DIGITAL INNOVATION

THEORETICAL FOUNDATION AND EMPIRICAL EVIDENCE

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DEDICATION BY PROF. DR. TIM WEITZEL (WIDMUNG)

"It isn't all over; everything has not been invented;
the human adventure is just beginning."
Gene Roddenberry

Peter Drucker wrote in 1955 " ... *any business enterprise has two - and only these two - basic functions: marketing and innovation*". While marketing has gone digital for almost two decades now, Dr. Hund addresses the second of the basic functions of an enterprise by asking how digital innovation can be conceptualized, created and managed. In this context, the "digital" in digital innovation has now opened up a completely new playing field, where it has become clearly visible that some of the previous theories and recommended actions on innovation have reached their limits (e.g. Vega, Chiasson, JSIS 2019).

Digital innovations are essentially, not only gradually, different from classic innovations in terms of their nature, creation/emergence, and value generation, and thus require fundamental re-contextualization and re-theorization. Today, for example, it is often no longer possible, or meaningful, to distinguish between the innovation process and its outcome, or the inputs and outputs of innovations, when usage and utility of digital technologies influence each other, this happens across expertise, company and industry boundaries, and changes can be implemented quasi-continuously. Digital innovations, even more than classic software, are thus never really finished (Nambisan, Lyytinen, Majchrzak, MISQ 2017; Lyytinen, Yoo, Boland Jr., ISJ 2016; Seo, JAIS 2017).

Against this background, Dr. Hund argues that and why inferring properties of physical objects to properties of digital objects leads to logical fallacies and shows that a comprehensive understanding and shaping of digital innovation requires an extended socio-technical perspective that requires, for example, redefining social and organizational identities, which in turn entails a change in technological identities. Accordingly, one of the main results of the present work is to determine why classical knowledge on innovation management no longer does justice to the continuous malleability and the more network-like value generation processes of digital contexts. In his deep and methodologically as well as theoretically excellent work, Dr. Hund develops insights and new knowledge on the essence, creation and governance of digital innovation.

In a Special Report on Innovation and Entrepreneurschip, The Economist wrote in 2009: "*85% of all the high-growth businesses created in America in the past 20 years were launched by college graduates. University research departments have helped to drive innovation in everything from design to entertainment.*" (The Economist, 3/14/2009).
DIGITAL INNOVATION - Theoretical foundation and empirical evidence is a fine example of how science drives innovation capabilities and a "must read" for any scholar and practitioner interested in digital innovation.

Prof. Dr. Tim Weitzel

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DEDICATION BY PROF. DR. HEINZ-THEO WAGNER (WIDMUNG)

The topic of Dr. Axel Hund's thesis gains significant awareness in academia and practice alike. The topic of "Digital Innovation" is a central tenet in IS as well as recent innovation research and, among others, deals with the theoretically important and equally challenging nature of "the Digital" and its consequences for established core concepts and paradigms.

Digital Innovation is highly relevant for organizations seeking to gain and sustain competitiveness and is, therefore, a relevant object for strategic considerations. In a similar vein, studies across various disciplines, such as innovation management, organization science, and information systems, have investigated the antecedents, nature, and effects of digital innovation, including considerations about the unique characteristics of digital innovation as opposed to traditional innovation. But, despite basically acknowledging the distinctiveness and importance of digital innovation, there are surprising research gaps regarding the generation, management, and governance of digital innovation, as well as the conceptualization of what is "the Digital" in digital innovation, in particular.

Considering these research gaps, the thesis of Dr. Axel Hund aims at these challenges and discusses how the perspective of research on digital innovation can be changed to handle the phenomenon of digital innovation in a conceptually consistent framing.

Dr. Axel Hund evaluated more than 400 articles and processed not less than 227 pertinent articles just for one of the thesis' topics - the literature review on digital innovation - and provided substantial contributions to the scientific literature. The work impresses by its methodologically elaborate and clear structure that fully meets the requirements of current research literature and by the sound analysis of a large number of evaluated literature contributions.

Corresponding to the challenging task of his thesis, Dr. Axel Hund's cumulative dissertation stands out by its exceptionally remarkable development of the concept of "the Digital", the scrutinization of the technical and social identity of digital innovation, as well as the clarification of relationships between core concepts within the existing literature. These contributions significantly go beyond extant insights and are of utmost importance for our understanding of all concepts referring to "the Digital" such as in "digital innovation" and "digital transformation".

The thesis thus significantly contributes to our understanding of digital innovation and the fundamental differences between theoretical approaches to capture digital phenomena as opposed to traditional theoretical approaches. Grounded in the insights achieved, the thesis offers essential building blocks for further research to the scientific community and provides a solid fundament for a more sophisticated understanding of digital innovation.

For researchers interested in digital innovation, this dissertation is essential to read as it offers deep theoretical insights, as well as sound methodological approaches to tap into existing knowledge.

Prof. Dr. Heinz-Theo Wagner

Dedicated to my parents

Ulrike and Michael

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I am deeply grateful for the opportunity to embark on this intellectual journey and for the support I have received from supervisors, colleagues, friends, and family along the way.

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To my family, thank you for your unwavering support and understanding throughout the years of research and writing. I owe my parents, Ulrike and Michael, my sister Nina, and especially my better half, Priyanka, more gratitude than words can express. I am forever grateful for your unconditional love and support, which have been a constant source of joy and motivation.

Thank you all for being a part of this journey. I could not have done it without you.

GERMAN SUMMARY (ZUSAMMENFASSUNG)

Die rapide Verbesserung der Verarbeitungsleistung von Prozessoren, gekoppelt mit der rasanten Miniaturisierung von Hardware haben es ermöglicht Produkte aus dem Industriezeitalter zu digitalisieren und mit immer neuen Fähigkeiten auszustatten (Porter und Heppelmann 2014; Yoo et al. 2010). Dadurch sind digitale Technologien zu einem festen Bestandteil unserer Welt geworden und haben im privaten wie im beruflichen Kontext viele etablierte Abläufe und Annahmen grundlegend geändert. Die zentrale Rolle von digitalen Technologien für alltägliche Aufgaben wie Kommunikation, Datenverarbeitung und Koordination hat dabei nicht nur die Art und Weise verändert, wie wir zusammenarbeiten und uns organisieren (Boland et al. 2007; Lyytinen et al. 2016), sondern durch das Zusammenführen von digitalen und physischen Komponenten (Yoo et al. 2010) hat sich auch das Wesen der Innovation selbst verändert (Nambisan et al. 2017).

Während es einen disziplinübergreifenden Konsens darüber gibt, dass digitale Innovationen qualitativ anders sind als die traditionell untersuchten Informationssysteme und ein interessantes, neues Phänomen darstellen (Markus und Nan 2020) fehlen Theorien, die digitale Phänomene ganzheitlich erfassen und erklären können, wie regelmäßig in der Literatur diskutiert wird (bspw. Benner und Tushman 2015; Faulkner und Runde 2019; Vega und Chiasson 2019).

Dabei stellt die allgegenwärtige Nutzung von digitalen Technologien viele grundlegenden Annahmen in Frage. Digitale Innovationen, also Innovationen bei denen digitale Technologien einen zentralen Bestandteil darstellen, sind beispielsweise nie abschließend fertig, da sie immerzu weiterentwickelt werden können (Lehmann und Recker 2021) bis zum Zeitpunkt der tatsächlichen Nutzung (Henfridsson et al. 2014). Dadurch wird es zunehmend schwieriger zwischen Innovationsprozess und -ergebnis zu unterscheiden, was in der traditionellen Innovationsforschung eine zentrale Unterscheidung darstellt (Crossan und Apaydin 2010; Nambisan et al. 2017). Hinzu kommt, dass die Schaffung von Innovationen traditionell von der Produzentenseite aus untersucht wurde, während bei digitalen Innovationen Nutzer selbst Werte schaffen können, indem sie verschiedene bestehende Angebote neu interpretieren und kombinieren, während sie diese nutzen (Henfridsson et al. 2018). Dadurch wird es auch immer schwieriger, die treibende Kraft hinter Innovationsprojekten klar zu definieren, da digitale Innovationen in der Regel im Rahmen von Innovationsnetzwerken mit vielen Akteuren aus oft grundlegend unterschiedlichen Bereichen entstehen (Boland et al. 2007; Lyytinen et al. 2016). Angesichts der Relevanz digitaler Innovationen für Praxis und Forschung (Holmström et al. 2021) wird folgende übergreifende Forschungsfrage definiert:

Wie lassen sich digitale Innovationen konzeptualisieren, schaffen und managen?

Um die übergreifende Forschungsfrage zu adressieren, beinhaltet diese kumulative Dissertation ein einführendes Kapitel und elf Forschungsartikel, welche auf drei Unterkapitel aufgeteilt sind. Dabei fokussieren sich die drei Unterkapitel jeweils auf einen der drei Kernpunkte der übergreifenden Forschungsfrage.

Kapitel I: Konzeptualisierung digitaler Innovationen legt das konzeptionelle Fundament der Dissertation. Dazu wird im ersten Schritt die theoretische Diskrepanz zwischen bestehenden Theorien und dem Phänomen der digitalen Innovation erläutert (**Forschungsartikel I** und **II**). Zur Adressierung dieser theoretischen Diskrepanz wird in **Forschungsartikel I** eine neue Konzeptualisierung von digitaler Innovation erarbeitet. Dazu wird im ersten Schritt das Konzept der digitalen Objekte eingeführt um eine klare Definition von digitalen Technologien abzuleiten. Auf dieser Basis kann eine Definition von digitalen Innovationen eingeführt werden, die deren soziotechnischen Charakter unterstreicht und auch eine klare Unterscheidung zu anderen Innovationsarten zulässt. Zudem wird ein umfassender Überblick über bestehendes Wissen im Bereich digitaler Innovationen erarbeitet und im Rahmen eines Frameworks dargestellt.

Kapitel II: Schaffung digitaler Innovationen geht näher auf die Entstehung digitaler Innovationen ein, indem es die monolithische Sichtweise auf das Konzept der Rekombination aufbricht. **Forschungsartikel III** legt hierfür die konzeptionelle Grundlage indem eine Typologie für Rekombinationen entwickelt wird, die zwischen vier verschiedene Arten der Rekombination unterscheidet und mit dem Kontext des digitalen Zeitalters verknüpft. Unteranderem befasst sich **Forschungsartikel IV** mit der Frage, wie organisatorisches Wissen durch strukturelle Rekombination, z. B. in Form internen Neuorganisationen, beeinflusst wird, und argumentiert, dass die Rekombination von Wissen ein zentraler Motor für die Schaffung digitaler Innovationen ist. Zudem wird die Rolle der Wissensrekombination im Kontext von digitalen Innovationlaboren erforscht und gezeigt welche Mechanismen für den Wissensaustausch und die Wissensrekombination genutzt werden können (**Forschungsartikel V**). Weiterführend wird zwischen verschiedenen Wissensarten unterschieden um Strategien zu identifizieren die den Zugang zu speziellen Wissensarten ermöglichen und um die verschiedenen Phasen der Wissensrekombination, die zu digitalen Innovationen führen, genauer zu beleuchten (**Forschungsartikel VI**).

Kapitel III: Management digitaler Innovationen untersucht, wie die Auswirkungen der digitalen Innovation bewältigt werden können. **Forschungsartikel VII** präsentiert Einblicke in die fortschreitende digitale Konvergenz über technologische und industrielle Grenzen hinweg und **Forschungsartikel VIII** beleuchtet die Nutzung branchenübergreifender Innovationsnetzwerke und identifiziert Mechanismen, die Unternehmen beim Übergang zwischen verschiedenen Arten von Innovationsnetzwerken helfen können. **Forschungsartikel IX** befasst sich zudem mit auftretenden Spannungen, indem es sich auf die Unterschiede zwischen traditioneller IT-Governance und digitaler Innovations-Governance konzentriert. Nach der Identifizierung etablierter IT-Governance-Mechanismen in der vorhandenen Literatur werden diese zu vier Spannungen in Beziehung gesetzt, die typischerweise im Kontext der digitalen Innovation auftreten. Dazu wird ein theoretischer Rahmen zur Governance digitaler Innovationen entwickelt, der zeigt wie bestimmte Arten von Governance-Mechanismen eingesetzt werden können, um den Status quo aus dem Gleichgewicht zu bringen und dadurch ein neues Gleichgewicht zu erreichen, das der digitalen Innovation förderlich ist. Darüber hinaus wird das Konzept der technischen Identität in die Literatur zur digitalen Innovation eingeführt

(**Forschungsartikel I**), und das komplizierte Zusammenspiel von sozialer und technischer Identität beleuchtet. Im ersten Schritt befasst sich **Forschungsartikel X** näher mit Mission Statements, die zu den beliebtesten Managementinstrumenten gehören und die Identität einer Organisation mit ihrem Handeln verbinden und **Forschungsartikel XI** beleuchtet wie das Zusammenspiel zwischen sozialen und technischen Identitäten zu grundlegenden Änderungen und auch Paradoxien führen kann.

Zusammenfassend lässt sich sagen, dass die Ergebnisse der Dissertation den Grundstein für ein besseres Verständnis digitaler Innovationen an sich legen und neue Einblicke in ihre Entstehung sowie in den Umgang mit den sich daraus ergebenden Auswirkungen liefern. Damit leistet die Dissertation einen Beitrag zur Bewältigung der Herausforderungen, die derzeit sowohl in der Praxis als auch in der Forschung bestehen, und zeigt bedeutende Bereiche für die zukünftige Forschung auf.

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Introductory Paper

DIGITAL INNOVATION

THEORETICAL FOUNDATION AND EMPIRICAL EVIDENCE

1 INTRODUCTION

"The emergence of a wide range of digital technologies and the ever-expanding digital infrastructures they comprise [...] is radically reshaping the nature, process, and outcomes of innovation."
(Nambisan et al. 2020, p. 2)

"It is not too much of a stretch to think we have entered a golden age of digital innovation."
(Fichman et al. 2014, p. 330)

Digital technology has become an integral part of our world. From personal to professional contexts, few circumstances are left that are not enabled, mediated, or influenced by some digital technology. Our reliance on digital technology for everyday tasks such as communication, computation, and coordination has not only changed the way we collaborate and organize to create innovation (Lyytinen et al. 2016) but carrying out "new combinations of digital and physical components to produce novel products" (Yoo et al. 2010, p. 725) has changed the nature of innovation itself. *Digital innovation* is therefore defined as "the creation or adoption, and exploitation of an inherently unbounded, value-adding novelty (e.g., product, service, process, or business model) through the incorporation of digital technology" (Hund et al. 2021c, p. 6).

The cross-disciplinary consensus that "digital innovations represent an important emerging phenomenon that differs in fundamental ways from the information systems we have traditionally studied" (Markus and Nan 2020, p. 64) increasingly raises questions about whether established theories capture the whole picture (Barrett et al. 2015; Benner and Tushman 2015; Vega and Chiasson 2019). For example, the inherent malleability of digital technology (Kallinikos et al. 2013; Yoo 2010) makes it possible to implement changes in digital innovation right up to the point of use. As a result, digital innovation is never fully finished, making it increasingly difficult to distinguish between the innovation process and outcome, which is a central distinction in traditional innovation research (Crossan and Apaydin 2010). Furthermore, digital innovation spans entire innovation networks, including various fields of expertise (Lyytinen et al. 2016), transcending established organizational and industrial boundaries (Nambisan et al. 2017; Seo 2017). Within such innovation networks, various actors can contribute simultaneously to shared innovation efforts without having to identify with a common goal since their "push to innovate [is] shaped by their professional identity, unique vocabularies, and craft-specific knowledge, rather than by shared identity, common vocabularies, and mutual understanding" (Boland et al. 2007, p. 641). Therefore, defining the innovation agency, another important assumption within traditional innovation research, is becoming increasingly difficult (Nambisan et al. 2017).

Additionally, the creation of innovation was traditionally carried out from the producer side, yet in digital innovation, users themselves create value by re-interpreting and recombining various existing offerings while using them (Henfridsson et al. 2018).

In summary, digital innovation has already caused fundamental upheavals across disciplinary and industrial boundaries, bringing great opportunities on the one hand but also considerable risks on the other. This dissertation aims to help harness the opportunities of digital innovation while mitigating its risks by (1) laying a conceptual foundation for how to think about digital innovation per se, (2) addressing how to create digital innovation, and (3) providing guidance on how to manage the resulting implications of digital innovation. The overarching research question (RQ) is, therefore:

RQ: How can digital innovation be conceptualized, created, and managed?

