF48, and the text-based network industries from Hoberg and Phillips (2010), denoted as TNIC. The equally weighted and industry-adjusted six factor alpha of the long-short portfolio is 0.72% (0.69%) per month based on the FF48 (TNIC) classification. While returns are slightly lower, the statistical significance is slightly higher with t-statistics of 7.13 and 6.79, respectively. The value-weighted and industry-adjusted six factor alpha of the long-short strategy equals 0.29% (0.27%) per month using the FF48 (TNIC) classification. The statistical significance is almost unchanged compared to using raw returns with t-statistics of 3.93 and 3.42, respectively.

These findings show that the return difference which is associated with the DI factor is a cross-industry phenomenon. It could be a compensation for systematic risk or a sign of market inefficiency. Our sample period from 1996 to 2020 coincides with a period of supposedly increasing market efficiency (e.g., Green et al., 2017; McLean & Pontiff, 2016). Moreover, we focus on larger stocks for which most return anomalies are substantially less pronounced (e.g., Hou et al., 2020). This makes the market inefficiency explanation less appealing. To formally test if the DI factor should be considered as a systematic risk factor, we run return regressions for every stock to measure its historical exposure against the DI factor. We then form five stock portfolios which differ in their exposure to the DI factor but have on average the same DI score.

It follows that the quintile (5) minus quintile (1) portfolio has a strong positive exposure against the DI factor but is neutral with respect to the digital innovation characteristic. Such "characteristics-vs.-covariances" tests are an established tool in the literature to separate between the systematic component of a factor (i.e., its factor loading) and the underlying firm-specific characteristic (Daniel et al., 2020; Daniel & Titman, 1997; Davis et al., 2000; Hirshleifer et al., 2012). In addition, according to Kozak et al. (2020), expected returns should always be explained by few common factor exposures.

The equally weighted (value-weighted) monthly six alpha factor of the long-short DI factor exposure portfolio is 0.93% (0.53%). Both alphas are statistically significant at the 1% level with t-statistics of 4.14 and 2.69, respectively. As expected, this outperformance declines to 0.58% (equally weighted) and 0.2% (value-weighted) per month once we add the DI factor as control variable in the regressions. Overall, the evidence is consistent with the DI factor being a new systematic factor.

This research connects with extant knowledge in two ways. First, we add to the fast-growing field of research using textual analysis (Loughran & McDonald, 2016). Earlier research has relied on textual analysis to assess the link between firms' financial performance and accounting documents' readability (e.g., Guay et al., 2016; Li, 2008), changes in the language and construction of annual reports (e.g., Cohen et al., 2020), document similarity (e.g., Brown & Tucker, 2011; Hoberg & Phillips, 2016), and the sentiment prevailing in annual reports or media (e.g., Hillert et al., 2014; Hillert et al., 2021; Loughran & McDonald, 2011; Tetlock, 2007). We use a bag-of-words approach, on which sentiment analysis is also based, but use the approach to assess the extent to which firms have used and created digital innovation. The measure, which is well grounded in extant knowledge on digital innovation in the Information Systems field allows us to draw conclusions of firms' degree of digitalization and its connection to firms' financial performance.

Second, with the identification of a digital innovation factor, we contribute to literature on asset pricing for intangible assets. Financial market participants seem to widely ignore information derived out of intangible assets as for instance a firm's innovative activities (e.g., Cohen et al., 2013; Daniel & Titman, 2006; Fitzgerald et al., 2021; Hirshleifer et al., 2013, 2018), leading at least partially to a commonly reported predictability in future equity returns. Yet, intangible assets account for around one third of investment volume in the U.S. market making them economically significant (Corrado & Hulten, 2010).

There exists a small strand of asset pricing studies analyzing the impact of intangible assets in explaining certain asset pricing factors as, for instance, a firm's value premium (e.g., Ai et al., 2013; Eisfeldt & Papanikolaou, 2014; Hulten & Hao, 2008). However, the "premia associated with intangible information [still] pose challenges for both traditional asset pricing models and models based on psychological factors" as for instance argued by Daniel and Titman (2006, p.1605). Thus far, existing asset pricing models as for instance the Fama-French three (1993) and five (2015) factor models, the Carhart (1997) four-factor model, the q-factor model by Hou et al. (2015) as well as the Stambaugh and Yuan (2017) mispricing factor model still seem to fail to account for a firm's intangible assets, and in particular its digital innovation abilities. We address this issue proposing a new asset pricing factor that can be used in the future to account for intangible assets in the digital age.

The paper is organized as follows. Section 2 outlines the theoretical foundation by reviewing literature on digital innovation from the field of Information Systems and builds the foundation for the construction of our text-based measure of digital innovation, described in Section 3. Additionally, Section 3 provides details of the data sources, descriptive statistics, and the analysis of our measure of digital innovation. Section 4 compares digital leaders, firms with a high level of digital innovation, to digital laggards, firms with a low level of digital innovation. We also present the results of portfolio tests based on the DI characteristic and historical DI factor exposure. Section 5 concludes.

2 Theoretical Foundation

Extant literature on digital innovation discusses the characteristics and effects of digital innovation and argues, among others, that the properties of digital technology support the creation, diffusion and use of digital innovation. Digital innovation are defined as "carrying out new combinations of digital and physical components to produce novel products" enabled by digital technology (Yoo et al., 2010). These digital innovation eventually are deeply embedded in most organizational processes and market offerings, shape strategy, and unfold disruptive potential changing entire industries (Bharadwaj et al., 2013; Vial, 2019).

Since firms are under pressure to "[…] harness outside expertise and ingenuity on an unprecedented scale" (Tiwana et al., 2010, p.676), organizations need to facilitate increasingly distributed ways to create digital innovation. These distributed sources of digital innovation are associated largely with digital technologies that enable various actors to cooperate within innovation networks across organizational boundaries (Lyytinen et al., 2016), often beyond the control of the original innovator (Bogers & West, 2012), and regardless of industry boundaries. In addition, digital innovation shift the focus from single products towards connected products, which transcend established industrial boundaries (Porter & Heppelmann, 2014) and challenge the separation of firms along industrial areas.

Moreover, firms strive to embed digital technology in physical products ("smart products") (Yoo et al., 2012) and to provide more and more functions in the form of digital objects that can be easily changed and enhanced (Faulkner & Runde, 2019). Consequently, similar digital technology is used in different products, regardless of industry boundaries. In that regard, firms across industries build up similar technological competencies and rely on the same group of suppliers. In a similar vein, digital devices process any type of digital information (Tilson et al., 2010), which leads to similarity of devices across industries. Eventually, smart products lead to the convergence of user experiences, as demonstrated by smartphones that bring together various communication, entertainment and computation experiences (Yoo et al., 2012). For example, as already mentioned, Microsoft competes with established telecommunication companies since the acquisition of Skype (Yoo et al., 2010). Consequently, organizations from different industries compete with each other, while relying on similar digital technologies.

As discussed above, digital innovation gives rise to a number of consequences. Yoo et al. (2010) identify that digital technology embedded in digital innovation follows a layered modular architecture consisting of the four layers of devices, networks, services, and contents. These loosely coupled layers are product-agnostic (Yoo et al., 2010) and pave the way to be applied across diverse industries and markets. Yoo et al. (2010) discuss the four layers in detail. The device layer encompasses physical machinery, such as computer hardware, and control and maintenance capabilities, such as an operating system. For example, the physical smartphone and its operating system would be assigned to the device layer. The network layer encompasses physical transport mechanisms, such as cables and transmitters, and logical network protocols, such as TCP/IP. Staying with the smartphone example, 5G connectivity and the respective communication protocols form examples of the network layer.

The content layer encompasses data, such as videos, but also directory information where to find which data, copyright, or encoding methods. Photos on a smartphone or movies on servers are examples of this layer. The service layer provides the functionality for users to deal with content, such as storing, creating, or streaming it. The four layers are only loosely coupled, and each layer can be designed with low consideration of other layers. This allows companies to offer products and services that concentrate on certain layers, or cover several layers, or combine their offerings with offerings of other companies focusing on the same or other layers. Thus, digital innovation might be created within a certain layer or across layers. In sum, this architecture spurs an unprecedented level of generativity, where one digital innovation is used to create another one, which in turn enhances the first one, and so on (Yoo et al., 2010). This in turn leads to fluid product boundaries, which also enables serving different markets.

3 Data and Methodology

We use firms' 10-K Management's Discussion and Analysis (MD&A) and a bag-of-words approach to compute firms' level of digital innovation for each firm-year. We then match this measure with data on all common stocks traded on the main stock exchanges (NYSE, AMEX and NASDAQ) in the United States available in both CRSP and Compustat between 1996 and 2020.

3.1 Digital Innovation and Text Analysis of Firms' 10-Ks

We rely on computer-aided text analysis to measure the extent to which firms create and use digital innovation by deriving a quantitative measure from firms' annual report. We web-crawl

the SEC Edgar database for all 10-K, 10K-405 and 10K-KSB filings, excluding amended documents. This results in a sample of 158,631 reports. Our sample is reduced to 91,151 reports when matching the reports with data from Compustat and CRSP (see Section 3.2). Our data collection is restricted by the availability of the annual reports in the SEC Edgar database, since electronic filing was only mandated in 1996.

Following extant research (e.g., Loughran & McDonald, 2011), our text analysis is constricted to the MD&A section since it is not audited and reflects the management's thoughts and opinions. We use regular expressions in Python to extract the relevant MD&A section as well as firm information, such as the central index key (CIK), the report type, fiscal year and report date for each 10-K. In order to control for different formats of the reports, we revise our code iteratively in order to ensure the coverage of the right section of the report for all companies in the sample.

In a next step, we quantify the MD&A by using a dictionary describing digital innovation. Thus, we follow a bag of words approach to parse the 10-Ks and derive vectors of words and word counts. This approach has been used in the Finance discipline, for instance to measure negative sentiment (Hillert et al., 2014; Hillert et al., 2021; Loughran & McDonald, 2011, 2016; Tetlock, 2007). Our dictionary is based on word lists developed and validated by Kindermann et al. (2021). They measure digital orientation using word lists of four dimensions: digital technology scope, digital capabilities, digital ecosystem coordination, digital architecture configuration. Our study focuses on exploring whether processes of convergence across industries occurring due to the rise of digital innovation give rise to a new factor that can explain similarities across firms. Due to our focus on digital innovation, instead of digital orientation in general, we build our own dictionaries. Thus, we use the words selected and validated by Kindermann et al. (2021) to build a dictionary describing the four loosely coupled layers composing the layered architecture of digital innovation: device, network, service and content layer (Yoo et al., 2010). We use the characterization of each layer, as outlined in Section 2, to categorize each word.

We also include synonyms and alternative spellings in our dictionary. Moreover, we add terms that were related to existing elements of the wordlist and who are significant in the context of digital innovation. For instance, we include the terms "internet protocol" and "local area network" on the network layer as they build important components of the "internet". On the content layer, we complement the list with terms related to "data", such as "data analytics" and "meta data". Occupational titles or roles, such as "or "programmer" or "chief information officer" are excluded, as they cannot be clearly assigned to a distinct layer. Moreover, words where no clear link to digital innovation exists, such as "ubiquitous" and "advanced technology" are excluded in our dictionary. Table 1 depicts our dictionary for digital innovation with its four dimensions and the corresponding word lists.

In order to derive a comparable measure, we divide the number of words counted by the overall lengths of the MD&A section without stopwords (e.g., the, is, at, which). Thus, our measure of digital innovation (DI) is computed using the following formula:

$$DI = \frac{No.\ words\ digital\ innovation}{No.\ words\ in\ MD\&A\ section\ without\ stopwords}$$

Table 2 depicts the summary statistics for the DI measure. Across the 94,485 10-K reports analyzed in our final sample the average value of DI is 0.0029. The device and content layer account for larger proportions of the total measure than the network and service layer. Across firm-years we see a large variation, where firms with the highest DI score deviate significantly from the mean score across all firm-years. Further, a large number of firm-years have a DI value of 0 leading

Layer	Words
Device layer	3-D printer, 3D printer, 3-D printers, 3D printers, computer, computers, compute, computing, control system, control systems, cybernetics, cyber physical system, cyber physical systems, desktop, desktops, digital device, digital devices, drone, drones, electronic, electronics, hardware, information system, information systems, information technology, information technologies, informatics, integrated solution, integrated solutions, IT infrastructure, IT infrastructures, IT solution, IT solutions, IT system, IT systems, operating system, operating systems, phone, phones, resource planning system, resource planning systems, robot, robots, sensor, sensors, smartphone, smartphones, software, tablet, tablets
Network layer	bandwidth, bandwidths, bluetooth, broadband, connectivity, highspeed, high-speed, high speed, internet-based, internet, IP, internet protocol, LAN, local area network, mobile, network infrastructure, network infrastructures, network service, network services, network standard, network standards, online, on-line, peer-to-peer protocol, P2P protocol, wifi, wi-fi, wireless
Service layer	3-D printed, 3D printed, 3D printing, 3-D printing, additive manufacturing, algorithm, algorithmic, algorithms, AI, analytics, analytical tool, analytical tools, app, apps, app-based, API, APIs, application programming interface, application programming interfaces, artificial intelligence, autonomous, automated, automating, automation, blockchain, bot, bots, cloud, cloud-based, cloudbased, cyberspace, cyber space, cybersecurity, cyber security, digital platform, digital platforms, deep learning, ecommerce, e-commerce, fintech, homepage, homepages, home page, home pages, information security, insurtech, internet of things, internet-of-things, IoT, legaltech, machine learning, open source, open-source, robotics, robotic, SaaS, self-driving, smart, software as a service, software-as-a-service, suptech, technology platform, technology platforms, telematic, telematics, telemedicine, web, web-based, webs, website, websites
Content layer	big data, data, data analytics, data network, data networks, data service, data services, data transmission, data-dependent, data-driven, data-enbaled, data-intensive, database, databases, digital, digitalization, digitalisation, digitally, digitization, digitisation, digitalized, digitalised, interface, GUI, graphical user interface, metadata, meta data, multichannel, multi-channel, omnichannel, omni-channel, real time, real-time, realtime, remote monitoring, social media, social technology, social technologies, streaming, user experience, UX, user interface, UI, virtual, virtualization, virtualisation, virtuality, virtualities, virtualize, virtualized

Table 1: Digital innovation dictionary

to a right-skewed distribution of the measure. This is especially evident in the 25^{th} percentile. With the exception of the aggregated measure of DI (Total), the 25^{th} percentile only includes companies with a DI value of 0.

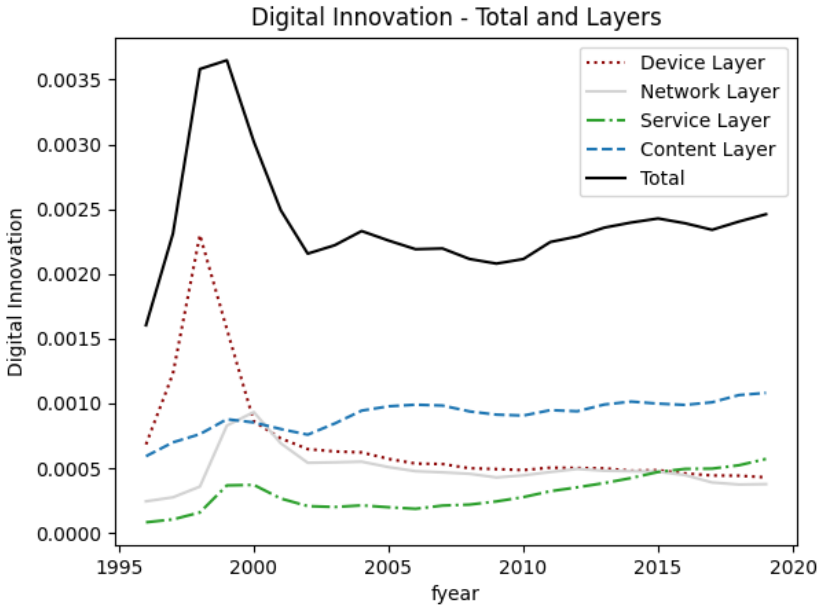
	Mean	Standard deviation	Min	25th percentile	Median	75th percentile	Max
Total	0.0024	0.0042	0.0000	0.0002	0.0009	0.0027	0.0909
Device layer	0.0008	0.0015	0.0000	0.0000	0.0002	0.0008	0.0405
Network layer	0.0005	0.0017	0.0000	0.0000	0.0000	0.0002	0.0460
Service layer	0.0003	0.0010	0.0000	0.0000	0.0000	0.0001	0.0313
Content layer	0.0009	0.0028	0.0000	0.0000	0.0003	0.0009	0.0909