To answer this research question, the introductory paper of this cumulative dissertation sets out the theoretical underpinnings and identifies research gaps, provides an overview of the research methods used, and presents and discusses the main findings of the eleven research articles included. The identified research gaps are then addressed in three main chapters, as depicted in Figure 1.

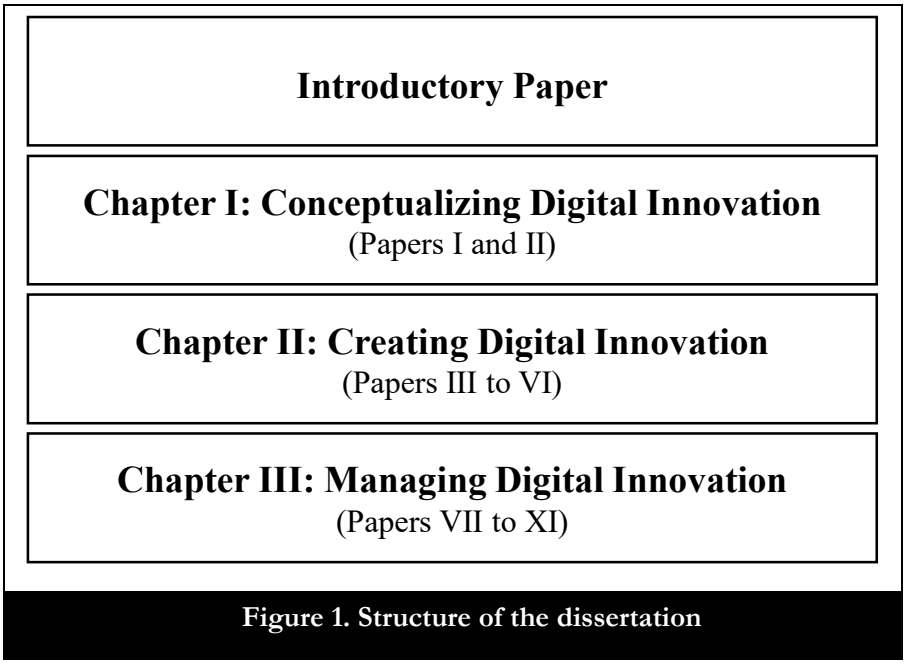

Figure 1. Structure of the dissertation

The first chapter, "Conceptualizing Digital Innovation", lays the theoretical foundation by addressing what constitutes *digital* innovation and linking central concepts to the phenomenon. Additionally, central themes from extant research are organized and presented (**Papers I** and **II**).

The second chapter, "Creating Digital Innovation", begins with a review of the existing literature on recombination to derive a typology of recombination and highlight its importance for digital innovation (**Paper III**) before developing a conceptual model about the role of organizational knowledge in creating digital innovation (**Paper IV**). Digital Innovation Labs (DILs) are then presented as an empirical context to

explore how knowledge is retrieved and recombined from different disciplines (**Papers V** and **VI**).

The third chapter, "Managing Digital Innovation", highlights how digital innovation drives the dissolution of established industrial and technological boundaries, leading to digital convergence (**Paper VII**) and the need to participate in digital innovation networks (**Paper VIII**). Furthermore, a digital innovation governance framework is developed by building on established insights from the IT governance literature (**Paper IX**) before taking a closer look into the management of organizational identity (**Paper X**). Lastly, digital innovation's seemingly negative effects, such as emerging paradoxes, are theoretically reframed as a central component of successfully operating in an increasingly digitalized environment (**Paper XI**).

The next section of the introductory paper provides an overview of the theoretical underpinnings before presenting the qualitative, quantitative, and computational research methods used in this dissertation, including case studies, literature reviews, technological distance analysis, and latent Dirichlet analysis. Afterward, an overview of the eleven research papers is presented, and a detailed discussion of theoretical and practical implications is provided. After pointing out limitations, the introductory paper closes by developing promising avenues for future research on digital innovation.

2 THEORETICAL FOUNDATION AND RELATED RESEARCH

The prefix *digital* is currently attached to various prominent concepts such as innovation (Nambisan et al. 2017), transformation (Vial 2019), and entrepreneurship (Briel et al. 2021). The frequent, often unspecific use of the term carries the risk of making "'digital' a buzzword that becomes attached to multiple phenomena" (Wessel et al. 2021, p. 119). Yet, while the term appears to have become ubiquitous, the problem remains that "digital technology is often portrayed in rather simplistic ways in IS, and […] the field lacks theories rich enough to do justice to its uniqueness and diversity" (Faulkner and Runde 2019, p. 2). Therefore, any meaningful discussion of digital innovation requires, as a first step, an in-depth discussion of the ontology of the digital per se.

In the following, the theoretical foundation is laid by introducing the concept of digital objects and their basic ontology (2.1) before delineating and defining the concept of digital technology (2.2), based on which digital innovation is defined and insights from extant research are summarized (2.3)[1]. Building upon these theoretical underpinnings, this chapter concludes by introducing and motivating six specific research questions (2.4) addressed in this cumulative dissertation.

[1] The underlying structure of this section is based on findings reported in Hund et al. (2021c)

2.1 DIGITAL OBJECTS

2.1.1 ONTOLOGICAL DIFFERENCES OF THE DIGITAL

Ontology, in simple terms, determines our view of the world and influences how we can study a particular phenomenon (Gioia 2021). While the prefix digital is frequently used to indicate a "specific nature and ontology" (Nambisan et al. 2020, p. 2), its exact meaning remains ambiguous. To understand differences in the ontology of the digital and non-digital per se, it is necessary first to take a closer look at what constitutes an object and how we can distinguish between different types of objects, such as material, nonmaterial, and hybrid. Figure 2 provides an overview of different types of objects and their distinctive attributes.

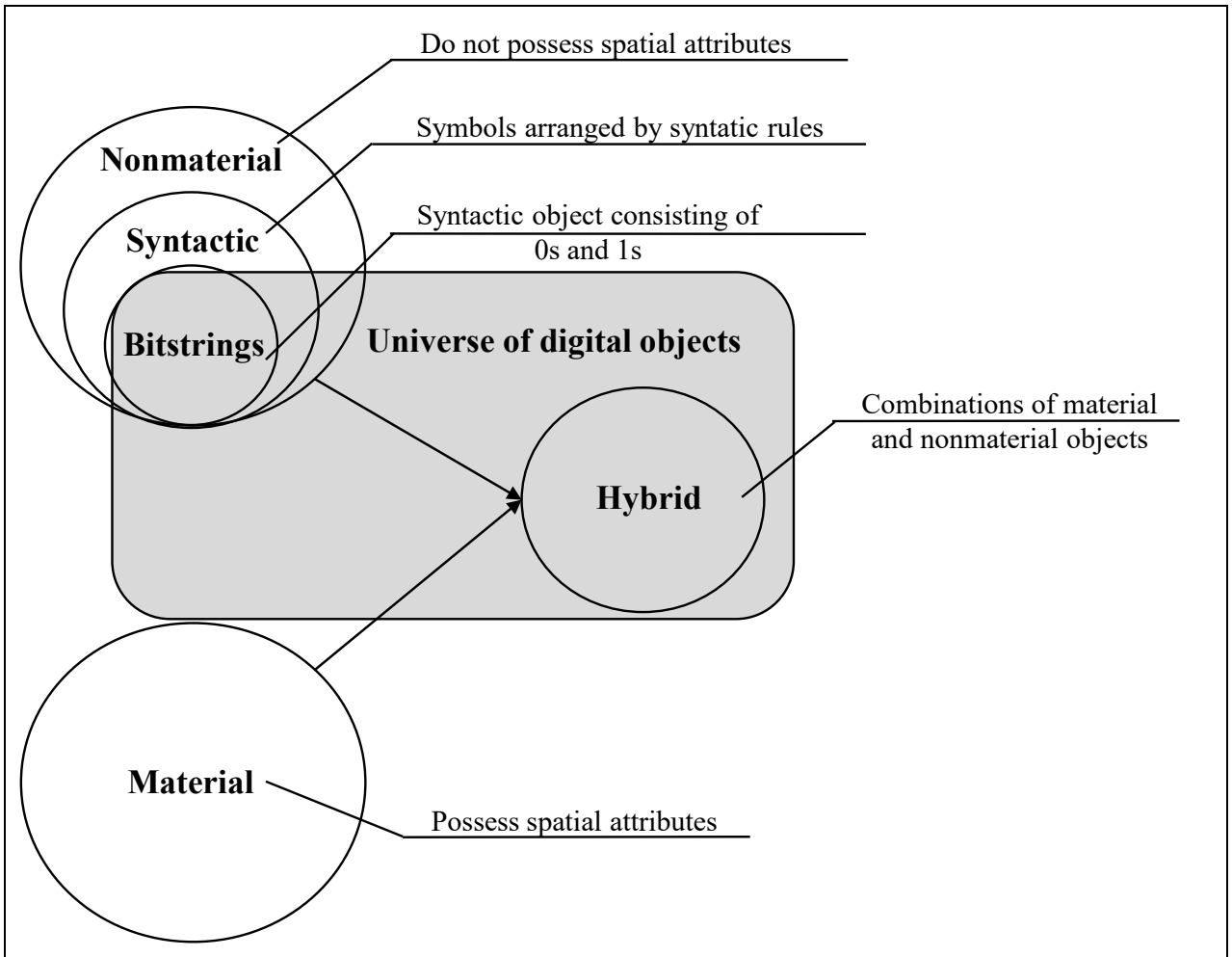

Figure 2. Different types of objects based on Faulkner and Runde (2019)

For an entity to be classified as an object, it must be structured and enduring (Faulkner and Runde 2013). An entity classifies as *structured* when it is made up of various components organized in a specific way and *enduring* if all these components persist together throughout the entity's existence. Enduring, therefore, means that an object is a continuant instead of an occurrent since it "endures over time rather than being something that takes place in time" (Faulkner and Runde 2019, p. 6). To illustrate, a corporate event includes different parts such as various receptions and functions and can therefore be seen as structured. Yet, since

these "[...] different parts occur at different times" (Faulkner and Runde 2019, p. 5), the corporate event does not classify as enduring and, therefore, cannot be classified as an object. On the other hand, a chair can be considered an object since it is made up of different parts, such as the chair legs and the seat itself; thus, it is structured, and because all these parts exist together, it is also considered enduring.

Within the context of objects, there are fundamental differences between material, nonmaterial, and hybrid objects, which is an important consideration for understanding digital phenomena. First, material and non-material objects can be distinguished by the possession or absence of spatial attributes such as location, shape, or mass. As discussed, a chair classifies as an object since it is structured and enduring. In addition, a chair also possesses spatial properties such as an observable location, shape, and mass, making it a material object. Nonmaterial objects are also structured and enduring but do not possess spatial attributes. For example, syntactic objects are a subtype of nonmaterial objects made up of symbols arranged according to a syntactic set of rules. Anything written such as a research paper is enduring since all parts of an article must persist throughout its entire existence, and second, it is structured since it consists of different parts (i.e., the letters) that are arranged following specific syntactic rules (i.e., grammar and spelling rules).

Furthermore, while an article can be printed on paper, which would give it spatial attributes, the article itself consists of a nonmaterial arrangement of letters and punctuation. Bitstrings are, therefore, a type of syntactic object and "are one of the cornerstones of the digital revolution, since the information stored and manipulated on almost all silicon-based von Neumann computers, including traditional transistor-based digital PCs, is encoded in bitstrings" (Faulkner and Runde 2019, p. 7). Bitstrings consist of 0's and 1's that follow the syntactical rules of specific file formats (thus being structured), and each part exists simultaneously throughout time (thus being enduring) while not possessing spatial attributes (thus being nonmaterial). To understand digital phenomena, the concept of digital objects is central. Essentially, digital objects consist of one or multiple bitstrings, and while bitstrings are always nonmaterial, digital objects can also be hybrids that combine nonmaterial objects (e.g., bitstrings) with material objects (e.g., transistors) (see Figure 2).

Understanding and conceptualizing digital objects is challenging because the criteria we normally use to make sense of objects are not appropriate when atoms are replaced by bits. At this level of detail, for example, the application of Leibniz's law, also known as the Identity of Indiscernibles, reveals fundamental differences. Following Allison et al. (2005), we can define the following logical proposition as true: If two physical objects, x and y, possess the exact same properties F, then both objects are identical since each object possesses a property F only if the respectively other object also possesses it. Thereby "they are equivalent in the strong sense of everything that is true about x is true about y, and that x and y are intersubstitutable salve veritate" (Allison et al. 2005, p. 366). Expressed in a formal notation[2], this means:

$$(\forall F)(Fx \leftrightarrow Fy) \rightarrow x = y$$

[2] The formal notation is taken from Allison et al. (2005, p. 366)

The same holds for the inversion of the law, the Indiscernibility of Identicals, which is formulated similarly:

$$x = y \rightarrow (\forall F)(Fx \leftrightarrow Fy)$$

These laws apply since we can observe material objects and their respective properties directly and without mediation. Even in the case of material objects, our perception always depends on various factors, such as the individual differences between the people "carrying out" the perception. Yet, in the case of digital objects, our perception is mediated by various computational mechanisms such as rendering and encoding that transform bitstrings into something that a human actor can perceive. Therefore, for digital objects, "the problems of individual perception are overlaid by problems involving variation in the mechanisms that bring the object to a state at which individual perception starts" (Allison et al. 2005, p. 368). Figure 3 depicts the perceptional differences between digital and non-digital objects.

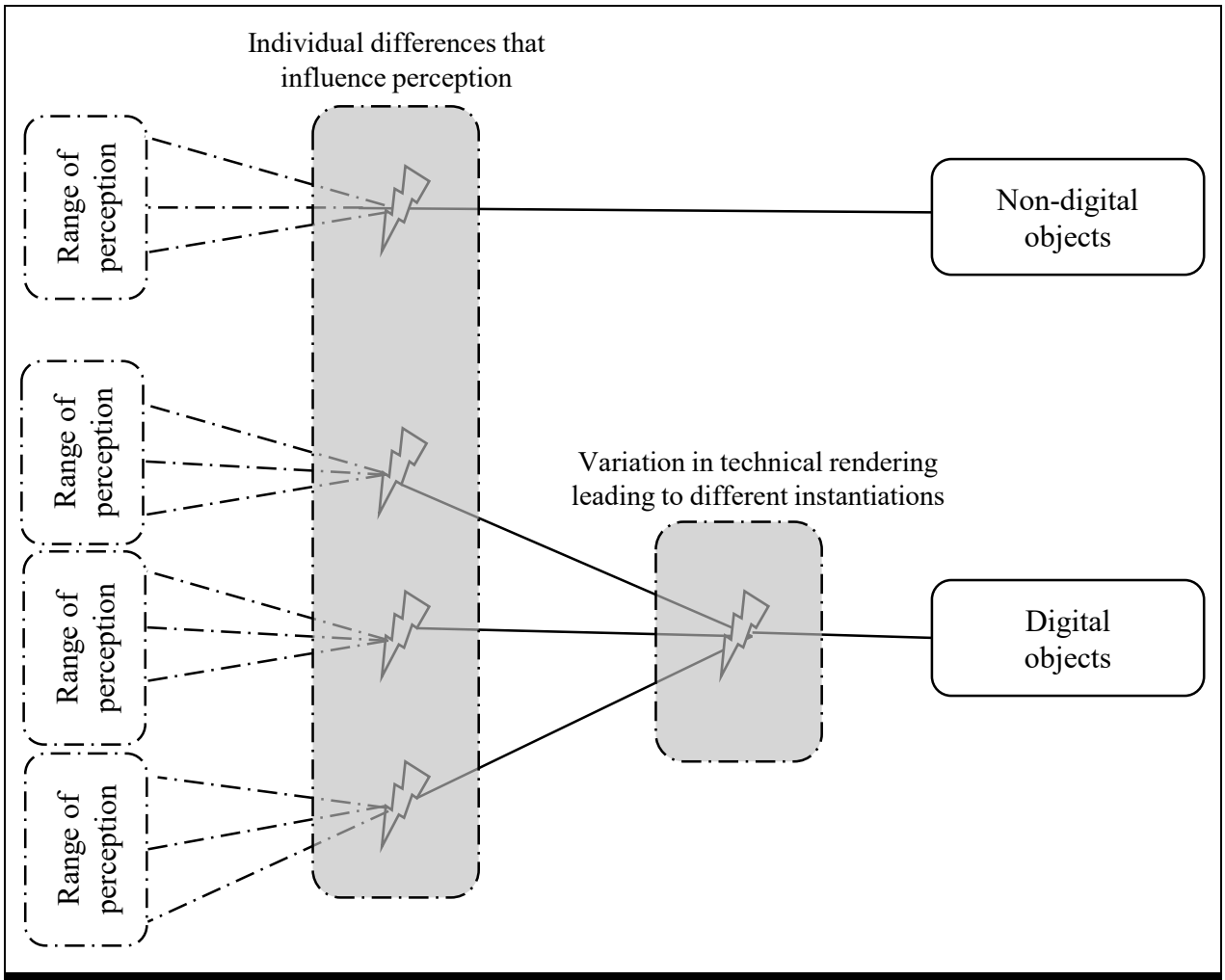

Figure 3. Differences in perceiving digital and non-digital objects based on Allison et al. (2005)

The arising differences due to variations in the technical rendering imply that in the context of digital objects, (1) there exist objects with the same properties but different implementations (violating the Identity of Indiscernibles), and (2) exact copies of an object exist, but these are rarely the same due to, for example, differences in rendering (violating the Indiscernibility of Identicals) (Ekbia 2009). The attempt to conceptualize digital objects using existing logic grounded in a physical context is, therefore, what Smith (1996, p. 50) calls an "inscription error: a tendency for a theorist or observer, first, to write or project or impose or inscribe a set of ontological assumptions onto a computational system [. . .], and then, second, to read those assumptions or their consequences back off the systems, *as if that constituted an independent empirical discovery or theoretical result*" (original emphasis).