Table 2 shows the summary statistics of the digital innovation measure in total and separately for each layer. The digital innovation measure represents the frequency of words in the digital innovation dictionary (see Table 1) relative to the overall number of words in the MD&A section of a firm's 10-K without stopwords. The analysis is based on 91,151 10-Ks covering the timespan 1996 to 2020 included in the final sample of the analysis.

Table 2: Summary statistics of digital innovation measure

Figure 1 illustrates the measure's development over time, both for the aggregated DI measure and the distinct layers. We observe a strong peak of the aggregated measure around 2000, which can be attributed to the dot-com bubble, excessive speculation with internet-related stocks that

reached its peak in March 2000. After this peak, the value of DI across firms decreases strongly and then stabilizes at a high level. Starting around 2010 we can observe a slight increase in the 91,151 DI measure that is more pronounced in recent years. Figure 1 also illustrates that this evolution of the aggregated DI measure can be attributed to different developments across the layers. The strong peak around 2000 is driven primarily by a sharp increase in the device and network layer. Thereafter, the device and network layer measures initially drop sharply and then continue to decrease slightly over time. In contrast, the service and content layer measures are characterized by a steady increase over the observation period.



This figure illustrates the measure of digital innovation in total and separately for each layer over time. The digital innovation measure represents the frequency of words in the digital innovation dictionary (see Table 1) relative to the overall number of words in the MD&A section of a firm's 10-K without stopwords. The analysis is based on 91,151 10-Ks covering the timespan 1996 to 2020 included in the final sample of the analysis.

Figure 1: Digital innovation over time – Total and layers

Table 3 depicts the most frequent words in firms' 10-Ks across time. Unsurprisingly, very generic terms, such as software, data, internet, computer, and hardware top the list. At the same time, we can also find more specific terms associated with DI in this list, such as cloud, analytics, and smart. Table 3 also illustrates the earlier observations with respect to the evolution of DI across time. Words belonging to the device layer, such as "software", "computer", and "hardware" are most frequent between 1996 and 2010, after that their frequency decreases, but remains at a high level. For the most frequent words of the network layer (i.e., internet, online, wireless) the frequency peak primarily occurs slightly delayed between 2001 and 2010. Some words belonging to the content and service layer, however, reach their frequency peak between 2001 and 2010 (e.g., digital, web, database) and others between 2011 and 2020 (e.g., data, website, e-commerce, cloud).

Since generic terms, such as software, data, internet, computer, and hardware, occur with high frequency (see Table 3), we also calculate an alternative DI measure. This alternative measure accounts for the importance of a word within the entire sample by adjusting for the so-called term-frequency-inverse document frequency (tf-idf) based on Loughran and McDonald (2011).

Words	Total	1996-2000	2001-2010	2011-2020	Layer
software	353,186	78,352	172,760	102,074	Device
data	322,501	34,316	138,779	149,406	Content
internet	79,136	16,737	47,738	14,661	Network
computer	76,546	35,888	29,603	11,055	Device
hardware	67,576	16,796	30,071	20,709	Device
digital	60,526	6,044	27,286	27,196	Content
wireless	55,714	6,212	34,244	15,258	Network
online	48,932	5,066	22,337	21,529	Network
electronic	44,659	7,666	22,749	14,244	Device
information technology	42,824	6,836	18,357	17,631	Device
mobile	40,842	2,180	15,409	23,253	Network
web	28,549	5,731	17,242	5,576	Service
electronics	27,999	3,587	13,920	10,492	Device
information systems	23,364	8,846	9,629	4,889	Device
broadband	20,933	1,261	13,076	6,596	Network
website	18,197	884	7,596	9,717	Service
e-commerce	16,449	1,626	7,051	7,772	Service
computing	14,921	2,149	6,333	6,439	Device
cloud	12,327	29	240	12,058	Service
database	11,884	2,340	6,879	2,665	Content
computers	11,564	4,378	5,011	2,175	Device
IP	11,450	715	6,173	4,562	Network
automation	11,243	1,699	5,383	4,161	Service
websites	10,679	401	3,795	6,483	Service
automated	10,072	1,996	4,782	3,294	Service
connectivity	8,515	1,051	3,897	3,567	Network
phone	8,378	915	4,485	2,978	Device
analytics	8,067	78	1,517	6,472	Content
smart	8,065	609	2,941	4,515	Service
desktop	6,506	1,885	2,783	1,838	Device

Table 3 shows the 30 most frequently used words of the digital innovation dictionary in the MD&A section of firms' 10Ks in total and separately for each layer. For each word, the absolute frequency in the sample, the frequency for the three time periods 1996-2000, 2001-2010, 2011-2020, and the respective layer in the layered architecture of digital innovation (see Section 2) is depicted. The analysis is based on 91,151 10-Ks covering the timespan 1996 to 2020 included in the final sample of the analysis.

Table 3: Thirty most frequent words of digital innovation dictionary in firms' 10-Ks

The weighted measure of each word w_{ij} is calculated using the following formula:

$$w_{ij} = \left(1 + \log\left(tf_{i,j}\right)\right) * \log\left(\frac{N}{df_i}\right)$$

$tf_{i,j}$ is the raw count of the i^{th} word in the j^{th} annual report, N measures the total number of annual reports and df_i represents the number of annual reports where the i^{th} word occurs at least once.

3.2 Financial Data and Analysis

We match each 10-K report and the derived measure of digital innovation to data of the CRSP and COMPUSTAT database using the CIK and report date. We perform multiple rounds of matching by first using the exact report date and then time windows around the report and filing date

for the merge to Compustat/CRSP data. Since Edgar also included 10-Ks of firms only traded over-the-counter (OTC), firms temporarily not listed on a stock exchange, and asset-backed partnerships, which are required to file with the SEC but are not included in Compustat/CRSP (CRSP, 2021), our initial sample is reduced during the matching process. We also filter out firm-years that did not belong to common stocks traded on the main stock exchanges (NYSE, AMEX and NASDAQ) in the United States. Overall, the final sample constitutes 91,151 firm-years with 24 time periods and 10,367 unique firms. In order to prevent that our results are driven by outliers, we use winsorization by setting all variables derived from financial statements in the bottom and top one percentiles to the value of the variables at the 1^{st} and 99^{th} percentile.

To study the determinants of DI, we run cross-sectional Fama/MacBeth regressions (Fama & MacBeth, 1973) using firm age, firm size, membership in the S&P 500 and NASDAQ, and analyst coverage as explanatory variables. The construction of these variables follows earlier literature and is described in detail in Appendix A. Our baseline model uses the following regression formula:

$$ln(DI) = \alpha + \beta_1 ln(age) + \beta_2 ln(size) + \beta_3 S\&P500 + \beta_4 NASDAQ + \beta_5 ln(1 + analyst) + \epsilon_{DI} \quad (4)$$

Table 4 depicts the results of the cross-sectional Fama/MacBeth regressions to explain firms' DI. As illustrated by specification (1), a firm's age offers explanatory power for a firm's DI by adding an adjusted R^2 of 1.50%. With increasing age, the DI of a firm decreases. Whereas a firm's size, measured as the firm's natural logarithm of market capitalization, and the membership in the S&P 500 offer low explanatory power, NASDAQ membership is another important determinant of a firm's DI with a R^2 of 1.50%, as the univariate specifications (2) to (4) illustrate. Analyst coverage explains DI to a lesser, but still statistically significant extent (see specification (5)). Our baseline model is depicted in specification (9). We find that the five independent variables together can explain 3.00% of DI's variance, a rather modest value. Overall, the regression results suggest that the selected firm characteristics can explain only a small proportion of DI's variance. These findings demonstrate the benefits of inferring a firm's digital innovation focus directly from the MD&A section with the help of textual analysis, instead of using secondary variables that are only weak proxies for DI.

To identify the effect of digital innovation on key firm characteristics, we use two approaches. First, we use the raw data of firms' digital innovation measure when sorting stocks into quintiles. Since a large proportion of firm-years has a digital innovation value of zero, the first quintile containing these firm-years is larger in size than the remaining four quintiles. Second, we derive a residual digital innovation measure by following Hillert et al. (2014) and Hong et al. (2000). Thus, we use regression specification (9), where we control for the firm characteristics, firm age, firm size, S&P 500 and NYSE membership, and analyst coverage, to obtain the residual digital innovation measure. This second approach offers the advantage that it allows us to eliminate possible dependencies between digital innovation and firm characteristics by following a simple approach. The variables used in the quintile analysis are described in detail in Appendix A.

Variables	Firm Age (1)	Firm Size (2)	S&P 500 (3)	NASDAQ_ (4)	Analyst (5)	1 + Firm Size (6)	6 + S&P 500 (7)	7 + NASDAQ_ (8)	Baseline (9)
Constant	0.0034***	0.0025***	0.0024***	0.0018***	0.0021***	0.0032***	0.0033***	0.0022***	0.0027***
	(11.23)	(11.66)	(18.18)	(19.20)	(13.71)	(9.70)	(9.83)	(9.03)	(10.31)
Firm Age	-0.0004***					-0.0004***	-0.0004***	-0.0004***	-0.0003***
	(-4.20)					(-4.59)	(-4.65)	(-5.33)	(-4.88)
Firm Size		0.0000				0.0000*	0.0000	0.0001***	-0.0001**
		(-0.89)				(1.83)	(0.57)	(4.51)	(-2.54)
S&P 500			-0.0002				0.0002*	0.0003***	0.0002**
			(-1.38)				(1.64)	(2.60)	(2.38)
NASDAQ_				0.0010***				0.0009***	0.0009***
				(6.03)				(14.01)	(15.20)
Analyst					0.0002***				0.0004***
					(4.07)				(6.82)
Sample Size	91,151	90,553	91,151	91,151	91,151	90,553	90,553	90,553	90,553
Adjusted R-squared	0.0154	0.0001	0.0004	0.0150	0.0005	0.0152	0.0154	0.0271	0.0300

Table 4 shows the results Fama-MacBeth regressions to explain digital innovation, measured as ln(1+(no. words digital innovation/no. words MD&A section without stopwords)). Regression (9) shows our baseline model, which we used to derive the residual digital innovation measure. *Firm age* is the natural log of a firm's age in years. Firm *size* is defined as the natural log of market capitalization. *S&P 500* and *NASDAQ_* are dummy variables indicating the membership of the firm in the S&P 500 index or its listing on the NASDAQ_. *Analyst* is defined as the natural log of (1+no. earnings estimates) and describes a firm's coverage by analysts. The sample period is 1996–2020. Following Fama and MacBeth (1973), coefficients are calculated as time-series averages of yearly estimates. t-statistics (shown in parentheses) are based on time-series average coefficients and standard deviation, and adjusted for serial autocorrelation using Newey and West (1994) standard errors with a lag of two years, based on the formula $\left\lfloor [4 * (0.01 * T)^{\frac{2}{9}}] \right\rfloor$ with T=24. The significance level is indicated as follows: * significant at the 10% level; ** significant at the 5% level; and *** significant at the 1% level.

Table 4: Multivariate regression to explain digital innovation

4 Results

4.1 Digital Leaders vs. Digital Laggards

Table 5 illustrates the distribution of firm characteristics after sorting stocks into quantiles based on the raw DI measure (panel A) and the residual DI measure (panel B). Additionally, we also sorted stocks into quantiles based on the alternative DI measure (tf-idf DI), which considers the adjusted term-frequency-inverse document frequency (see Section 3.1). The comparison DI portfolios sorted by raw values shows notable and highly significant differences in firm characteristics.

Digital leaders, firms in the high DI portfolio, are characterized by a lower book-to-market ratio. Furthermore, these firms are estimated to show higher profitability in the long-run, as the measure of long-term earnings forecasts shows. This finding corresponds to the notion that the value of digital innovation unfolds over time, because it depends on particular use contexts and how digital innovation can be combined with other innovation (Henfridsson et al., 2018). The development of respective capabilities to develop digital innovation needs several years and may involve the creation of networks transcending the traditional organization structure (Vial, 2019). In a similar vein, Svahn et al. (2017) report that building new capabilities requires breaking away from established practices and creating new capabilities, which includes rethinking existing norms. Building new capabilities requires a considerable amount of time, but also fosters firms' intangible value as well as their long-term performance (Bharadwaj et al., 1999).

At the same time, developing capabilities bears risks as the value of digital innovation is not predetermined but depends on, first, the design choices regarding the combination of technologies and the affordances thereof, and, second, on the use context (Henfridsson et al., 2018). In addition, "(a)s physical resources—including products—become comparatively less relevant than services, as consumers contribute to influence trends related to the use of digital technologies, and as value networks become broader and more complex, firms experience higher levels of uncertainty" (Vial, 2019, p.16). This reasoning corresponds with our finding that digital leaders are also characterized by significantly higher volatility, measured as the monthly return over the previous 60 months.

Digital leaders are also characterized by lower short-term returns, as illustrated by lower ROA, ROE and short-term forecasts. While developing capabilities for digital innovation and creating digital innovation impact the development of a firm's intangible value and future prospects, they are subject to uncertainty as discussed above and, in the short term, require considerable investment and management attention. Thus, there are "time lags necessary for realizing the potential of capital investments" which are not accounted for by accounting measures (Bharadwaj et al., 1999, p. 1009). Accordingly, we find lower values for digital leaders when it comes to short-term profitability.

At the same time, firms placed in the high DI portfolio also have notably smaller cost ratios than digitally lagging companies. In that regard, studies show that companies increase their operational efficiency and cost positions by employing digital technologies to automate and improve business processes, by using cloud-computing to provide on-demand services instead of owning data centers with high fixed costs, and by applying big data and analytics to speed up decision-making processes (Vial, 2019).

Moreover, sales growth is almost double in size for firms placed in the high DI portfolio. Extant research shows that the growth of entrepreneurial firms is nonlinear and similar to digitally oriented firms that use digital technologies to shape entrepreneurial processes and outcomes

(Vial, 2019). Namely, the development of digital façades – the digital coupling of firms' activities with customers and partners as a first step towards building up digital capabilities - have been found to enable growth (Tumbas et al., 2015) by attracting new customers.

The picture is mixed for organizational slack, considered an important source for financing innovation in organizations. Organizational slack refers to an organization's excess resources, i.e., resources not required to maintain the existing organization but enabling the search for innovation, the so-called slack search (Pitelis, 2007). The different concepts of slack are built around this notion (Greve, 2003). Absorbed slack refers to slack as use of administrative resources larger than necessary for short-term operation and is defined as ratio of selling, general and administrative expenses to sales. Unabsorbed slack denotes excess financial resources in form of cash or financial instruments measured as the ratio of assets over liabilities. Compared to the unabsorbed slack, potential slack focuses on the financial resources acquired by lending, or which an organization would be able to lend. Potential slack is measured as the ratio of debt to equity. Thus, while unabsorbed and potential slack refer to financial resources, and denote the potential to invest money, absorbed slack is already invested money, which is transformed into some form of assets in excess of what is needed for daily operations. Observed and unobserved slack are significantly higher for digital leaders. This is in line with the stream of literature, which argues that organizations engaged in innovative activities exhibit higher levels of slack enabling slack search for innovation (Pitelis, 2007). In contrast, potential slack is highest for digitally lagging firms. The tentative explanation is that digital leaders exhibit significantly higher financial resources, e.g., in form of cash, and do not exhibit high levels of debt. This corresponds with the higher unobserved slack, but renders our measure of potential slack lower for digital leaders. However, that might change if we would have been able to consider the credit line in addition to debt, which would encompass the ability to lend.