Moreover, Figure 3 highlights an important consideration: objects are not interpreted uniformly, particularly in the case of digital objects, where the variation of the technical representation precedes individual perception (Allison et al. 2005). Differences in perception affect an object's meaning, role, and position in the world. These differences arise from the intricate entanglement of an object's form and function (Faulkner and Runde 2013). *Form* is not about the physical appearance of an object but rather the inherent properties that enable it to perform specific tasks or actions. *Function* defines how a social group perceives the form of an object and what specific use cases are associated with it. Therefore, specific uses of an object are inscribed by members of social groups and are not inherent in the object itself (Faulkner and Runde 2013).

In order to avoid inscription errors and to derive meaningful insights into the "qualitative change" (Kallinikos et al. 2013) of digital innovation, the particular ontology of the digital has to be considered (Nambisan et al. 2020). To this end, the following section addresses the form of digital objects, which is about the inherent properties of digital objects and thus emphasizes the technical perspective, before addressing the function, which is about inscribed meanings and thus accentuates a more social perspective.

2.1.2 Implications of the Form: A Technical Perspective

Regarding the inherent properties of digital objects, extant literature has already identified various such properties of digital objects. Table 1 below provides an overview of the most important digital artifacts' properties discussed in Information Systems (IS) research.

While there are differences regarding the used terminology, all of these discussions of digital properties lend support to the "widespread sentiment of digital artifacts being, in principle, if not in practice, far more mutant and changeable than physical" (Kallinikos et al. 2013, p. 360). To illustrate digital objects are, for example, *editable* (Kallinikos et al. 2013), making it possible to implement changes such as updates and modifications up until the point of use (Henfridsson et al. 2018). In many instances, regular updates and modifications enabled by the inherent editability are an important part of continuous value creation (Kallinikos et al. 2013). Furthermore, digital artifacts can be changed through other digital artifacts, making them *open* (Kallinikos et al. 2013) and *re-programmable* (Yoo et al. 2010). For example, it is possible to edit a digital

soundwave by accessing it with a music editing program.

Additionally, digital artifacts are *interactive* in that the inherent capabilities of and information about a digital artifact are accessible to users. The interactivity afforded by triggering specific capabilities or exploring the associated information of a digital artifact "enables actions of a contingent nature (depending upon user choice), an affordance that sets digital artifacts apart from the fixed responses of physical objects, and the inert nature of paper and non-digital records" (Kallinikos et al. 2013, p. 359). Digital artifacts are also *distributed* in that they are typically incorporated across various sources and infrastructures, making them compared to physical artifacts virtually borderless (Kallinikos et al. 2013). Thus, the first important insight about digital artifacts is that they are never fully finished and remain in a constant state of flux (e.g., Kallinikos et al. 2013; Nambisan et al. 2017; Yoo et al. 2010).

Articles	Research context	Properties
Ekbia (2009)	Digital artifacts as quasi-objects	• Largely unstable • Unbounded • Resisting reification
Faulkner and Runde (2009, 2013, 2019)	Material and nonmaterial objects including digital objects	• Non-rivalry in use • Infinite expansibility • Recombinability
Kallinikos and Mariategui (2011); Kallinikos et al. (2013)	Digital artifacts	• Editability • Openness • Transfigurability • Distributedness • Interactivity
Yoo (2010); Yoo et al. (2010); Yoo et al. (2012)	Digitized products and digital innovation	• (Re-)programmability • Addressability • Sensibility • Communicability • Memorizability • Traceability • Associability • Data Homogenization • Self-referentiality
Zittrain (2009); Benkler (2006)	Networks and generativity	• Leverage Adaptability • Ease-of-mastery • Accessibility • Transferability

Table 1. Overview of digital properties adapted from Kallinikos et al. (2013)

The inherent properties of digital artifacts have major implications for the broader systems in which they are embedded. First, the concept of granularity describes the constitution of an entity per se and, second, modularity provides a framework to understand how different entities can be related to each other. *Granularity*, in the most general sense, describes "the size of the modules" (Benkler 2006, p. 7). Thus, rather than

describing how different modules can make up a whole (i.e., modularity), granularity describes the constitution of specific modules. Where non-digital entities have a comparatively low granularity, the "granularity of digital objects derives from their ultimately numerical constitution and the ability this furnishes for tracing composite units deep down to the most minute elements and operations by which they are made" (Kallinikos et al. 2013, p. 360). This high granularity is enabled by the unprecedented level of malleability rooted in the properties of digital objects, enabling changes in any aspect of the digital object (Kallinikos et al. 2013). Similar to how modularity allows stakeholders to decide when and how to contribute to specific modules, the high granularity of digital objects allows stakeholders to contribute piecemeal to collective efforts without exceeding potential availability or ability (Benkler 2006).

Modularity describes the degree to which an entity "can be broken down into smaller components, or modules, that can be independently produced before they are assembled into a whole" (Benkler 2006, p. 7). Different entities such as products, systems, or projects can be modularized as they consist of various relatively independent components that are loosely coupled through predefined interfaces (Benkler 2006; Yoo et al. 2010). As modularization increases, each module becomes more independent, allowing different stakeholders to decide when and how much to contribute to each module (Benkler 2006). Therefore, the concept of modularity relates to digital and non-digital entities alike since it provides a framework for breaking down larger entities, which are difficult to control and change, into smaller components, which can be changed and controlled more easily (Kallinikos et al. 2013). Yet, while the remarkable malleability of digital objects enables a frequent redesign of modules up to the point of use, the design and the associated functionality of non-digital modules must be defined and frozen before production (Henfridsson et al. 2014). Thereby, non-digital modules are function-specific and can typically only be coupled with the particular product or system they were designed for. Although industry standards can be negotiated for compatible interfaces, such as the common use of USB-C ports on smartphones, which can increase the overall compatibility of physical modules, they "seldom cross the functional boundaries of different industries" (Kallinikos et al. 2013, p. 360). Digital modules, on the other hand, are function-agnostic (Yoo et al. 2010) and typically exhibit interfaces that are easily compatible with other modules.

In summary: This section lays the groundwork for the following discussion of digital technology by (1) conceptualizing ontological differences of the digital at the level of fundamental objects and (2) considering the form (i.e., inherent properties) of digital objects and their implications for the broader systems they are embedded in. In the next section on digital technology, the function of digital objects is considered, shifting the focus from the technical to the sociotechnical perspective.

2.2 DIGITAL TECHNOLOGY

2.2.1 IMPLICATIONS OF THE FUNCTION: A SOCIOTECHNICAL PERSPECTIVE

Digital technology consists of several layers of material and non-material objects, which remain open for

re-interpretation (Faulkner and Runde 2019; Yoo et al. 2010). Therefore, the specific *function,* i.e., the agreed-upon social meaning (cf. Faulkner and Runde 2013) of a digital object, can be reinterpreted across different contexts. Whenever an actor or group of actors reinterprets the basic function of digital objects, they assign them a technical identity that determines "their use, and 'fit' generally within the social world" (Faulkner and Runde 2019, p. 5). The assigned technical identity is always dependent on the form, which refers to the technical properties and capabilities of the digital object. The entanglement of technical (i.e., form) and social (i.e., function) aspects determines the sociotechnical character of digital technology, which can be defined as "a digital object that has been assigned a socially agreed-upon meaning" (Hund et al. 2021c, p. 5). Since different actors have different goals in mind, various technical identities might arise that are all assigned to the same digital object (Faulkner and Runde 2019). Yet, while the technical properties of the digital object remain the same, the diverging social meanings inscribed in different contexts lead to differences in the use of digital technology per se. Therefore, the "social aspect of digital technology" (Faulkner and Runde 2019, p. 5) plays an important role in understanding how the boundaries of digitally-enabled products are shaped. The extent to which the function of digital technology can be reinterpreted is enabled by the underlying layered modular architecture of digital technology.

2.2.2 The Layered Modular Architecture of Digital Technology

Understanding how the *function* assigned to digital technology can be reinterpreted on a fundamental level requires a closer look into the underlying architecture of digital technology. Digital technology consists of different layers of material and non-material objects (Faulkner and Runde 2019), resulting in the *layered modular architecture* comprising the four layers of device, network, service, and content (Yoo et al. 2010).

Starting from the bottom, the device layer comprises software such as the operating system, which inscribes logical capabilities on the hardware (i.e., physical machinery). On the network layer, physical transport components such as transmitters enable the physical transmission, whereas the logical transmission sublayer defines network standards (e.g., TCP/IP). The service layer contains functional software, including computer programs and smartphone apps, enabling users to use a device and access information. Such information lies in the form of digital data on the content layer and takes the form of, for example, video, text, and music (Henfridsson et al. 2018; Yoo et al. 2010).

The layered modular architecture has important implications for digital innovation. For example, on each of the four layers of the modular layered architecture, numerous independent digital objects exhibit *component-product-platform consubstantiality* since they might serve as a component, a product, and a platform at the same time (see Wang 2021a; Yoo et al. 2010). For example, a tablet can be used as a standalone product but can also serve as a component within the context of another product, as is the case in modern cars that include prominently featured tablets as control consoles. Additionally, these tablets serve as a platform for an entire industry of app developers.

Second, digital objects are inherently *product-agnostic* in that their function might be reinterpreted in the context of a different product (Yoo et al. 2010). The relative independence of each layer facilitates combining and recombining components on and across each layer, which leads to increasingly blurring product boundaries (Yoo et al. 2010). Thus, in the context of digital innovation, products are not designed upfront but are enacted inductively through the combination of various components across the four layers without having a clear final product design in mind (Henfridsson et al. 2018; Yoo et al. 2010). With increasingly blurring product boundaries, the function assigned to the product itself becomes increasingly dependent on the specific use case. For example, smart speakers such as Amazon Echo or Apple HomePod are composed of a bundle of digital objects across all four levels, including hardware, logical transmission standards, functional applications, and access to digital data (Henfridsson et al. 2018). Furthermore, these digital objects that make up the smart speaker can be recombined with digital articles or music in the context of various other digital products such as smart TVs or online libraries (cf. Henfridsson et al. 2018; Yoo et al. 2010).

Third, existing relations between different digital objects are only *contingently obligatory,* meaning that the established links between different digital objects in the context of a specific product are not determined a priori but dependent on the specific combination (Henfridsson et al. 2018; Wang 2021a). For example, modern cars are often combined with tablets. Yet, while being recombined within the context of this specific product, the relationship between tablets and cars remains contingently obligatory since both maintain their own evolutionary trajectories and time horizons (Henfridsson et al. 2018; Wang 2021a). Figure 4 illustrates the discussed concepts along the value spaces framework developed by Henfridsson et al. (2018). The illustrated concepts are applicable across all four layers of the value spaces framework. For example, product-agnosticism, which relates to the value connections between different digital objects, is illustrated between digital objects on the device and network layer but also relates to any other connection between two digital objects. The same is true for the product-component-platform consubstantiality and the contingently obligatory relations.

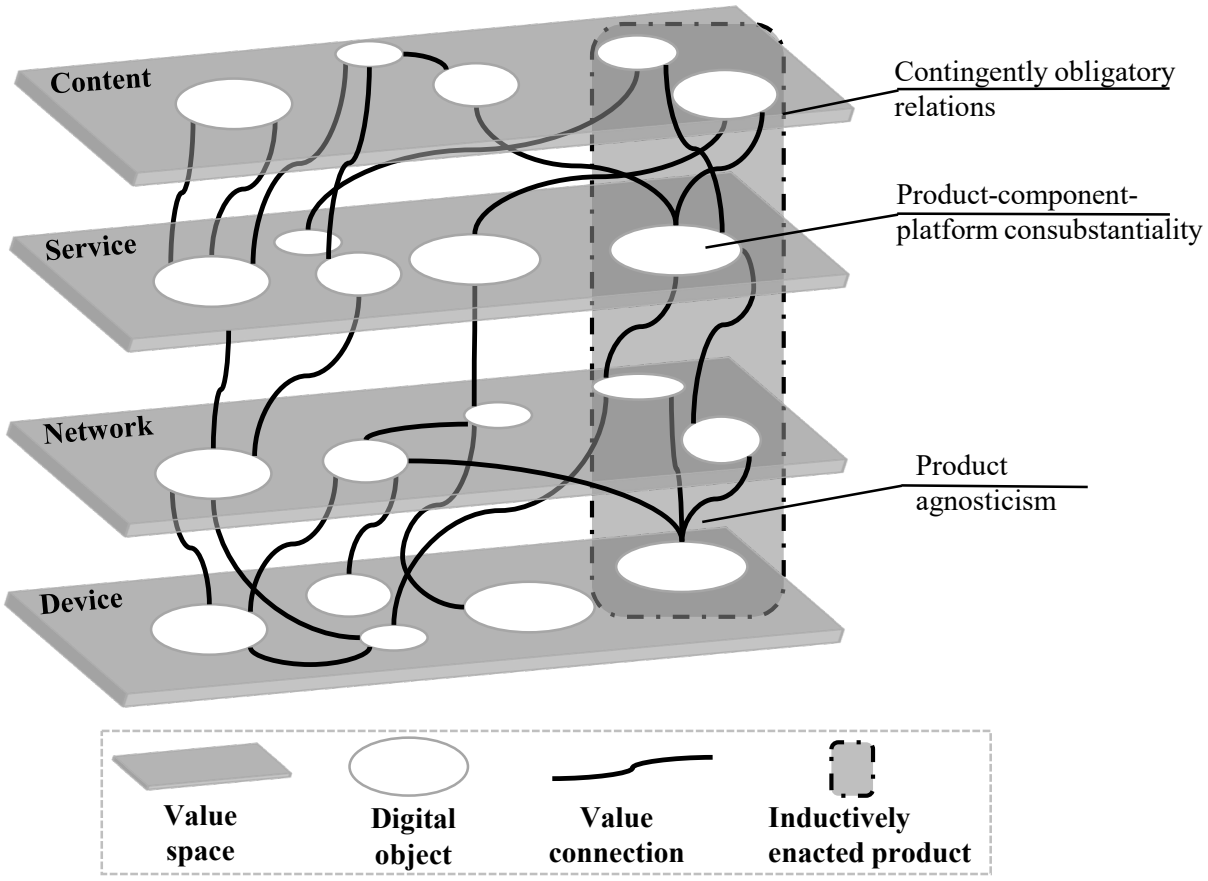

Figure 4. Value spaces framework adapted from Henfridsson et al. (2018)

Each grey rectangle represents a value space that comprises various digital objects. Each layer of the layered modular architecture represents one value space, and each digital object belongs to only one value space. For example, the device value space layer includes operating systems, which can only be found on this layer, not on any other layer. In the context of the value spaces framework, digital objects can be viewed as the basic building blocks linked by value connections to enact digital products inductively. While each digital object only belongs to one layer of the value spaces framework, it can be included in more than one value path simultaneously, within the same value space, or across different value spaces. This independence enables unprecedented flexibility for reinterpreting the specific function of a digital object since (1) *each* digital object might be used as a standalone product, as a component in the context of inductively enacted products, or as a platform upon which other products can be developed and distributed (product-component-platform consubstantiality), (2) *each* value connection that is established between different digital objects remains contingent on the overall context of the specific combination (contingently obligatory relations), and (3) *each* digital object might be part of various inductively enacted products simultaneously (product-agnosticism) (Henfridsson et al. 2018; Wang 2021a).