The differences between digitally leading firms and digitally lagging firms are equally evident when sorting stocks into quantiles based on the alternative measure tf-idf DI. Thus, this untabulated analysis - like the analysis based on the raw DI measure (Table 5, Panel A) – shows, for instance, significant lower book-to-market ratio (Q5-Q1: -0.16, t-stat Q5-Q1 25.53), higher long-term profitability (Q5-Q1: 3.95, t-stat Q5-Q1 122.40), higher volatility (Q5-Q1: 0.04, t-stat Q5-Q1: 150.81), and lower short-term profitability (e.g., ROA Q5-Q1: -0.03, t-stat Q5-Q1: 21.10) for digital leaders.

For portfolios sorted by residual values, Panel B mostly echoes these results. While some differences in firm characteristics between digital leaders and digitally lagging firms disappear (i.e., sales growth, and ROA) or reverse (i.e., available slack), most of the described differences in firm characteristics for firms in the extreme portfolios 1 and 5 remain after controlling for firm size, age, analyst coverage, S&P 500 and NASDAQ membership. Our analysis based on residual values of tf-idf DI shows similar results.

Especially, in the quintile analysis based on residual values some variables are subject to nonlinear effects. For instance, sales growth is highest in the extreme quintiles 1 and 5 and lowest in the intermediate quintiles. Such nonlinearities can also be observed for other variables, such as long- and short-term earnings forecasts. Since we are predominantly interested in comparing the firms positioned at the extremes of the DI spectrum, we focus on comparing firms in the portfolios 1 and 5.

Panel A: Quintile sorts based on the raw digital innovation measure												
Variables	**Book-to-market**	**Long-term forecast**	**Stock volatility**	**ROA**	**ROE**	**Short-term forecast**	**COGS/ assets**	**XOPR/ assets**	**Sales growth**	**Ab-sorbed slack**	**Unab-sorbed slack**	**Potential slack**
Q1	0.71	14.44	0.12	0.03	0.02	0.04	2.05	2.62	0.15	0.30	1.25	0.83
Q2	0.75	14.00	0.14	0.01	-0.03	0.01	2.17	2.69	0.15	0.32	1.33	0.89
Q3	0.71	15.26	0.14	0.01	-0.05	0.01	1.91	2.49	0.16	0.37	1.57	0.86
Q4	0.66	17.28	0.16	0.01	-0.05	0.00	1.66	2.30	0.19	0.41	1.57	0.65
Q5	0.59	20.55	0.18	0.00	-0.11	-0.01	1.32	2.07	0.27	0.53	1.73	0.54
Q5-Q1	-0.12***	6.11***	0.06***	-0.03***	-0.14***	-0.05***	-0.73***	-0.55***	0.12***	0.23***	0.48***	-0.29***
t-stat Q5-Q1	-19.02	159.24	233.53	-19.02	-22.66	-94.58	-44.05	-29.05	21.05	39.65	17.36	-9.00
Panel B: Quintile sorts based on the residual digital innovation measure												
Q1	0.70	17.54	0.14	0.00	-0.06	0.00	1.88	2.45	0.25	0.39	2.14	0.78
Q2	0.71	14.80	0.13	0.02	-0.02	0.02	1.99	2.55	0.16	0.35	1.48	0.84
Q3	0.72	14.38	0.13	0.02	-0.00	0.03	1.98	2.52	0.14	0.33	1.28	0.87
Q4	0.70	16.28	0.15	0.02	-0.03	0.02	1.75	2.35	0.15	0.38	1.35	0.73
Q5	0.61	20.32	0.17	0.00	-0.10	-0.01	1.36	2.10	0.24	0.51	1.68	0.54
Q5-Q1	-0.08***	2.78***	0.03***	0.00	-0.04***	-0.01***	-0.52***	-0.35***	-0.00	0.13***	-0.46***	-0.23***
t-stat Q5-Q1	-11.67	17.71	32.29	0.30	-5.72	-5.70	-24.47	-14.55	-0.59	16.86	-12.22	-6.79

Table 5 shows time-series averages of firm variables' yearly mean for quintile portfolios based on the raw digital innovation measure (panel A) and the residual digital innovation measure (panel B). The raw digital innovation measure is defined as ln(1+(no. words digital innovation/no. words MD&A section without stopwords). The residual digital innovation measure is derived from Fama-MacBeth regressions with firm age, firm size, S&P500, NASDAQ, and analyst coverage as explanatory variables (see Table 3) using time-series averages of yearly estimates. *Book-to-Market* is the book value of equity divided by market value of equity following Greenwood and Hanson (2012). *Long-term forecast* is measured as the average of analysts' forecast of the expected long-run earnings growth rate per share over the next five years following La Porta (1996).*Stock volatility* is measured using the monthly return over the previous 60 months. *Return on assets* (ROA) is calculated as the ratio between income before extraordinary items and assets. *Return on equity* (ROE) is calculated following Greenwood and Hanson (2012). *Short-term forecast* is measured as the average of analysts' earnings forecast for the fiscal year annual earnings scaled by the price per share. *Cost ratios* are defined as cost of goods sold over assets and operating expenses over assets. *Sales growth* is measured as the log change in sales over one year. Absorbed slack is the ratio of selling, general, and administrative expenses to sales. Unabsorbed slack is the ratio of short-term assets to liabilities. Potential slack is the ratio of debt to equity. The sample period is 1996–2020. The final rows in each panel display the difference between the fifth and first quantile as well as the t-statistic associated with this portfolio difference. The significance level is indicated as follows: * significant at the 10% level; ** significant at the 5% level; and *** significant at the 1% level.

Table 5: Firm characteristics for portfolios sorted by raw and residual digital innovation measure

4.2 Portfolio Tests based on the Level of DI

The previous section highlights systematic differences between firms with high and low values for the text-based measure of DI. In this section, we analyze if firms with high and low levels of DI have also different stock returns. At the end of June of every year, we group stocks into quintile portfolios based on their DI value. The measure of DI is extracted from the firms' most recent fiscal year financial statements ending in the previous calendar year. For example, our sorts for June 2009 rely on data from financial statements ending in the calendar year 2008 (in most cases December 2008).

Because a large proportion of stocks has a digital innovation orientation of zero, we group these stocks in the first quintile. The remaining stocks are then equally spread across the other quintiles according to their DI value. Our sorts are based on the absolute DI value instead of the residual value from regression equation (1), because other firm variables have low explanatory power to explain DI (see Section 3.2). Therefore, portfolio tests based on the absolute value of DI and its residual value deliver similar results. Moreover, while we use DI based on the total number of word counts, we also calculate portfolio performance for the alternative DI measure which considers the adjusted term-frequency-inverse document frequency (tf-idf) from Loughran and McDonald (2011) as described in Section 3.1. The correlation between both measures of digital innovation is at 0.59 which suggests that sorts lead to different compositions for the stock portfolios. Nevertheless, we find that the resulting portfolio performances are very similar for both measures, and briefly comment also on the results for the tf-idf DI measure.

We calculate equally weighted and value-weighted quintile (5) minus quintile (1) long-short portfolio returns from July, 1^{st} until June 30^{th} of next year, when the portfolio is rebalanced.[2] The transaction costs which are associated with the DI factor are supposedly minimal because the annual rebalancing frequency implies a comparatively low portfolio turnover, and because we focus on non-micro-cap stocks, i.e., stocks with a market capitalization above the second NYSE size decile.

Low limits-to-arbitrage are even more emphasized for the second weighting scheme based on market values. For this scheme, we also exclude micro-cap stocks. Moreover, we use a capped value-weighting approach that winsorizes all market capitalizations at the 80th percentile of the stock universe before calculating the stock weights. The capped value weighting is advocated in Jensen et al. (2021) because it avoids a dominating influence of few mega caps like FANG (Facebook, Amazon, Netflix, Google), and hence produces more robust factors. The benefits of a capped weighting scheme seem to be particularly relevant in our context as many of the dominating mega-cap stocks at the end of the sample period also tend to have a high level of DI.

Besides reporting raw returns, the long-short portfolio returns are also regressed on a set of commonly used factors (e.g., Carhart, 1997; Fama & French, 1993, 2015) to infer the abnormal, i.e. unexplained, return of the digital innovation (DI) factor. Results for equally weighted (value-weighted) portfolio scheme are shown in Table 6, Panel A (Panel B).

Column (1) in Panel A of Table 6 reports the raw return of the equally weighted long-short strategy. It amounts to 0.69% per month and is statistically significant at the 5% level (t-statistic: 2.48). We find that the Fama and French three factor alpha, which is reported in column (3), is lower at 0.42% per month with a t-statistic of 2.40. However, as can be seen in column (6) of Panel A, the six-factor alpha of a regression which controls for the market, size, value, momentum,

[2] Because we use financial statements for fiscal years from 1996 onwards, portfolio returns are calculated from July 1997 onwards.

profitability, and investment factor, is 0.92% per month (approximately 11% annualized) with a very high t-statistic of 6.51.

Panel A: Equally weighted portfolios						
	(1)	(2)	(3)	(4)	(5)	(6)
Alpha	0.0069**	0.0044*	0.0042**	0.0051***	0.0087***	0.0092***
	(2.48)	(1.74)	(2.40)	(3.02)	(6.03)	(6.51)
mktrf		0.4331***	0.3216***	0.2573***	0.1194***	0.0834**
		(7.93)	(8.30)	(6.43)	(3.26)	(2.27)
smb			0.4177***	0.4429***	0.1582***	0.1849***
			(7.47)	(8.16)	(3.15)	(3.75)
hml			-0.8416***	-0.9109***	-0.4494***	-0.5241***
			(-16.02)	(-17.19)	(-7.42)	(-8.50)
umd				-0.1595***		-0.1167***
				(-4.54)		(-4.08)
rmw					-0.8252***	-0.7945***
					(-12.18)	(-11.98)
cma					-0.2717***	-0.2378***
					(-3.08)	(-2.76)
N	275	275	275	275	275	275
R-squared	0.000	0.187	0.622	0.649	0.758	0.772
Panel B: Value-weighted portfolios						
	(1)	(2)	(3)	(4)	(5)	(6)
Alpha	0.0029	0.0005	0.0003	0.0010	0.0046***	0.0050***
	(1.12)	(0.20)	(0.17)	(0.67)	(3.88)	(4.22)
mktrf		0.4201***	0.3195***	0.2696***	0.1260***	0.1006***
		(8.39)	(9.44)	(7.66)	(4.16)	(3.29)
smb			0.3618***	0.3813***	0.1166***	0.1355***
			(7.41)	(7.98)	(2.81)	(3.30)
hml			-0.8182***	-0.8720***	-0.4415***	-0.4941***
			(-17.84)	(-18.71)	(-8.82)	(-9.62)
umd				-0.1238***		-0.0824***
				(-4.01)		(-3.45)
rmw					-0.7819***	-0.7603***
					(-13.96)	(-13.76)
cma					-0.2706***	-0.2467***
					(-3.71)	(-3.44)
N	275	275	275	275	275	275
R-squared	0.000	0.205	0.665	0.684	0.808	0.816

Table 6 shows the results of regressions to investigate the profitability of equally weighted (Panel A) and capped value-weighted (Panel B) quintile 5-minus-1 portfolios based on digital innovation (DI). Column (1) shows the raw returns per month of this DI factor. The remaining columns show the results, if the monthly long–short DI portfolio returns are regressed on the excess market return (MKTRF); on the Fama and French (1993) size and value factors (SMB, HML); on the Fama and French (2015) profitability and investment factors (RMW, CMA); and on the momentum factor from Kenneth French (UMD); t-statistics are reported in parentheses. *, ** and *** indicates significance at the 10%, 5%, and 1% levels, respectively.

Table 6: Abnormal returns of the digital innovation (DI) factor

The pronounced increase in the economic and statistical significance of the alpha in column (6) is to a large extent explained by a very negative correlation with the profitability factor RMW. We also observe a negative correlation with the value factor HML, and to a lesser extent with the

investment factor CMA in column (6). The correlations line up with findings from Section 4.1 which shows that firms with a high level of DI tend to be growth firms with lower profitability. After we account for these relations, the results in Panel A show that firms with a high level of digital innovation earn higher returns than firms with a low level of digital innovation.

The same conclusion can be drawn from Panel B of Table 6, although the (abnormal) returns for the value-weighted long-short portfolio are lower in economic and statistical significance. Column (1) shows a raw return of 0.29% per month for the strategy, which is statistically insignificant (t-statistic 1.12). The CAPM one-factor, Fama and French (1993) three-factor, and Carhart (1997) four-factor alpha are also statistically insignificant.

The regressions suffer from omitted variable bias because the negative correlations between the DI factor with respect to both RMW and CMA are not taken into account. Doing so, we observe a statistically significant Fama and French (2015) five-factor alpha of 0.46% per month (t-statistic of 3.88) in column (5). The alpha of a six-factor regression which additionally controls for momentum exposure is 0.50% per month or 6% annualized (t-statistic 4.22).

In un-tabulated tests, we find that the DI factor also changes our assessment of the performance of RMW and CMA. If we regress RMW (CMA) on the remaining five factors without the DI factor, the alpha is 0.47% (0.28%) per month with a t-statistic of 3.75 (2.88). The economic and statistical significance of the regression intercept increases to 0.55% (0.36%) per month with a t-statistic of 5.64 (3.61) after controlling for the value-weighted version of the DI factor.

Un-tabulated results for the long-short portfolio based on the tf-idf DI measure yield monthly equally weighted (value weighted) six factor alphas of 0.86% (0.50%) per month with a t-statistic of 5.98 (4.17), which is comparable to our baseline findings. Correlations with the model factors are also similar.

Because digital innovation is a cross-industry phenomenon, we expect that the abnormal returns which are associated with digital innovation are not well explained by industry affiliation. To formally test this expectation, we recalculate equally-value and value-weighted portfolio returns based on industry-adjusted stock returns. For the industry adjustment, we use industry returns based on the Fama and French (1997) 48 industry classification system, denoted as FF48, and industry returns based on the network industry classification of Hoberg and Phillips (2010, 2016), denoted as TNIC. Results are reported in Table 7.

In Panel A of Table 7, we report results for equally weighted returns. The six-factor alpha of the industry-adjusted DI strategy is 0.72% (0.69%) per month using the FF48 (TNIC) industry classification. While both alphas are lower in magnitude in comparison to the six factor alpha in Panel A of Table 5 (0.92% per month), the statistical significance is higher (7.13 and 6.79, respectively versus 6.51). The reason is that the industry-adjustment also reduces the volatility of the strategy.

Panel B of Table 7 shows value-weighted returns. The six-factor alpha of the industry-adjusted DI strategy is 0.29% (0.27%) per month using the FF48 (TNIC) industry classification of. The strategy alphas are lower compared to Panel B in Table 5, but remain statistically significant at the 1% level with t-statistics of 3.93 and 3.42 respectively.