In contrast to traditional modularity, where the recombination of components requires detailed expert knowledge about the overall product design and the modular interfaces between different modules, the

layered modular architecture facilitates combining and recombining digital objects without knowing the product design a priori (Yoo et al. 2010). Even users themselves are in a position to combine and recombine various digital objects while using them (Henfridsson et al. 2018). Thus, in addition to the flexibility enabled by classical modularity, the layered modular architecture enables generativity because each of the four layers follows its own design hierarchies, allowing design decisions to be made that are virtually independent of design decisions made on other layers (Yoo et al. 2010).

In summary: This section complements the predominantly technical perspective of the previous section by (1) discussing the entanglement of technical and social aspects in the context of digital technology along with the concepts of form and function. Furthermore, this section (2) details the implications of the layered modular architecture and value spaces framework of digital technology. In the next section, the findings on digital objects and technology are brought to a common denominator in the context of the sociotechnical phenomenon of digital innovation.

2.3 DIGITAL INNOVATION

The importance of digital technology for innovation is illustrated through the cross-disciplinary attention to the phenomenon of digital innovation. While each discipline accentuates different aspects of the phenomenon, there exists cross-disciplinary consensus about the far-reaching implication for the way we live, strategize, and organize (Majchrzak and Griffith 2020; Nylén and Holmström 2015; Pershina et al. 2019). In particular, five main themes are central to understanding the phenomenon of digital innovation: Blurring of boundaries, digital systems, digital innovation strategy, organizational determinants, and paradoxes (Hund et al. 2021c).

2.3.1 BLURRING BOUNDARIES AND CONVERGENCE

The previously discussed implications of form and function (Faulkner and Runde 2013) of digital technology lead to increasingly blurring boundaries in the context of digital innovation. Blurring boundaries can be defined as "borders between previously clearly demarcated entities or fields are becoming increasingly permeable" (Hund et al. 2021c, p. 9). For example, where traditional innovation research distinguished between innovation as a process and innovation as an outcome (Crossan and Apaydin 2010), this distinction is increasingly difficult for digital innovation due to the high malleability of digital technology (Nambisan et al. 2017), which leaves digital products in a state that is 'ever-in-the-making' (Lehmann and Recker 2021). Furthermore, for individuals, the pervasive use of digital technology is increasingly blurring boundaries between the established work-persona and the home-persona, "as the time and place boundaries that once distinguished the two melt" (Belk 2013, p. 483). At the same time, organizational boundaries are becoming blurred due to an increasing need to work with external actors within the context of entire networks (Boland et al. 2007; Lyytinen et al. 2016), and because users themselves can combine and recombine digital offerings, the boundaries between producers and users are becoming increasingly blurred (Henfridsson et al. 2018).

Furthermore, since digital innovation typically requires input from various areas of expertise (Yoo et al. 2012), industrial boundaries are increasingly blurring (Nambisan et al. 2017).

Beyond merely blurring the borders between different areas or entities, digital innovation frequently leads to convergence, defined as the "merger and blending of previously separate entities or fields into one" (Hund et al. 2021c, p. 9). By recombining material objects with digital objects, a new type of hybrid objects is created, which converges the properties of material and nonmaterial objects (cf. Figure 2). The convergence of physical and digital components enables the creation of smart, connected products with great implications for strategy (Porter and Heppelmann 2014) and organizing (Majchrzak and Griffith 2020; Yoo et al. 2012). Moreover, the need to engage more closely with different areas of expertise across industrial boundaries leads to the convergence of different industrial areas. For example, organizations rooted in and regulated under one set of industrial rules suddenly compete with organizations from other industries, as is the case for Microsoft, which competes directly with telecommunication providers due to the acquisition of Skype (Seo 2017; Tilson et al. 2010; Yoo et al. 2010).

2.3.2 Digital Systems

With the increasing blurring and convergence of different fields and entities due to digital innovation, the focus of research is shifting toward the interdependence of different technical and social actors rather than on isolated actors (Henfridsson and Bygstad 2013; Vega and Chiasson 2019). The need for a broader perspective is particularly pronounced by the emergence of different digital systems such as digital infrastructures, digital platforms, and digital ecosystems.

Digital infrastructures are "the basic information technologies and organizational structures, along with the related services and facilities necessary for an enterprise or industry to function" (Tilson et al. 2010, p. 748). As with the discussion about the form and function of digital objects, technical and social aspects must be considered simultaneously for digital infrastructures such as the Internet. Since digital infrastructures are not constrained by clearly defined functions, they remain relatively unbounded, enabling them to serve as a powerful foundation for many of the services we depend on (Tilson et al. 2010). Thereby, digital infrastructures are deeply embedded in our social activities and routines and are often most noticeable when they break down, requiring us to carefully distinguish "*digitizing* - a technical process - from *digitalization* - a *socio-technical process* of applying digitizing techniques to broader social and institutional contexts that render digital technologies infrastructural" (Tilson et al. 2010, p. 749, original emphasis).

Digital infrastructures enable digital platforms, defined as an "extensible codebase of a software-based system that provides core functionality shared by the modules that interoperate with it and the interfaces through which they interoperate" (Tiwana et al. 2010, p. 676). To harness the inherent generative power of digital platforms, the different dynamics across each have to be considered (e.g., Bonina et al. 2021; Gawer

and Cusumano 2014; Rolland et al. 2018). Digital platforms are becoming increasingly common, as integrating digital functions into previously physical products can turn these products into platforms themselves, with the power to alter existing market dynamics (Nambisan et al. 2020). Therefore, organizations are increasingly focusing on creating and managing digital platforms rather than standalone products (Yoo et al. 2012) and developing strategies to compete with other actors on such digital platforms. One important difference to traditional products is that platforms typically foster the creation of entire digital ecosystems around them (Gawer 2009; Gawer and Cusumano 2014; Tiwana et al. 2010).

A digital ecosystem is a "collection of the platform and the modules specific to it" (Tiwana et al. 2010, p. 676). Within a digital ecosystem, there develop "specific market, regulatory and environmental contexts" (Suseno et al. 2018, p. 2), which can lead to unique evolutionary trajectories (Beltagui et al. 2020; Wang 2021b). Participation and involvement in such digital ecosystems are becoming inevitable for most organizations, as competition increasingly occurs between entire ecosystems rather than individual companies (Tiwana et al. 2010). To illustrate, the widespread distribution and use of the Internet, a digital infrastructure, has enabled the creation of social media sites such as Facebook and LinkedIn, which are digital platforms. On these social media platforms, developers can create and distribute applications and services such as educational courses and games that represent the specific modules of each platform. Specific rules and implicit norms that can be enforced technically on each platform develop over time. The specific rules and norms distinguish the two platforms, which comprise the digital ecosystem. Taken together, the pervasive use of digital technology leads to the emergence of numerous digital systems, which are central to the generativity inherent to digital innovation.

2.3.3 Digital Innovation Strategy

The increased importance and prevalence of digital systems lead to new strategy requirements. Berente (2020) argues that effective strategy making in the context of digital innovation requires a new perspective by shifting from traditional ideas about industrial production towards agile development. Where strategy is traditionally focused on value chains and industrial competition, digital innovation strategy requires a stronger focus on ecosystems rather than industries (Parker and van Alstyne 2018; Tiwana et al. 2010). For example, the seminal Five Forces framework by Porter (2008) depicts strategy in terms of spatial positions since organizations are either "*in* the industry, *entering* the industry, taking *positions* in the industry" (Berente 2020, p. 83, original emphasis). Among others, these differences require organizations to consider new approaches toward a strategy based on the root metaphor of agile development rather than industrial production (Berente 2020). Differences include, for example, new conceptualizations of competitive boundaries, shifting away from industrial boundaries towards industry-transcending platforms and ecosystems. Furthermore, where traditionally the IT strategy is aligned with – and therefore always subordinate to – the business strategy, there is now a stronger focus on fusing both areas rather than viewing them as separate areas in need of alignment (Bharadwaj et al. 2013). Table 2 provides an overview of the main differences between

industrial production and agile development metaphors.

	Industrial production – metaphor	Agile development - metaphor
Cooperation	Alignment of separate strategies (i.e., IT strategy and business strategy)	Increasing fusion of different departments and strategies (i.e., IT and business department)
Competitive boundaries	Industrial boundaries	Industry transcending platforms and ecosystems
Strategy focus	Product and product positioning within an industry	Customer relationships and experiences
Strategic management	Long-term planning	Fast, iterative development cycles

Table 2. Different root metaphors for strategy based on Berente (2020)

To consider the pervasiveness of digital technology in modern products and processes (Rigby 2014; Yoo et al. 2012), organizational strategies must account for the risks of embracing digital technology while finding ways to benefit from the associated possibilities (Sebastian et al. 2017). Research surrounding the concept of digital business strategy, which is defined as an "organizational strategy formulated and executed by leveraging digital resources to create differential value" (Bharadwaj et al. 2013, p. 472), addresses this balancing act by pointing out the need to "examine three-way dynamics among environmental turbulence, dynamic capabilities, and IT systems" (El Sawy et al. 2010, p. 836) and the importance of considering the inherent properties of digital technology (Nylén and Holmström 2015).

2.3.4 Organizational determinants

Implementing and maintaining a strategy that is in line with the new digital logic requires "fundamentally rethinking how the business is organized, how it makes decisions, with whom it partners, and how those partnerships are managed" (Svahn et al. 2017b, p. 16). Doing so entails changes in various areas, including the need to rethink organizing per se (Lyytinen et al. 2016), transforming the organizational culture and identity (Lucas and Goh 2009; Tripsas 2009), and building up digital capabilities (Holmström et al. 2021; Kane et al. 2016; Tumbas et al. 2017).

Organizing for digital innovation is about aligning organizational structures and processes with the need to participate in cross-industry ecosystems and networks (e.g., Gawer and Cusumano 2014; Lyytinen et al. 2016; Wang 2021b). In the context of digital innovation, innovation agency becomes increasingly distributed (Lakhani and Panetta 2007; Nambisan et al. 2017), which, among other factors, requires a "new organizational form that departs dramatically from traditional industrial production" (Berente 2020, p. 92). For example, in order to benefit from the access to external knowledge (Altman et al. 2015), organizing considers involving external actors (Trantopoulos et al. 2017) and crowds (Boons and Stam 2019; Eiteneyer et al. 2019) but also customers and users (e.g., Eaton et al. 2015; Parmentier and Mangematin 2014).

To harness digital innovation opportunities, changes in the organizational structure must be accompanied by changes in the digital identity and culture, encompassing the "shared norms, beliefs, and values within an organization" (Hund et al. 2021c, p. 11). Organizations that fail to transform their organizational identity are often blind to the new opportunities afforded by new digital technologies since the established identity hinders efforts to try new approaches (Tripsas 2009). Changes in the organizational identity frequently lead to fundamental changes, transforming the entire value proposition of an organization (Wessel et al. 2021). Therefore, initiatives for changing the organizational identity and culture can lead to resistance or even outright conflict (Hylving and Schultze 2020; Svahn et al. 2017a).

Organizational culture, which concerns the core values of an organization (Lokuge et al. 2019), can promote digital innovation, for example, by facilitating knowledge exchange between various actors, as illustrated by 'hacker culture' (cf. von Hippel 2006) or hinder digital innovation initiatives by increasing inertia and rigidities (Lucas and Goh 2009). In general, extant literature suggests that organizational culture in times of pervasive digital technology must facilitate the development of new skills and foster lower risk adversity to enable frequent experimentation (Kane et al. 2017; Magnusson et al. 2020).

In addition to changes in the organizational structure, identity, and culture there is also a need to build capabilities that align with the requirements of digital innovation (Lanzolla et al. 2021; Svahn et al. 2017b; Tumbas et al. 2017). Extant literature highlights that particularly dynamic capability, agility, and ambidexterity are important capabilities in digital innovation. Dynamic capabilities can be defined as the ability to "innovate, adapt to change, and create change that is favorable to customers and unfavorable to competitors" (Teece et al. 2016, p. 18). Thereby, dynamic capabilities are a valuable tool to mitigate the effects of inertia and rigidities that arise from existing capabilities that are no longer useful (Lucas and Goh 2009). Karimi and Walter (2015) highlight in this context that the capability to change and adapt already existing capabilities is an important skill to preserve despite regular upheavals due to digital innovation (Nambisan et al. 2017; Seo 2017). Moreover, with the increasing pace of change (Abrell et al. 2016; Henfridsson 2020) due to the regular disruptions that come along with digital innovation, agility represents a further digital capability that helps to react quickly to unforeseen changes (Chan et al. 2019; Teece et al. 2016). Lastly, ambidexterity, which is about the duality of exploration and exploitation, is an important capability to balance efforts to identify novel digital technologies without jeopardizing existing capabilities and capabilities (e.g., Del Giudice et al. 2021; Magnusson et al. 2020; Magnusson et al. 2021).

2.3.5 Tensions and Paradoxes in Digital Innovation

Digital innovation leads to tensions and paradoxes overlaying the four introduced key themes. The changes necessary to pursue digital innovation are frequently diametrically opposed to existing routines and beliefs (Hund et al. 2021c). Being founded in the industrial age, many incumbents today are still organized around the logic of a modular product (Yoo et al. 2012). Yet, embedding digital capabilities into physical

products leads to a layered modular architecture, which requires different organizational setups (e.g., Henfridsson et al. 2014; Hylving and Schultze 2020) due to, among other things, the arising tension between a product and process focus (Svahn et al. 2017a). In addition, the layered modular architecture often requires collaboration with external actors from various backgrounds, leading to increasingly blurring boundaries on the organization and industrial level (Nambisan et al. 2017; Seo 2017), causing tension between an internal and external orientation (Svahn et al. 2017a). At the same time, collaboration with external actors often takes place in large, distributed networks and ecosystems (Lyytinen et al. 2016; Tiwana et al. 2010), making it increasingly difficult to assign the innovation agency to a single actor (Nambisan et al. 2017). In such settings, various actors can work jointly on a project where the "push to innovate [is] shaped by their professional identity, unique vocabularies, and craft-specific knowledge, rather than by shared identity, common vocabularies, and mutual understanding" (Boland et al. 2007, p. 641). These changes, in turn, cause tensions between the need to maintain sufficient control over the project without limiting the flexibility of exploring new options and collaborations too much (Svahn et al. 2017a).

Beyond the described tensions, digital innovation is particularly prone to paradoxes, which can be defined as the "enduring opposition of interrelated elements" (Hund et al. 2021c, p. 12). For example, when using digital technologies, employees often encounter paradoxes, such as between the opposition of rigidity (i.e., the digital technology restricts specific things) and malleability (i.e., the digital technology offers various affordances at once) (Ciriello et al. 2019). Furthermore, in the context of digital infrastructures and platforms, various paradoxes related to change and control are emerging (Eaton et al. 2015; Tilson et al. 2010). The paradox of change, which describes the opposition between stability and flexibility (Tilson et al. 2010), affects developers on such platforms since they must balance out past and future developments (Brunswicker and Schecter 2019). The paradox of control, which describes the opposition between control and autonomy, is central to digital platforms and infrastructures (Tilson et al. 2010). High levels of autonomy enable actors on the platform to act more independently and generate generativity on the overall platform, whereas centralized control ensures better control over the entire platform but also restricts overall generativity (Eaton et al. 2015; Nambisan et al. 2019; Tilson et al. 2010).

2.4 RESEARCH QUESTIONS

In this section, six specific research questions are motivated using the insights derived from the extant literature. The first chapter poses two research questions that address the conceptual foundation of digital innovation and summarize the current state of research across disciplines. The second chapter focuses on a research question about the role of recombination in creating digital innovation, and the third chapter focuses on three research questions that address managing the implications of digital innovation.

As indicated in the theoretical foundation, one key challenge in studying digital innovation is overcoming traditional thinking patterns by clearly demarcating ontological differences of digital innovation. While digital

innovation is a rapidly growing field, conceptual ambiguities remain that make it hard to define how digital innovation differs from traditional innovation research. Warnings regarding the ambiguity of what constitutes digital are regularly expressed (e.g., Baskerville 2012; Ekbia 2009; Grover and Lyytinen 2015; Orlikowski and Iacono 2001; Zammuto et al. 2007). Particularly research on digital innovation lacks a concise definition that avoids conflating the concepts of traditional and digital innovation by clearly addressing the sociotechnical nature of digital innovation (Majchrzak and Griffith 2020; Nambisan et al. 2017; Yoo et al. 2010). To create a conceptual foundation for the remainder of this thesis, the first research question is:

RQ 1: What constitutes the nature of digital innovation and simultaneously distinguishes it from traditional innovation?