Panel A: Equally weighted portfolios						
	Adjustment: Fama and French 48 industries (FF48)			*Adjustment: Hoberg and Philipps network industry classification (TNIC)*		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Alpha	0.0057***	0.0041***	0.0072***	0.0061***	0.0050***	0.0069***
	(3.61)	(3.50)	(7.13)	(4.59)	(4.56)	(6.79)
mktrf		0.1647***	0.0194		0.1085***	0.0144
		(6.23)	(0.74)		(4.43)	(0.54)
smb		0.3355***	0.1964***		0.2959***	0.1986***
		(8.79)	(5.60)		(8.38)	(5.57)
hml		-0.2871***	-0.1393***		-0.1579***	-0.0942**
		(-8.01)	(-3.18)		(-4.76)	(-2.11)
umd			-0.1025***			-0.0856***
			(-5.03)			(-4.13)
rmw			-0.4778***			-0.3272***
			(-10.13)			(-6.82)
cma			-0.0686			0.0322
			(-1.12)			(0.52)
N	275	275	275	275	275	275
R-squared	0.000	0.456	0.644	0.000	0.346	0.484
Panel B: Value-weighted portfolios						
	Adjustment: Fama and French 48 industries (FF48)			*Adjustment: Hoberg and Philipps network industry classification (TNIC)*		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Alpha	0.0017	0.0003	0.0029***	0.0021**	0.0011	0.0027***
	(1.28)	(0.51)	(3.93)	(1.99)	(1.34)	(3.42)
mktrf		0.1511***	0.0285		0.1031***	0.0329
		(7.37)	(1.49)		(5.45)	(1.62)
smb		0.2714***	0.1441***		0.2364***	0.1442***
		(9.18)	(5.63)		(8.66)	(5.31)
hml		-0.2615***	-0.1180***		-0.1593***	-0.0952***
		(-9.42)	(-3.68)		(-6.21)	(-2.80)
umd			-0.0711***			-0.0472***
			(-4.78)			(-2.99)
rmw			-0.4273***			-0.2921***
			(-12.41)			(-7.99)
cma			-0.0675			0.0424
			(-1.51)			(0.89)
N	275	275	275	275	275	275
R-squared	0.000	0.514	0.717	0.000	0.403	0.542

Table 7 shows the results of regressions to investigate the industry-adjusted profitability of equally weighted (Panel A) and capped value-weighted (Panel B) quintile 5-minus-1 portfolios based on digital innovation (DI). To account for industry effects we deduct value-weighted industry returns from the stocks' raw return before forming portfolios. For the industry adjustment, we use two different industry classifications. Results in columns (1) to (3) are based on the Fama and French (1997) 48 industry classification system; results in columns (4) to (6) are based on the network industry classification of Hoberg and Phillips (2010, 2016). Columns (1) and (4) show industry-adjusted raw returns per month of the DI factor. Columns (2) and (5) show industry-adjusted monthly Fama and French (1993) three-factor alphas, which control for exposure to the excess market return (MKTRF), and the Fama and French (1993) size and value factors (SMB, HML). Columns (3) and (6) show industry-adjusted monthly six-factor alphas, which additionally control for exposure to the Fama and French (2015) profitability and investment factors (RMW, CMA); and on the momentum factor from Kenneth French (UMD); t-statistics are reported in parentheses. *, ** and *** indicates significance at the 10%, 5%, and 1% levels, respectively.

Table 7: Industry-adjusted abnormal returns of the digital innovation (DI) factor

4.3 Portfolio Tests based on DI Factor Exposure

Why do firms with a high level of DI earn higher stock returns? One potential explanation lies in market inefficiencies. For instance, investors may have underestimated the earnings and growth potential of digital leaders in the past. This argument seems less appealing for two reasons. First, our sample period from 1996 to 2020 largely coincides with a period of a supposedly very efficient US stock market. For instance, Green et al. (2017) who study 94 cross-sectional return phenomena, report a sharp decline in return predictability post 2003. Using the same definition of micro-cap stocks as we do, they find that post-2003 a hedge portfolio based on the 94 return predictors delivered a mean monthly return of only 0.1% with a t-statistic of 0.2. Second, our focus on non-micro-cap stocks with an annual rebalancing frequency makes it unlikely that transaction costs and other limits-to-arbitrage could explain the association between returns and DI.

An alternative explanation is that digitalization has become a widespread and hence systematic market phenomenon which carries a risk premium. To see if we find evidence for this possibility, we conduct "characteristics-vs.-covariances" tests in the spirit of e.g., Daniel and Titman (1997). Formally, for every stock, we run rolling-window regressions to infer the stock's exposure against the DI factor. To this end, we use the most recent two-year monthly stock returns and regress them on the market factor and the value-weighted version of the DI factor. Based on the regression results, we form five stock portfolios which differ in their exposure to the DI factor but have on average the same DI score.

The methodology ensures that the resulting quintile (5) minus quintile (1) portfolio is neutral with respect to the DI characteristic, i.e., according to their financial statements stocks in quintile 5 have a similar level of DI as stocks in quintile 1. However, by construction the return of the long-short portfolio should have a high positive exposure against the DI factor. If the abnormal returns of the DI factor reflects a compensation for systematic risk, one would hence expect that stocks with a high exposure to this factor also earn higher returns, independent of the DI level from financial statements. To see if this is the case, we study the performance of the high minus low DI factor exposure portfolio. Results are shown in Table 8. Panel A (B) reports equally weighted (value-weighted) portfolio returns.

We find that the equally weighted (value-weighted) monthly six alpha factor of the long-short DI factor exposure portfolio is 0.93% (0.53%). Both alphas are statistically significant at the 1% level with t-statistics of 4.14 and 2.69, respectively. The abnormal returns decline to 0.58% (equally weighted) and 0.20% (value-weighted) per month once we add the value-weighted DI factor as control variable in the regressions. While the alpha for the value-weighted portfolio is statistically insignificant (t-statistic 1.09), there remains a statistical significance for the unexplained return of the equally weighted portfolio (t-statistic: 2.74).

As expected, the long-short DI factor exposure portfolio is indeed exposed to the DI factor factor. In column (4) of Panel A, the regression coefficient for the DI factor equals 0.75 (t-statistic 7.14). In column (4) of Panel B, the regression coefficient for the DI factor equals 0.71 (t-statistic 7.87). While we use historical returns to estimate stock specific factor exposures, the strong relation between the long-short DI factor exposure portfolio and the actual DI factor suggests that stock specific exposures are largely persistent.

The interpretation of these findings is that the systematic DI factor exposure, rather than the characteristic, explains the higher returns of stocks with a high level of DI. This suggests that the DI factor is a priced risk factor.

Panel A: Equally weighted long-short portfolio				
	(1)	(2)	(3)	(4)
Alpha	0.0070	0.0032	0.0093***	0.0058***
	(1.63)	(1.21)	(4.14)	(2.74)
mktrf		0.2857***	0.0556	-0.0176
		(4.85)	(0.96)	(-0.32)
smb		0.7185***	0.3079***	0.1995***
		(8.40)	(3.90)	(2.71)
hml		-1.4047***	-0.9128***	-0.5390***
		(-17.91)	(-9.41)	(-5.23)
umd			0.0529	0.1164***
			(1.17)	(2.76)
rmw			-1.2057***	-0.6364***
			(-11.64)	(-5.14)
cma			-0.1114	0.0683
			(-0.83)	(0.54)
DI				0.7489***
				(7.14)
N	263	263	263	263
R-squared	0.000	0.641	0.766	0.805
Panel B: Value-weighted long-short portfolio				
	(1)	(2)	(3)	(4)
Alpha	0.0035	-0.0002	0.0053***	0.0020
	(0.84)	(-0.10)	(2.69)	(1.09)
mktrf		0.2994***	0.0968*	0.0270
		(5.65)	(1.89)	(0.58)
smb		0.5921***	0.2017***	0.0982
		(7.69)	(2.90)	(1.54)
hml		-1.4263***	-0.9557***	-0.5990***
		(-20.20)	(-11.18)	(-6.72)
umd			0.0769*	0.1375***
			(1.93)	(3.76)
rmw			-1.1281***	-0.5849***
			(-12.37)	(-5.46)
cma			-0.0998	0.0717
			(-0.84)	(0.66)
DI				0.7146***
				(7.87)
N	263	263	263	263
R-squared	0.000	0.681	0.800	0.839

Table 8 shows the results of regressions to investigate the profitability of equally weighted (Panel A) and capped value-weighted (Panel B) quintile 5-minus-1 portfolios based on exposure to the digital innovation (DI) factor. Factor exposure is obtained from rolling-window regressions of past 24 monthly stock returns on the market factor and DI factor. Quintile portfolios are characteristics-neutral with regard to digital innovation. Column (1) shows the raw returns per month of this factor exposure portfolio. The remaining columns show the results, if the monthly long–short portfolio returns are regressed on the excess market return (MKTRF); on the Fama and French (1993) size and value factors (SMB, HML); on the Fama and French (2015) profitability and investment factors (RMW, CMA); on the momentum factor from Kenneth French (UMD); and on the value-weighted DI factor from Table 6; t-statistics are reported in parentheses. *, ** and *** indicates significance at the 10%, 5%, and 1% levels, respectively.