Beyond conceptual ambiguities, research on digital innovation remains fragmented due to its cross-disciplinary character and lacks "a common vocabulary or generic framework of digital innovation" (Lyytinen et al. 2020, p. 279). Since different fields of research focus on different aspects of a phenomenon, integrating different perspectives offers valuable insights. For example, the IS field typically has a stronger focus on the technology itself (e.g., Ciriello et al. 2019; Eaton et al. 2015; Jarvenpaa and Standaert 2018), whereas the economics field is more interested in deducting policy recommendations on the inter-organizational level (e.g., Boons and Stam 2019; Brunswicker and Schecter 2019; Pershina et al. 2019), and the marketing field typically produces insights regarding customer behavior (e.g., Belk 2013; Konya-Baumbach et al. 2019; Lamberton and Stephen 2016). To bring these different perspectives on a common denominator, enable cross-disciplinary exchange, and identify remaining research gaps, the second research question is:

RQ 2: What are key themes across extant research and avenues for future research on digital innovation across disciplines?

The Schumpeterian idea that innovation is created through different combinations of already existing things (see Schumpeter 1934) is accepted cross-disciplinary. The concept of recombination is also central for research on digital innovation, which is driven by "new combinations of digital and physical components" (Yoo et al. 2010, p. 725). The unprecedented malleability afforded by the layered modular architecture and the value spaces framework (see Figure 4) opens up various opportunities for recombination. However, due to the application of recombination within different contexts, different perspectives on the concept itself have developed. For example, recombination might be done by changing the ways already combined resources are combined (Galunic and Rodan 1998; Henderson and Clark 1990) or by combining resources that have not yet been combined (Galunic and Rodan 1998; Hargadon and Sutton 1997). Furthermore, while the recombination of tangible components in the context of digital innovation is frequently studied, the recombination of other resources (e.g., knowledge) is not. To identify the different types of recombination, summarize the existing knowledge about them, and explore their applicability in the context of digital innovation, the third research question is as follows.:

RQ 3: What role does recombination play in times of pervasive digitalization?

Convergence, defined as "[m]erger and blending of previously separate entities or fields into one" (Hund et al. 2021c, p. 9), is frequently discussed and often attributed to the pervasive use of digital technology (e.g., Lyytinen et al. 2016; Seo 2017; Yoo et al. 2012). Yet, concerns are voiced that "[c]onvergence, as a phenomenon, has been an overused and over-hyped term" (Bonnet and Yip 2009, p. 53). Furthermore, the "general dearth of empirical and theoretical analyses of digital convergence" (Tilson et al. 2010, p. 751) is exacerbated by the unclear conceptualization of digital convergence and a lack of insight into the effects of the increasing dissolution of industrial and technological boundaries. In addition, the dearth of empirical validation leads to ambiguity regarding the pace of digital convergence and what exactly is converging. The fourth research question is, therefore:

RQ 4: How can digital convergence be conceptualized, and what are the implications of the increasing dissolution of industrial and technological boundaries?

Technology-driven transformations have been studied in IS for decades (Besson and Rowe 2012). Yet, while the implementation of IT typically supports and reinforces existing beliefs, digital technology leads to more profound changes (Wessel et al. 2021). When organizations embrace digital innovation, they "must shift their identity as digital technologies intertwine with the routines, procedures, and beliefs of key constituents" (Svahn et al. 2017a, p. 239). The intertwining of social and technical aspects requires considering implications on the social and technical level as well. However, while research has already examined social implications due to digital technology (i.e., changes in the organizational identity) (Tripsas 2009; Vial 2019; Wessel et al. 2021), technical implications have been largely ignored. This is surprising since changes in social identity have implications for the technical identity as well since social actors identify new ways to use digital technology (Faulkner and Runde 2009, 2013). Hence, to better understand the sociotechnical implications of digital technology and digital innovation, the fifth research question is:

RQ 5: How do social and technical identities change and interact due to pervasive digital technology?

Intertwining social routines and digital technology requires fundamental changes, typically leading to tensions and paradoxes (Ciriello et al. 2019; Svahn et al. 2017a). While these tensions and paradoxes appear to be an integral part of engaging with digital innovation, they are typically framed as an undesirable byproduct (see Smith and Beretta 2021; Svahn et al. 2017a; Svahn et al. 2017b). However, since tensions and paradoxes are an integral part of the changes necessary to embrace digital innovation and enable digital transformations, organizations must find ways of dealing with them. Thus, to develop a better understanding of how to navigate the challenges that arise due to the intertwining of social and technical factors, the sixth research question is:

RQ 6: How can tensions and paradoxes in the context of digital innovation and digital transformation

be navigated?

2.5 SUMMARY

In summary, digital innovation is a phenomenon that is currently studied across various disciplines. The second chapter has introduced central concepts and terms by discussing digital objects (2.1) and digital technology (2.2), as well as developing a formal definition and summarizing the current state of research on digital innovation (2.3). Based on these insights, six research questions are introduced (2.4). The next section provides a detailed overview of the methods used to address the research questions before the fourth section presents the results.

3 METHODOLOGY

In order to investigate the phenomenon of digital innovation, several methodologies are used in this cumulative dissertation. The following subsections present different aspects of the applied methodologies along four *parameters* highlighted in extant research: Research approach (3.1), research design (3.2), data (3.3), and analysis (3.4) (cf. Chen and Hirschheim 2004; Creswell and Creswell 2018). Within each *parameter,* there are several *characteristics*. For example, *parameter* '3.1 Approach' comprises the *characteristics* 'qualitative', 'quantitative', and 'computational'. For each paper, at least one characteristic can be defined within each of the four parameters. Figure 5 provides a visual overview in the form of a morphological box. The arrangement of the parameters and characteristics is not interdependent. For example, a *case study* design may include data other than *interviews*.

Parameters	**Characteristics**				
3.1 Approach	Qualitative	Quantitative	Computational		
3.2 Design	Review and theory development	Case study	Patent analysis	Topic modelling	
3.3 Data	Past literature	Interviews	Patent data	Digital records	
3.4 Analysis	Qualitative content analysis	Grounded theory	Theorizing	Technological distance analysis	Latent Dirichlet allocation

Figure 5. Methodology overview as morphological box

3.1 RESEARCH APPROACH

Traditionally, research approaches are categorized as qualitative, quantitative, or, if both approaches are

used, as mixed methods (Creswell and Creswell 2018). Recently, other approaches that do not align with the standard research approaches have gained increasing popularity, such as design science and computational methods (Recker 2021). Since each research approach has specific strengths and weaknesses, relying on multiple approaches provides different perspectives on a phenomenon and allows the strengths of one method to be used in an appropriate context and its weaknesses to be avoided in another. In the context of this cumulative dissertation, qualitative, quantitative, and computational methods are used.

3.1.1 Qualitative Approaches

Qualitative approaches are characterized by "an emphasis on qualitative data (a focus on 'words')" (Recker 2021, p. 48). Qualitative work is an important step toward better understanding the context of a phenomenon. For example, in a letter from the Academy of Management Journal editors, it is stated: "What qualitative research can do that quantitative research often cannot is to bring the reader closer to the phenomenon being studied" (Bansal and Corley 2011, p. 235). This intimacy with the underlying phenomenon is an important aspect to avoid falling into established thinking patterns by considering the broader context of a phenomenon, including social and cultural aspects (Cecez-Kecmanovic et al. 2020). In the absence of clearly defined guidelines that specify how qualitative research should be structured and presented (Pratt 2009), qualitative research affords more flexibility to explore idiosyncratic phenomena in greater detail, even when the boundaries between phenomenon and context remain unclear (Recker 2021). In order to understand the ambiguous ontology of digital innovation, which requires looking at both the phenomenon and its context, most of the studies in this dissertation adopt a qualitative approach (**Papers I-VI**, **VIII**, **IX**, and **XI**)[3].

3.1.2 Quantitative Approaches

Quantitative approaches are characterized by "an emphasis on quantitative data (a focus on 'numbers')" (Recker 2021, p. 48). While qualitative approaches typically focus on an encompassing approach to understanding idiosyncratic phenomena within their context, quantitative approaches typically "isolate aspects of phenomena", allowing for the nomothetic identification of generalizable patterns across different phenomena (Recker 2021, p. 114). Within this dissertation, **Paper VII** applies a quantitative approach.

3.1.3 Computational Approaches

Computational approaches are characterized by "an emphasis on the digital records of activities and events captured and stored through digital information and communication technologies" (Recker 2021, p. 48). The widespread use of digital technologies produces an unprecedented volume of such digital records (e.g., Yoo et al. 2012), with estimations suggesting that the large majority of all data exists in the form of unstructured texts (Debortoli et al. 2016). Using computational approaches offers an opportunity to generate valuable insights from these otherwise exceedingly large data collections by making it possible that "certain

[3] Papers I-III and VIII are literature reviews and Papers IV and XI follow "methods for research of a conceptual nature–non-empirical research that emphasizes ideas and concepts" (Recker 2021, p.88). While there is some debate among scholars whether such approaches are qualitative in nature, for the context of this dissertation they are classified as qualitative due to their focus on words.

steps during data generation, processing, or analysis are carried out through—or with the help of—algorithms that either augment manual work or fully automate an otherwise manual activity" (Recker 2021, p. 141). Within this dissertation, **Paper X** applies a computational approach.

3.2 RESEARCH DESIGN

There are multiple research designs within each research approach to choose from (Creswell and Creswell 2018). A variety of research designs are relevant to this dissertation, specifically: Review and theory development (Leidner 2018), case studies (Eisenhardt 1989; Yin 2009), patent analysis (Trajtenberg 1990), and topic modeling (Debortoli et al. 2016). Each research design is presented in detail in the following subsections.

3.2.1 REVIEW AND THEORY DEVELOPMENT

Research on digital innovation, while not new, is still in its early stages from a theoretical perspective (Hund et al. 2021c) and requires the development of a new theoretical perspective on the nature of innovation itself (Nambisan et al. 2020). In developing a novel theoretical perspective, all four types of review and theory development (RTD) approaches defined in the polylithic framework by Leidner (2018) are used. The four different RTD types help navigate the tension between comprehensibility and feasibility by defining whether the *research objective* (y-axis) emphasizes synthesis or theorizing and whether the *review focus* (x-axis) is on the description or identification of gaps and trends. Figure 6 provides an overview of the four different RTD approaches, including differences regarding the research objective and review focus.

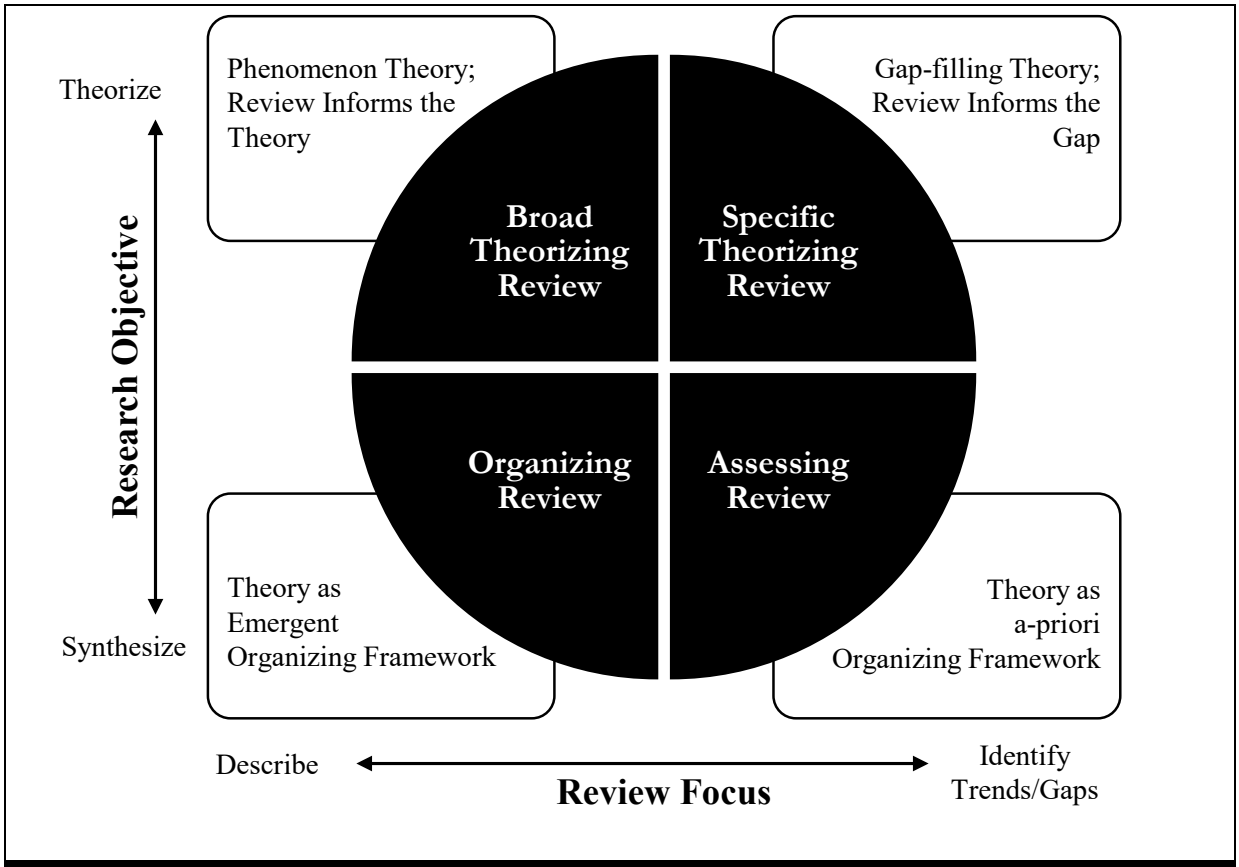

Figure 6. Polylithic framework of review and theory development papers based on Leidner (2018)

Beginning on the bottom right, **Assessing Reviews** have the research objective to synthesize existing literature and focus on identifying gaps and trends in a clearly defined research stream. Thus, assessing reviews address a clearly defined field of research, and existing theories are used as a-priori-defined frameworks to analyze and organize the examined literature. The aim is not to generate new insights or perspectives but rather the "explicit coding of the literature according to the existing a priori theory in order to identify those relationships that have been fully studied and those in need of greater attention" (Leidner 2018, p. 556). **Specific Theorizing Reviews** also focus on identifying gaps and trends, but their objective lies in developing a theory that fills the identified gap rather than just establishing it. Thus, the literature review is intended to inform the gap rather than the theory itself. After establishing a theoretical gap, insights from disparate streams of literature are used to develop a theory that fills the identified gap. From the bottom right, **Organizing Reviews** are focused on describing existing insights with an objective to synthesize existing literature. Where assessing reviews employ existing theories as an a-priori organizing framework, organizing reviews typically cover entire phenomena rather than just specific streams of research within a phenomenon. By favoring breadth over depth, organizing reviews are not comprehensive but enable the development of emergent theories that bring together insights from disparate areas of expertise and, thereby, provide a cross-disciplinary overview of research. **Broad Theorizing Reviews,** in turn, also describe existing literature but with a research objective to build new theory for an undertheorized phenomenon. In comparison to specific theorizing reviews, within a broad theorizing review, the reviewed literature informs the emerging theory

itself, rather than the gap, which enables bringing "together a stream of research and is typically covering a phenomenon, as opposed to a gap within a phenomenon" (Leidner 2018, p. 555).

Within this dissertation, there are two broad theorizing reviews about the phenomena of digital innovation (**Paper I**) and recombination (**Paper III**), one assessing review underscoring initial doubts about the suitability of existing theory (**Paper II**), and one specific theorizing review developing a gap-filling theory on digital innovation governance (**Paper IX**). Furthermore, two pure theory papers build upon extant literature to offer insights into the role of organizational knowledge in creating digital innovation (**Paper IV**) and develop a fresh perspectival theory regarding the role of paradoxes in digital innovation and transformation (**Paper XI**).

3.2.2 Case Study

Case studies are frequently used when "(a) 'how' or 'why' questions are being posed, (b) the investigator has little control over events, and (c) the focus is on a contemporary phenomenon within a real-life context" (Yin 2009, p. 2). Therefore, case studies allow an in-depth examination of how and why a phenomenon works within the natural setting of the phenomenon (Recker 2021). Case studies enable researchers to consider various primary and secondary data types such as interviews, archival documents, and observational field notes. Thus, case study research is well established for its strength in building theory based on empirical evidence (Eisenhardt 1989, 2021). There are different case study designs, ranging from holistic cases with one unit of analysis per case to embedded cases with several units of analysis per case and single-case and multiple-case designs (Yin 2009).

Within this dissertation, three papers apply an embedded multiple-case study design (**Papers V, VI,** and **VIII**).

3.2.3 Patent Analysis

The analysis of patents to understand innovation's creation and subsequent diffusion has a long tradition (e.g., Jaffe et al. 1998; Trajtenberg 1990). Since patents are only awarded for a non-trivial development in the underlying technology (Jaffe et al. 1998), the analysis of patents offers an objective, non-financial way to measure technological innovation. For example, patent analysis can be used to examine the effect of information technology (Dong and Yang 2019) or organizational networks (Ahuja 2000; Ahuja and Katila 2004) on innovation outcomes. Furthermore, patent analysis is used in the IS field, for example, to evaluate the effect of digital mergers and acquisitions (Hanelt et al. 2021) or software patents (Chung et al. 2015; Chung et al. 2019) on overall firm performance. In the context of digital innovation, the combination of different areas of technical knowledge, as documented in patent citations (Dong and Yang 2019), is of particular interest, for example, to gain insights into the increasingly distant areas of expertise that organizations have to engage with (Yoo et al. 2012).

Within this dissertation, **Paper VII** applies patent analysis to examine the dissolution of technological

and industrial boundaries in the context of digital convergence.

3.2.4 TOPIC MODELLING

Topic modeling is an umbrella term for various "algorithms for discovering latent topics in a collection of documents" (Müller et al. 2016, p. 5). Topic modeling in the general sense is well established in the IS literature (e.g., Gong et al. 2018; Syed 2019). For the context of this dissertation, topic modeling is defined as "an unsupervised model that learns the set of underlying topics (in terms of word distributions) for a set of documents and each document's affinities to these topics" (Nikolenko et al. 2017, p. 88). This is in line with the chosen topic modeling approach of Latent Dirichlet Allocation (Debortoli et al. 2016), which is described in more detail in the following subsections.

Within this dissertation, **Paper X** applies a topic modeling approach to uncover dominant topics communicated in mission statements across industrial boundaries.

3.3 DATA

3.3.1 EXTANT LITERATURE

Extant literature represents the coagulated knowledge of a research area. The state of knowledge within a given field can be examined to uncover potential gaps or ambiguities (Paré et al. 2015; Templier and Paré 2015). While particularly structured literature reviews rely on extant literature to organize or synthesize extant knowledge (Leidner 2018), any research project, whether inductive, deductive, or abductive, must consult the existing literature to determine the current state of knowledge and relate the research findings to existing knowledge (Recker 2021).

Within this dissertation, extant literature is an important component of every research paper, either as the basis for theorization (**Papers IV** and **XI**), for conducting a structured literature review (**Papers I-III**, and **IX**), or for identifying and motivating relevant research gaps (**Papers V-VIII**, and **X**).

3.3.2 INTERVIEWS

Interviews are frequently used in qualitative research approaches (Eisenhardt and Graebner 2007; Gioia et al. 2013) since they allow generating "deeply contextual, nuanced and authentic accounts of participants' outer and inner worlds, that is, their experiences and how they interpret them" (Schultze and Avital 2011, p. 1). Different interviewing styles exist, often referred to as structured, semi-structured, or unstructured (Recker 2021). In the context of this work, semi-structured interviews play an important role, as they offer a high degree of flexibility in terms of the need to cover a set of predetermined topics while simultaneously providing the opportunity to directly follow up on interesting statements during the interview (Recker 2021). Thereby, semi-structured interviews, in particular, enable research to "obtain both retrospective and real-time accounts by those people experiencing the phenomenon of theoretical interest" (Gioia et al. 2013, p. 19). In total, the interview data considered in this cumulative dissertation comprises more than 90 in-depth

management interviews from more than 30 organizations.

Within this dissertation, three papers use semi-structured interview data (**Papers V, VI**, and **VIII**).

3.3.3 Patent Data

Patents are an objective, non-financial way to quantify innovation and can be defined as „temporary monopoly awarded to inventors for the commercial use of an invention" (Jaffe et al. 1998, p. 185). Since the exchange between different fields of knowledge is particularly relevant in digital innovation, the International Patent Classification (IPC) categorizes patents at four hierarchical levels - section, class, subclass, and group (WIPO 2020) - plays an important role. The distance between different fields of expertise can be determined by looking at the different categories, as patents within the same patent category are more similar than patents between different patent categories (Jaffe 1986; Kay et al. 2014).

Within this dissertation, **Paper VII** analyzes a longitudinal patent data set covering 31 years with more than 650,000 patents from 124 industries.

3.3.4 Digital Records

Digital records refer to information from events and activities, which are stored using digital technologies. While digital records are similar to digital trace data, which can be defined as "evidence of human and human-like activity that is logged and stored digitally" (Freelon 2014, p. 59), they differ in that digital traces are typically understood as information about an activity (e.g., metadata about the time and place of publication of a mission statement). In contrast, the term digital records emphasizes the information itself (e.g., the content of a mission statement). As much of human activity is enabled, mediated, or augmented by digital technologies, digitally stored information is quickly becoming a data source of interest for research (Recker 2021) and also offers new opportunities for derivative digital innovation (Yoo et al. 2012). Due to the identity challenging aspects of digital technology (Tripsas 2009; Wessel et al. 2021), digitally published mission statements that serve "as a sociocognitive bridge between [an organization's] identity and its actions by specifying why the organization should exist and how it should act" (Grimes et al. 2019b, p. 819) are particularly interesting. Mission statements are one of the most popular management tools of the last decades (Rigby and Bilodeau 2018) and have been linked to, for example, firm performance (Williams 2008) or work-life practices (Blair-Loy et al. 2011).

Within this dissertation, **Paper X** analyzed a data set covering the mission statements of the 1,000 largest research and development spenders worldwide.

3.4 Analysis Techniques

3.4.1 Qualitative Content analysis

Qualitative Content Analysis is an analysis technique that offers the possibility to develop "categories

(codes) and developing a category system (coding frame)" both deductively (i.e., concept-driven) and inductively (i.e., data-driven) (Kuckartz 2019, p. 183). Qualitative Content Analysis is one of the most popular techniques for qualitative data (cf. Kuckartz 2019; Mayring and Fenzl 2014). In essence, after specifying the research question and an initial screening of the data, deductive coding rules (i.e., main categories) are developed in line with the guiding theoretical framing of the research project. After coding the data according to the established coding rules, the codes within each deductive category are inductively analyzed to identify patterns and subcategories (Kuckartz 2019; Mayring and Fenzl 2014).

Within this dissertation, four papers applied a Qualitative Content Analysis (**Papers V**, **VI**, **VIII**, and **IX**).

3.4.2 Grounded Theory

Grounded Theory is a tool to uncover and develop an inductive theory grounded in empirical data. More specifically, Grounded Theory can be defined as a "systematic method of conducting research that shapes collecting data and provides explicit strategies for analyzing them" (Charmaz and Thornberg 2020, p. 1). The success of Grounded Theory led to the development of various types that differ in terms of the underlying worldview (Goldkuhl and Cronholm 2019; Wiesche et al. 2017). Despite these differences, "the assertion that GTM [grounded theory method] is positivist, interpretive, critical realist, or constructivist is neither supported by the grounded theory literature, nor based on research practice. GTM is in many ways neutral and should be seen as a container into which any content can be poured" (Urquhart and Fernández 2013, p. 229)[4]. All types of Grounded Theory outline specific coding procedures that enable research to go from empirical data to theoretical insights without an *a priori* definition of key variables. Gioia (2013, p. 17) stresses the importance of doing so as follows: "If we had designed our interview protocol around existing theory and terminology, we would have missed a key aspect of *their* sensemaking by imposing *our* preordained understandings on their experience" (original emphasis).

In particular, Grounded Theory consists of open, axial, and selective coding (Corbin and Strauss 1990). Open coding is initiated by emersing oneself in the available data, for example, by reading and re-reading the available transcripts or articles and marking relevant excerpts. While doing so, each excerpt is labeled (Wiesche et al. 2017) and organized into a series of concepts, which are grouped into categories. Axial coding then involves identifying relationships between categories and uncovering possible subcategories within each category. During selective coding, the identified subcategories and categories are further refined, and the main categories are identified to highlight the study's main research objectives. This open, axial, and selective coding process is highly iterative and often requires numerous rounds of coding until theoretical saturation is achieved (Wolfswinkel et al. 2013).

[4] For a detailed discussion about the ontological and epistemological assumptions underlying Grounded Theory, please refer to (Hund et al. 2021)

Within this dissertation, two papers applied Grounded Theory (**Papers I** and **III**).

3.4.3 Theorizing: The Systematicity of Disciplined Imagination

"Theorizing is the intellectual engine of a scholarly community" (Burton-Jones et al. 2021, p. 301) and can be described as an act of disciplined imagination (Weick 1989). Through a systematic approach to generating, selecting, and developing ideas, theorizing enables theory development, which can be seen as the coagulated knowledge of a field (Recker 2021). In formal terms, a theory is "a statement of relations among concepts within a set of boundary assumptions and constraints" (Bacharach 1989, p. 496). While there exist different approaches toward theorizing (e.g., Gregory and Henfridsson 2021; Hassan et al. 2022; Leidner and Tona 2021; Rivard 2020) it typically involves the "deft use of abstraction, categorization, and a range of literatures" (Eisenhardt 2021, p. 155).

The papers within this dissertation relying on theorizing involved numerous rounds of closely working with and reflecting on empirical data (e.g., interview transcripts) or existing knowledge (e.g., extant literature), for example, by iteratively aggregating empirical insights into increasingly generalizable statements and concepts. To stimulate disciplined imagination, the process often involved generative techniques such as analogizing, metaphorizing, or mythologizing (see Hassan et al. 2019) while carefully documenting the different levels of abstractions, typically in the form of data tables (see Gioia et al. 2013) to ensure a rigorous link between empirical data or extant literature and theoretical abstraction.

While all papers within this dissertation apply some level of theorizing, **Papers IV** and **XI** relied on theorizing methods in particular.

3.4.4 Technological Distance Analysis

Technological distance is typically "proxied by patent categories, with patents in a given patent category being considered more similar to one another than to those in other patent categories" (Kay et al. 2014, p. 2433). Thus, technological distance analysis can exploit, for example, the fact that technological knowledge is documented within patents, which are categorized within different IPC classes. Calculating the distance between the patents citing each other allows for measuring how similar or dissimilar different areas of expertise are. If two patents are categorized within the same technological environment, for example, from the same 4th level subgroup, there is comparatively little technological distance between them. If, on the other hand, patents are categorized within different 1st level sections, then they are comparatively further apart. To illustrate with the words of Olsson (2005, p. 40): "technological distance between 'wheeled transport' and 'automobile' is shorter than between 'automobile' and 'electric light bulb'". While a smaller distance implies incremental changes by building upon similar knowledge bases, a larger technological distance implies rather radical change by building upon vastly different knowledge bases (e.g., Kay et al. 2014; Olsson 2005).

Technological distance is calculated by comparing the respective IPC classification to which patents are

assigned. The patents' IPC classification encompasses four different levels (IPC^n). If two patents are from different IPC sections (first level), IPC classes (second level), IPC subclasses (third level), or IPC groups (fourth level), the value of the respective IPC^n_{DIST} and all following levels are set to one; if not, the value is set to zero. For example, if there are two patents with the IPC classification of *B02C44* and *B03C44*, the value for $IPC1_{DIST}$ is set to zero since both patents are classified within section B. Yet, the patents are classified differently on the second level (class 02 and class 03); therefore, the value of $IPC2_{DIST}$ and all following levels ($IPC3_{DIST}$ and $IPC4_{DIST}$) is set to one.

The formula for the distance value ($TECH_{DIST}$) stems from Caviggioli (2016), who combined the first and third IPC categorizations with the World Intellectual Property Organization (WIPO) classification. However, since the IPC classification enables detailed insights across four levels of granularity, this cumulative dissertation considers all four levels of the IPC classification and adjusts the formula accordingly. Therefore, $TECH_{DIST}$ is calculated by adding the technological distances at all four IPC levels. The weights of the four levels are set to $w1 = 0.4, w2 = 0.3, w3 = 0.2$, and $w4 = 0.1$. The final formula is therefore:

$$TECH_{DIST} = IPC1_{DIST} * w1 + IPC2_{DIST} * w2 + IPC3_{DIST} * w3 + IPC4_{DIST} * w4$$

$$with: IPC^n_{DIST} \in \{0,1\}$$
$$with: IPC^{n+1}_{DIST} \neq 0 \; for \; IPC^n_{DIST} = 1$$
$$with: \; w1 > w2 > w3 > w4$$

Within this dissertation, **Paper VII** applies technological distance analysis.

3.4.5 Latent Dirichlet Allocation

Latent Dirichlet Allocation (LDA) is a "three-level hierarchical Bayesian model, in which each item of a collection is modeled as a finite mixture over an underlying set of topics" (Blei et al. 2003a, p. 993). LDA is rooted in linguistics, specifically, the distributional hypothesis that states that "words that occur in similar contexts tend to have similar meanings" (Turney and Pantel 2010b, p. 143). As an example: The co-occurrence of the words "flour", "oven", "yeast", and "fermentation" within a text allows the interpretation that the words are part of the category "baking" (Debortoli et al. 2016).

LDA uses an imaginary generative process that assumes that authors assemble d documents and define a distribution of t topics while extracting w words typical of each topic. Beta (β) represents per-topic per-word probabilities, and gamma (γ) represents per-document per-topic probabilities (Silge and Robinson 2016). This bottom-up procedure can be conceived of as each topic encompassing a limited dictionary of words, while each document determines a probability distribution over a fixed set of topics (Debortoli et al. 2016). In the context of this cumulative dissertation, digital trace data (i.e., mission statements) are used as

the underlying data source. Each mission statement is a separate document consisting of different proportions of topics, starting from 0% if a specific topic is not reflected in the document to 100% if the document exclusively covers a specific topic (Debortoli et al. 2016).

Within this dissertation, **Paper X** applies technological distance analysis.

4 MAIN RESEARCH RESULTS

The research papers included in this cumulative dissertation contribute to the overall research goal by addressing the defined research questions. Table 3 provides an overview of the contributions made by each of the eleven research papers to the six research questions.