Table 8: Abnormal returns of long–short trading strategies based on DI factor exposure

This conclusion holds if we measure exposure to digital innovation using the tf-idf DI measure. In this case, the equally weighted (value-weighted) monthly six alpha factor of the long-short DI factor exposure portfolio is 0.96% (0.54%). Both alphas are statistically significant at the 1%-level, and again comparable to our baseline results.

5 Conclusion

Although digital innovation have led to the disruption of business models in firms and challenged the boundaries of existing industries, we know little about the impact of digital innovation in explaining asset pricing. Relying on a bag-of-words approach we analyze annual reports of US firms in the period 1996-2020 to derive a text-based, objective, and easy to implement measure of digital innovation. We show that the extent to which firms engage in digital innovations has significant implications for the capital market and investors' valuation of stocks. Our findings illustrate that our measure of digital innovation can explain heterogeneity across firms that cannot be accounted for by other firm characteristics.

We show firms with a high level of digital innovation are systematically different from firms with a low level of digital innovation. Additionally, we identify a new digital innovation factor, which has significant explanatory power for expected stock returns. Against the backdrop that the digitalization and impact of digital innovation is unlikely to disappear in the next decade, our findings have significant implications for studying capital markets in the digital age.

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Appendix A: Definition of Variables

Analyst is defined as the natural logarithm of (1+number of next year earnings estimates for firm) and describes a firm's coverage by analysts. This measure follows Hong et al. (2000). The number of estimates stems from IBES (numest).

Book-to-Market is the book value of equity divided by market value of equity following Greenwood and Hanson (2012). Data is derived from Compustat.

Cost ratios are defined as cost of goods sold (cogs) over assets (act) and operating expenses (cogs) over assets (act) and based on data from Compustat.

Firm age is the natural logarithm of a firm's age in months since the firm's PERMCO is first part of the CRSP database (going back to 1925).

Firm size is defined as the natural logarithm of end-of-month market capitalization and derived from the product of number of shares outstanding (shrout) and price (prc) in CRSP.

Long-term forecast is measured as the average of analysts' forecast of the expected long-run earnings growth rate per share over the next five years derived from IBES following La Porta (1996).

NASDAQ is a dummy variable indicating the listing of the firm on the NASDAQ (exchcd=3) derived from CRSP.

Organizational slack is calculated following Greve (2003). *Absorbed slack* is the ratio of selling, general, and administrative expenses (xsga) to sales (sale). *Unabsorbed slack* is the ratio of short-term assets, cash and short-term investments (che), to liabilities (lct). *Potential slack* is the ratio of debt, the sum of debt in current liabilities (dlc) and long-term debt (dltt) to equity (teq). Data is derived from Compustat.

Return on Assets (ROA) is calculated as the ratio between income before extraordinary items (ibq) and assets (atq) derived from CRSP.

Return on equity (ROE) is calculated following Greenwood and Hanson (2012) and based on Compustat data.

S&P 500 is a dummy variables indicating the membership of the firm in the S&P 500 index, derived from the "Index Constituents" database available in Compustat.

Sales growth is measured as the log change in sales (sale) over one year. Data is available in Compustat.

Short-term forecast is measured as the average of analysts' earnings forecasts for the fiscal year annual earnings year scaled by the price per share and de*rived from IBES.*

Paper XII

At the Crossroads between Digital Innovation and Digital Transformation

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Appendix

Publications

Publications in Scientific Journals (peer-reviewed)

Chandra Kruse, L., **Drechsler, K.**. (2022) Digitalization of Multisensory Collective Activity: The Case of Virtual Wine Tasting. *Journal of Information Technology*, 37(4), 341–358.

Reibenspiess, V., **Drechsler, K.**, Eckhardt, A., & Wagner, H.-T. (2022). Tapping into the Wealth of Employees' Ideas: Design Principles for a Digital Intrapreneurship Platform. *Information and Management*, 59(3), 103287.

Drechsler, K., Reibenspiess, V., Eckhardt, A., & Wagner, H. T. (2021). Innovation Champions' Activities and Influences in Organisations - A Literature Review. *International Journal of Innovation Management*, 25(6), 2150066.

Drechsler, K., Gregory, R., Wagner, H. T., & Tumbas, S. (2020). At the Crossroads between Digital Innovation and Digital Transformation. *Communications of the Association for Information Systems*, 47(23), 521–538.

Publications in Conference Proceedings (peer-reviewed)

Drechsler, K., Grisold, T, Seidel, S. (2022). Evolution of Infrastructures through Digital Options: The Case of the Industrial Internet of Things. *Proceedings of the 43rd International Conference on Information Systems, Copenhagen, Denmark*

Drechsler, K., Grisold, T, Seidel, S., Gau, M. (2022). Studying Digital Infrastructure Evolution with Digital Trace Data. *Proceedings of the 43rd International Conference on Information Systems, Copenhagen, Denmark*

Schäfer, M., Schneider, J., **Drechsler, K.**, vom Brocke, J. (2022). AI Governance: Are Chief AI Officers and AI Risk Officers needed? *Proceedings of the 30th European Conference on Information Systems, Timisoara, Romania*.

Drechsler, K. (2020). Information Systems Executives : A Review and Research Agenda. *Proceedings of the 28th European Conference on Information Systems, A Virtual AIS Conference*.

Drechsler, K., Wagner, H.-T., & Reibenspiess, V. (2019). Risk and Return of Chief Digital Officers' Appointment – An Event Study. *Proceedings of the 40th International Conference on Information Systems, Munich, Germany*.

Gregory, R. W., Wagner, H.-T., Tumbas, S., & **Drechsler, K.** (2019). At the Crossroads between Digital Innovation and Digital Transformation. *Proceedings of the 40th International Conference on Information Systems, Munich, Germany*

Reibenspiess, V., **Drechsler, K.**, & Eckhardt, A. (2019). A Work Model for Employee-Driven Innovation in Public Organizations. *Proceedings of the 27th European Conference on Information Systems, Stockholm, Sweden*.

Hund, A., **Drechsler, K.**, & Reibenspiess, V. (2019). The Current State and Future Opportunities of Digital Innovation: A Literature Review. *Proceedings of the 27th European Conference on Information Systems, Stockholm, Sweden*.

Drechsler, K., Reibenspiess, V., Eckhardt, A., & Wagner, H.-T. (2019). The Changing Roles of Innovation Actors and Organizational Antecedents in the Digital Age. *Tagungsband zur 14.*

Internationalen Tagung Wirtschaftsinformatik, Siegen, Germany.

Drechsler, K., Hund, A., & Wagner, H.-T. (2018). Championing Digital Innovation Success: The Role of CDOs. *Proceedings of the 22nd Pacific Asia Conference on Information Systems, Yokohama, Japan*.

Reibenspiess, V., **Drechsler, K.**, Eckhardt, A., & Wagner, H.-T. (2018). Enabling Innovation Champions in Organizations - Results of a Systematic Literature Analysis. *Proceedings of the 51st Hawaii International Conference on System Sciences, Big Island, Hawaii*.

Working Paper

Drechsler, K., Müller, S., Wagner, H.-T. Digital Innovation...and the Cross-section of Stock Returns. SSRN Working Paper. https://dx.doi.org/10.2139/ssrn.3972173.