	RQ 1: Nature of digital innovation	RQ 2: Key themes in research	RQ 3: Role of recombination	RQ 4: Digital convergence	RQ 5: Social and technical identities	RQ 6: Paradoxes in digital innovation
Paper I	Conceptualization and definition of digital technology and innovation	Development of a framework of key themes across eight disciplines	Development of avenue for future research on knowledge recombination	Synthesis of research on convergence in a digital context	Conceptualization of the role of technical identity in digital innovation	Delineation of competing concerns and paradoxes; Development of avenue for future research
Paper II	Explication of differences to traditional innovation	Process vs. outcome view; Determinants of digital innovation				
Paper III			Typology of recombination			
Paper IV			Role of organizational knowledge			
Paper V			Knowledge management			
Paper VI			Introduction of types of knowledge; Recombination paths			
Paper VII		Conceptualization of digital convergence		Operationalization and measurement of social and technical convergence		
Paper VIII				Innovation networks for digital innovation		
Paper IX		Differences to IT governance				Digital innovation governance
Paper X		Role of identity in digital innovation			Management of identity	
Paper XI		Conceptualization of digital transformation			Interplay of technical and social identities	Arising paradoxes during changes in technical and social identity

Table 3. Overview of the contributions of the research papers to the research questions

4.1 CONCEPTUALIZING DIGITAL INNOVATION

4.1.1 PAPER I: DIGITAL INNOVATION: REVIEW AND NOVEL PERSPECTIVE[5]

Paper I summarizes key considerations that are central to this cumulative dissertation. While the phenomenon of digital innovation receives cross-disciplinary attention (e.g., Autio et al. 2018; Beltagui et al. 2020; Holmström et al. 2021; Konya-Baumbach et al. 2019), there remain conceptual issues about the nature of digital innovation per se, and insights from different disciplines lack integration. Furthermore, as further demonstrated in Paper II, there are doubts about whether existing theories can adequately capture digital phenomena. Paper I addresses these shortcomings by reviewing 227 articles from eight disciplines, developing a definition of digital innovation as *"the creation or adoption, and exploitation of an inherently unbounded, value-adding novelty (e.g., product, service, process, or business model) through the incorporation of digital technology"* (Hund et al. 2021c, p. 6). The definition is based on a three-layer conceptualization of digital innovation, comprising a digital object representing the technical side and digital technology representing the social side. Figure 7 provides an overview:

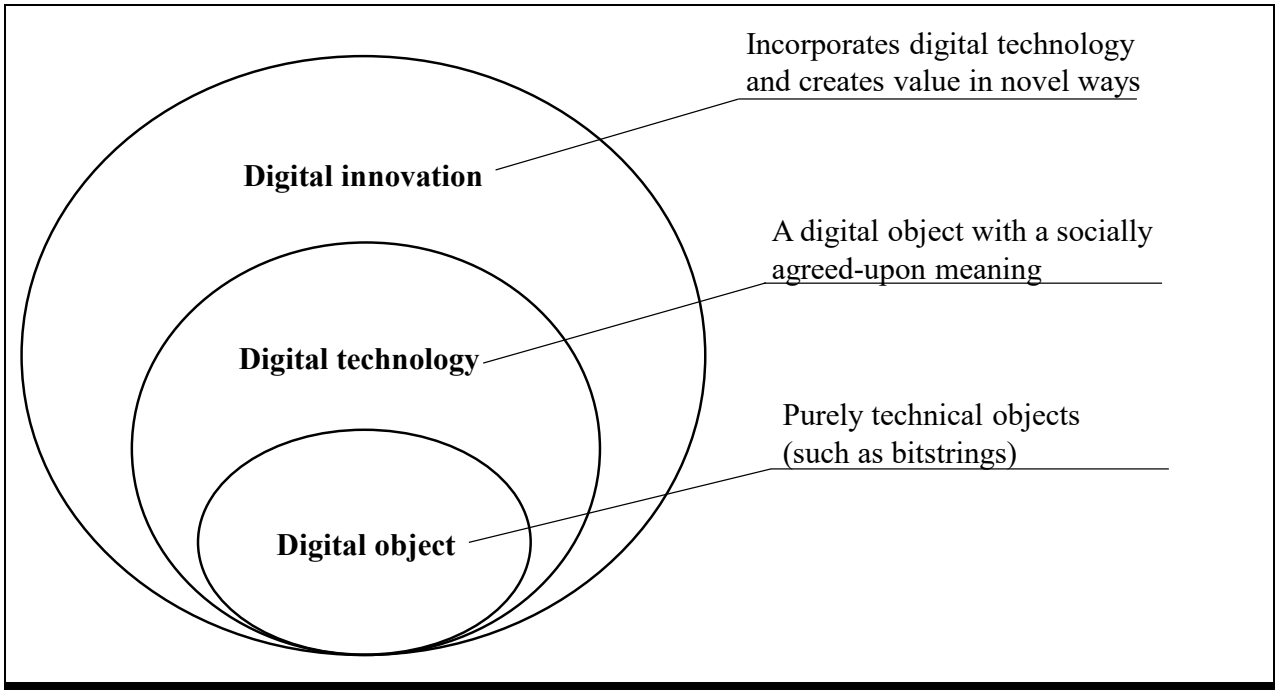

Figure 7: Three-layer conceptualization of digital innovation developed in Paper I

Furthermore, concepts such as the distinction between digital objects and digital technology (Faulkner and Runde 2019), digitization and digitalization (Tilson et al. 2010), ontological reversal (Baskerville et al. 2020), as well as key properties such as homogenization of data, reprogrammability, and self-reference (Yoo et al. 2010; Yoo et al. 2012) are organized and integrated. Figure 8 provides an overview of the central concepts and their interrelations:

[5] Hund, A., Wagner, H.-T., Beimborn, D., and Weitzel, T. 2021. "Digital Innovation: Review and Novel Perspective," The Journal of Strategic Information Systems (30:4), p. 101695 (doi: 10.1016/j.jsis.2021.101695).

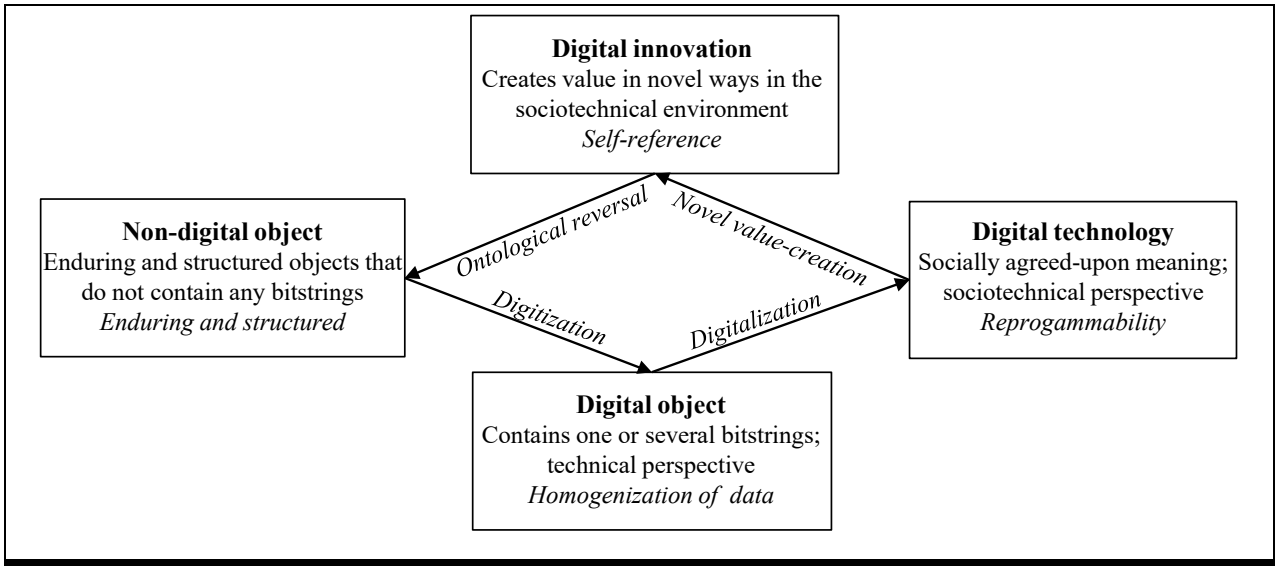

Figure 8: Integration of central concepts developed in Paper I

In addition, the review produces an overarching framework that integrates central themes in extant research across disciplines and links them to the three-layer conceptualization of digital innovation. The identified themes include the Redefinition of boundaries, Digital systems, Digital innovation strategy, Organizational determinants, and Arising tensions. Figure 9 provides an overview:

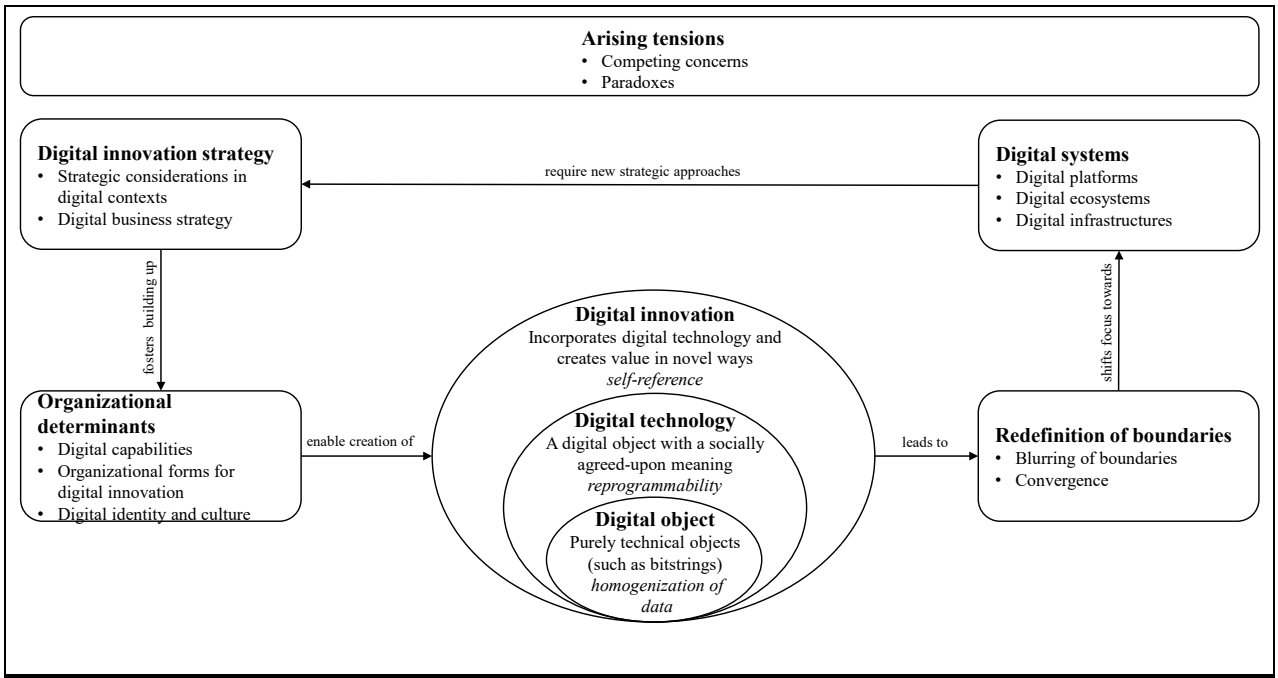

Figure 9. Framework developed in Paper I: Current themes in digital innovation research

Lastly, based on the insights of the review, Paper I develops two particularly promising avenues for future research regarding knowledge recombination and paradoxes in the context of digital innovation. In **Papers V** and **VI** knowledge recombination is addressed in more detail, and paradoxes are addressed in **Paper XI**.

4.1.2 Paper II: The Current State and Future Opportunities of Digital Innovation: A Literature Review[6]

Paper II offers an overview of the literature on digital innovation up to May 2018. With its aim of synthesizing extant knowledge using existing theory from the traditional innovation literature as an a priori framework, it can be classified as an assessing review (Leidner 2018) or descriptive review (Paré et al. 2015). The methodological approach is based on Rowe (2014), who suggests starting with identifying appropriate sources, followed by the actual search and screening of the identified literature. After screening the identified literature, a final sample of 24 articles remained. The a priori framework for coding the literature stems from traditional innovation research and distinguishes between two dimensions of innovation: innovation as an outcome and a process, as well as between the individual, organizational, and environmental levels of analysis (see Crossan and Apaydin 2010). The review contributes in the following ways: First, the review identifies the most frequently cited definitions of digital innovation that offer different perspectives on digital innovation. Figure 10 provides an overview:

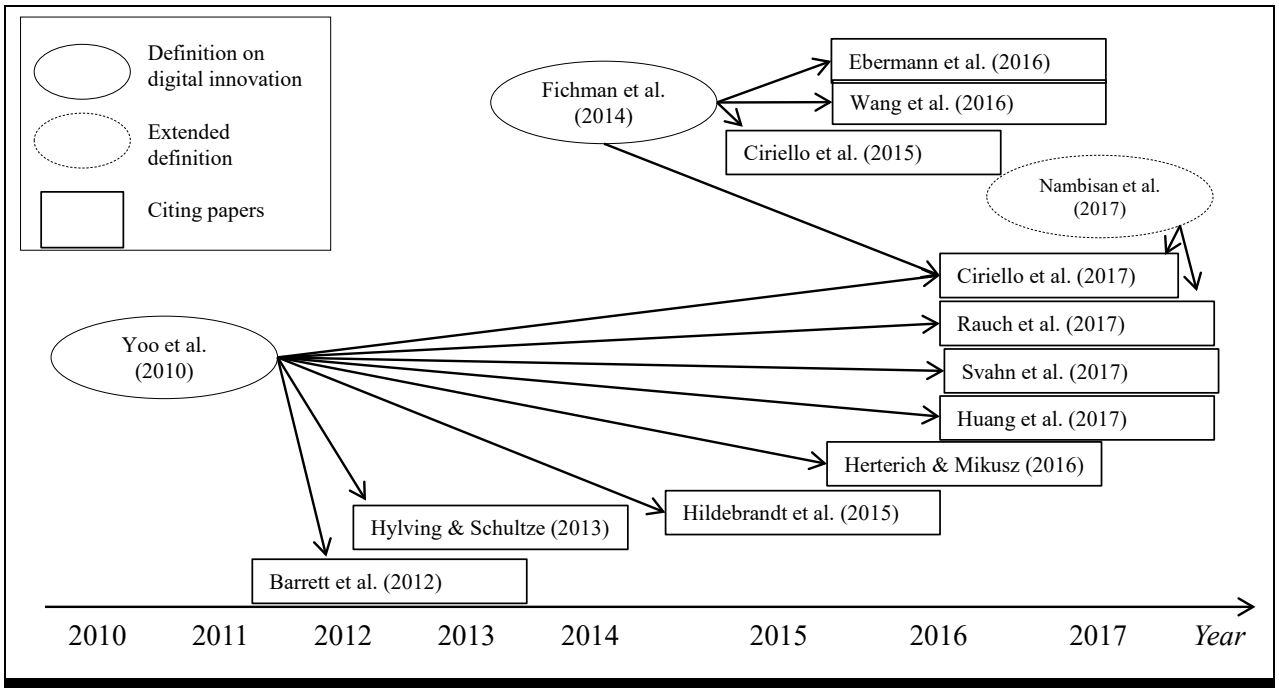

Figure 10. Results of Paper I:
Citation map of most influential definitions of digital innovation

Second, and most importantly, the results underscore insights from Nambisan et al. (2017) that there is a mismatch between established theories in traditional innovation and the new requirements in the context of digital innovation due to the increasing blurring between processes and outcomes. Third, it systemizes insights about the individual, organizational, and environmental determinants.

In summary, Paper II offers a systematic overview of the literature on digital innovation up until May

[6] Hund, A., Drechsler, K., and Reibenspiess, V. 2019. "The Current State and Future Opportunities of Digital Innovation: A Literature Review," Proceedings of the 27th European Conference on Information Systems (ECIS) (Stockholm-Uppsala, Sweden).

2018 and highlights a mismatch between some established assumptions in traditional innovation research and digital innovation research. These findings were the starting point for a much more comprehensive broad theorizing review presented in **Paper I**.

4.2 CREATING DIGITAL INNOVATION

4.2.1 PAPER III: RECOMBINATION IN TIMES OF PERVASIVE DIGITALIZATION: A REVIEW[7]

"Recombination is at the heart of innovation" (Henfridsson et al. 2018, p. 89). The second chapter of this cumulative dissertation (Chapter II: Creating Digital Innovation: The Central Role of Recombination) is dedicated to the role of recombination in digital innovation research. To provide a conceptual foundation for the following research papers in Chapter II, Paper III takes stock of the cross-disciplinary insights about recombination that have produced increasingly specialized interpretations of the concept by reviewing 90 articles from 49 outlets and four leading IS conferences. The cross-disciplinary insights are organized and integrated to delineate different types of recombination and their underlying assumptions. Thereby, Paper III makes three key contributions:

In a first step, an overview of existing knowledge is offered in the form of an inductively developed typology consisting of four different types of recombination:

- *Knowledge recombination* is the most productive stream within recombination research and focuses on recombining intangible factors such as knowledge, concepts, or expertise on the individual, intra-organizational, and inter-organizational levels.
- *Structural recombination* is frequently used within the context of corporate reorganizations and thereby focuses on the effects of recombining organizational entities such as units and divisions.
- *Component recombination* focuses on recombining tangible components and is further subdivided into recombinant creation, recombinant reuse, and digital recombination.
- *Use recombination* represents a comparatively new stream of thought that highlights the recombination of products and services in use by the user rather than by the company that offers the respective product or service.

Second, the implications of pervasive digitalization for recombination are discussed, leading to the development of four propositions, highlighting the role of knowledge, the shift towards more interconnected innovation actors, and the importance of recombination. Third, based on the insights of the review, four avenues for future research are developed. In particular, (1) the importance of conceptually distinguishing between different types of recombination and asking type-specific research questions, (2) the imbalance

[7] Hund, A. 2020. "Recombination in Times of Pervasive Digitalization: A Review," Proceedings of the 41st International Conference on Information Systems (ICIS) (India).

between use and design recombination in extant research, (3) the impact of digital technology on recombination per se, and (4) the prevailing black box status of recombination are highlighted.

The avenues for future research and the associated research questions have guided research within this cumulative dissertation. For example:

- Research avenue (1) is addressed in **Paper V** and **Paper VI** by considering how different types of knowledge can be acquired and recombined;
- Research avenue (3) is addressed in **Papers IX** and **XI** by taking a closer look into the nature and governance of tensions and paradoxes arising due to digital technology
- Research avenue (4) is addressed in **Paper VI** by identifying five specific recombination paths that offer insights into the specific role of different types of knowledge during the recombination process.

In summary, Paper III provides a theoretical foundation for this cumulative dissertation by organizing and integrating existing research on recombination and linking it theoretically to the implications of pervasive digital technology.

4.2.2 Paper IV: The Creation of Digital Innovation: Internal Reorganization, External Networks and Organizational Knowledge[8]

The frequent disruptions of established industries through digital innovation force organizations to align their innovation efforts with an increasingly digitized environment. In Paper IV particularly the combinatorial potential of digital innovation, which benefits from the absence of clear product boundaries and the continuous state of flux, is examined by theorizing how internal reorganization and the company's external network influence the overall organizational knowledge. Furthermore, the argument is developed that organizational knowledge positively affects the creation of digital innovation, which is positively moderated by a motivation to share resources. Figure 11 depicts the conceptual framework.

In essence, Paper IV develops the argument that organizational knowledge positively influences the creation of digital innovation. Since access to knowledge from various fields of expertise is facilitated by the pervasiveness of digital technology, firms benefit from the ease with which different areas of knowledge can be accessed. Furthermore, Paper IV argues that different types of recombination, as defined in Paper III, influence each other. In particular, internal reorganization, which can be seen as a type of structural recombination, changes established organizational structures, processes, and relations. On the one hand, this can positively affect organizational knowledge since it breaks down established boundaries between different areas of expertise within the organization. On the other hand, this might also lead to an overall negative effect since it breaks down productive combinations and relations. Therefore, the effect of internal

[8] Hund, A., Wagner, H.-T., Beimborn, D., and Weitzel, T. 2019. "The Creation of Digital Innovation: Internal Reorganization, External Networks and Organizational Knowledge," Proceedings of the Academy of Management Conference (Boston, MA, USA)

reorganization might depend on the difference between creating new, productive combinations versus destroying already existing ones.

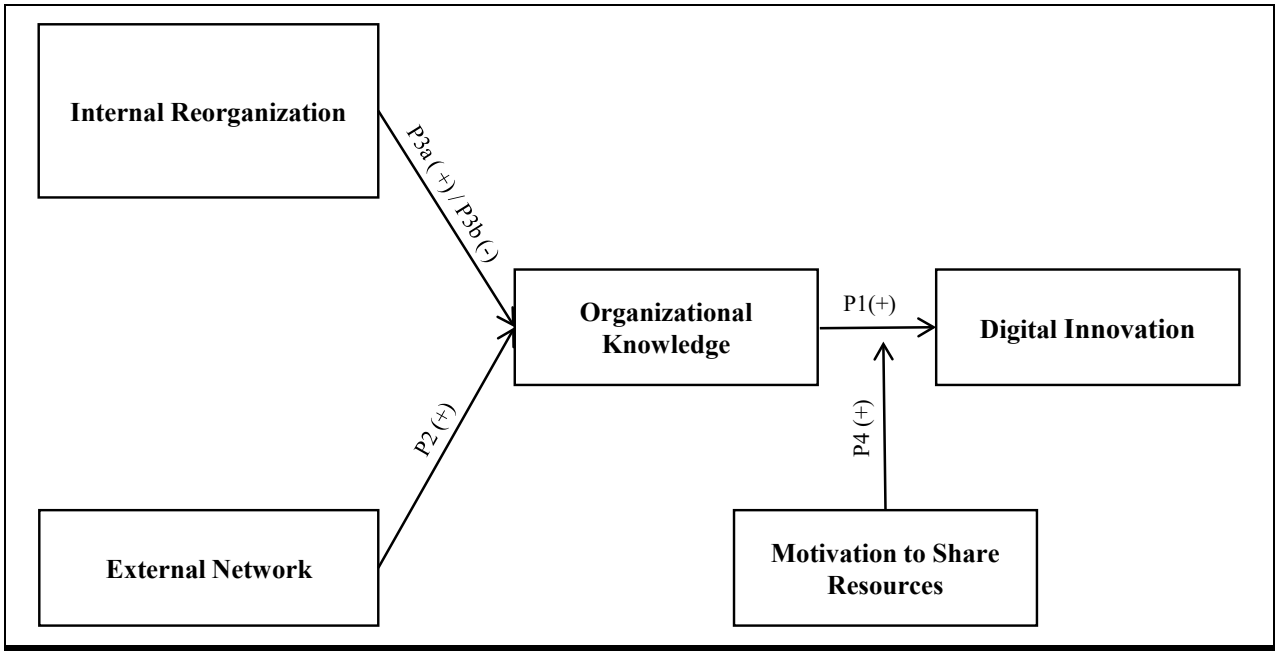

Figure 11. Conceptual Framework developed in Paper IV

4.2.3 Paper V: Knowledge Management in the Digital Era: How Digital Innovation Labs Facilitate Knowledge Recombination[9]

As highlighted in Paper III and Paper IV, knowledge is an important resource for creating and managing digital innovation. Since digital technology has enabled unprecedented access to knowledge from heterogeneous backgrounds, organizations often struggle to find efficient ways of harnessing it. Digital Innovation Labs (DIL) are an increasingly popular approach to deal with the increasing amount and heterogeneity of knowledge organizations have to deal with. Building upon insights from Alavi and Leidner (2001), a multiple case study encompassing four cases and twelve interviews in Paper V examines how knowledge enters specific units, how it is exchanged between units, and how it is combined and recombined. Figure 12 below illustrates the research focus of Paper V.

The results of Paper V reveal six key mechanisms that DILs use to bring knowledge into the DIL, combine and recombine it, and exchange it with other units such as IT or business units. *Liaison employees* are well connected with experts from different domains and can mediate between stakeholders and expert groups. Thereby, liaison employees help by sharing cross-functional knowledge, translating insights and key terms between different areas of expertise, and understanding how different areas of knowledge are connected. *Workshops* are mechanisms to synchronize different areas of expertise by enabling direct

[9] Hund, A., Holotiuk, F., Wagner, H.-T., and Beimborn, D. 2019. "Knowledge Management in the Digital Era: How Digital Innovation Labs Facilitate Knowledge Recombination," Proceedings of the 27th European Conference on Information Systems (ECIS) (Stockholm-Uppsala, Sweden).

knowledge exchange between different units. Furthermore, workshops require careful preparation of knowledge, which can help make implicit knowledge explicit and communicable. The *aggregation of cross-functional knowledge* is an informal mechanism that fosters a positive attitude toward engaging with knowledge areas outside the own expertise and incentivizes cross-disciplinary collaboration and exchange. *Small teams* enable an intensive exchange of knowledge between all team members, facilitating learning about different topics without losing the overview of the knowledge within the team. *Exploration* is a mechanism that fosters engagement with new areas of expertise to explore and harness new opportunities afforded by digital technology. *Rotation* is a mechanism that enables to rotate specialists through different positions and teams within the organization to encourage knowledge exchange and networking across boundaries.

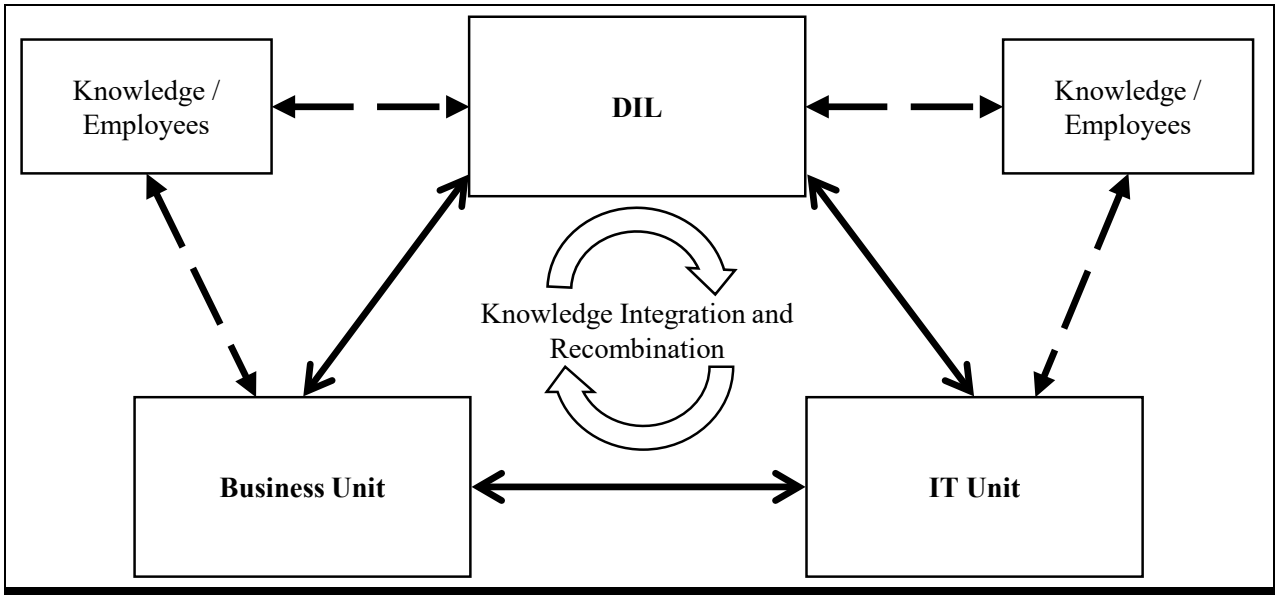

Figure 12. Research Focus in Paper V: Based on Alavi and Leidner (2001)

In summary, Paper V uncovers how organizations use new organizational structures such as DILs to harness the unprecedented amount of available knowledge by using six key mechanisms that help bring knowledge into the DIL, recombine knowledge, and exchange knowledge between different units.

4.2.4 Paper VI: How Digital Innovation Labs Use Knowledge: Access Strategies and Recombination Paths[10]

Recombination is central to research on digital innovation. Yet, while the recombination of digital and physical components is frequently examined, knowledge recombination receives less attention. This dearth in literature offers an interesting opportunity for research since the recombination of knowledge, as already pointed out in Paper I and Paper III, is a key driver of digital innovation. Paper VI, therefore, analyzes five case studies encompassing fifteen interviews and draws on insights from Paper V to uncover specific strategies that DILs use to access different types of knowledge. Using the knowledge taxonomy by Alavi

[10] Hund, A., Beimborn, D., Wagner, H.-T., Legl, S., and Holotiuk, F. 2021. "How Digital Innovation Labs Use Knowledge: Access Strategies and Recombination Paths," Proceedings of the 42nd International Conference on Information Systems (ICIS) (Austin, Texas, US).

and Leidner (2001), which distinguishes between declarative, procedural, causal, conditional, and relation knowledge, ten different strategies for accessing specific types of knowledge are identified:

- *Declarative knowledge* can be accessed through internal exploration, external exploration, and cross-disciplinary collaboration.
- *Procedural knowledge* can be accessed through the strategies of knowledge development and knowledge transfer.
- *Causal knowledge* can be accessed through proactive communication and experimentation.
- *Conditional knowledge* can be accessed by defining measures and incentivizing exploration.
- *Relational knowledge* can be accessed by understanding dependencies.

Distinguishing between different types of knowledge allows opening the black box of knowledge recombination by taking a closer look into the specific types of knowledge. Thereby, Paper VI identifies five distinct knowledge recombination paths that show how knowledge recombination is carried out. Figure 13 provides an overview:

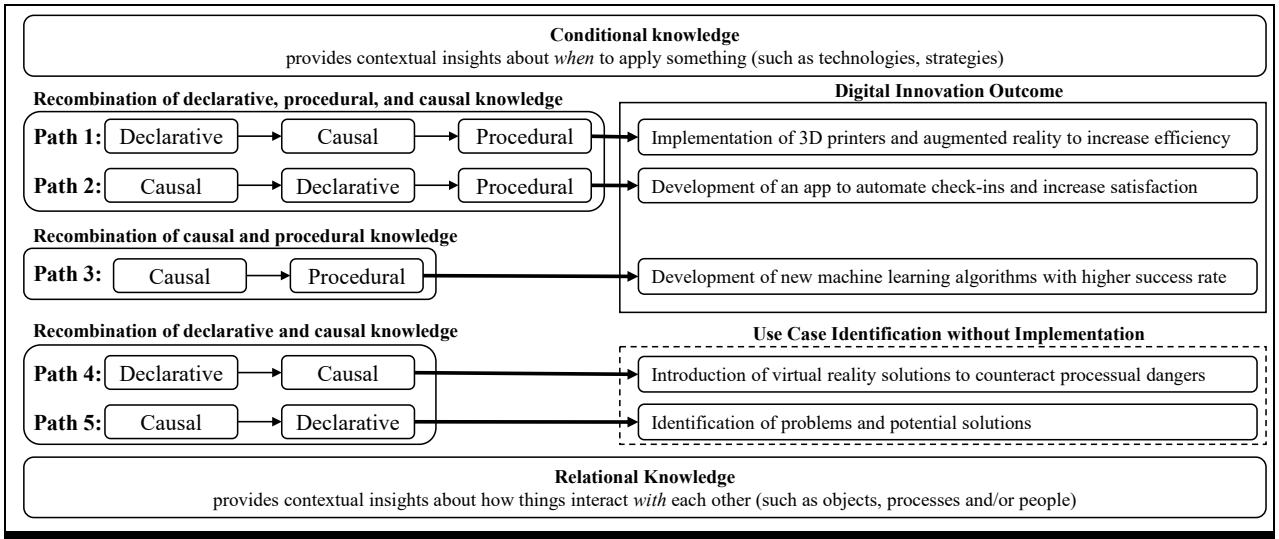

Figure 13. Results of Paper VI:
Knowledge recombination paths for digital innovation

In summary, Paper VI builds upon insights from the knowledge management literature (Alavi and Leidner 2001) to conceptually distinguish between different types of knowledge, which allows to (1) uncover specific strategies that DILs use to access different types of knowledge and (2) identify how different types of knowledge are recombined. Thereby, Paper VI highlights the need not to treat knowledge as a monolithic concept but to conceptually distinguish between different types of knowledge and their respective roles during the recombination process.

4.3 MANAGING DIGITAL INNOVATION

4.3.1 PAPER VII: DIGITAL CONVERGENCE: EXAMINING THE DISSOLUTION OF INDUSTRIAL AND TECHNOLOGICAL BOUNDARIES[11]

The pervasive use of digital technology requires cross-functional collaboration that often transcends organizational and industrial boundaries. Therefore, the recombination of knowledge plays a central role in digital innovation, as discussed in Papers III-VI. Recombining knowledge and expertise from previously disparate areas leads to convergence, which is the "[m]erger and blending of previously separate entities or fields into one" (Hund et al. 2021c, p. 9). Yet, despite the frequent mention of convergence (e.g., Seo 2017; Tilson et al. 2010; Yoo et al. 2012), few empirical insights exist about the precise nature and pace of convergence.

To understand the implications of convergence on an industrial level, Paper VII analyzes a patent data set of the S&P 500 covering 31 years and 124 industries by calculating the technological distance between different patents. Distinguishing between the dissolution of technological boundaries and the dissolution of industrial boundaries, the results highlight two key insights:

First, industrial boundaries defined using the Standard Industrial Classification (SIC) are increasingly blurring since organizations must engage with knowledge typically residing in different industries. If an industry is increasingly building upon patents from other industries, the technology distance increases, indicating that the dominant technologies within that industry are replaced, complemented, or extended by technologies that stem from other industries. Table 4 provides an overview of the increasing technological distance between 1989 – 2019 in five-year increments. As depicted, there is an increase in technological distance from an average of 0.391 in 1989 to 0.456 in 2019. Additionally, it displays the total number of primary patents, the number of comparisons (i.e., the cited patents of each primary patent), and the ratio of cited patents (average number of cited patents per primary patent).

Year	No. Primary Patents	No. Comparisons	Ratio of Cited Patents	Technological Distance
2019	51,382	1,075,741	20.936	0.456
2014	42,385	1,055,255	24.897	0.440
2009	22,436	466,145	20.777	0.410
2004	18,750	275,379	14.687	0.420
1999	11,649	125,373	10.763	0.387
1994	8,006	61,900	7.732	0.390
1989	5,288	29,400	5.560	0.391

Table 4. Results of Paper VII: Increasing Technology Distance between 1989-2019

[11] Müller, L., Hund, A., and Wagner, H.-T. 2022. "Digital Convergence: Examining the Dissolution of Industrial and Technological Boundaries," Proceedings of the 30th European Conference on Information Systems (ECIS) (Timisoara, Romania).

Second, technology classes, defined according to the International Patent Classification (IPC), increasingly cite patents within different technology classes, indicating a convergence over time. There are sections such as sections B (Transporting, Performing operations) and F (Heating, Weapons, Mechanical Engineering, Blasting, Lighting) that most frequently cite patents from their section, which indicates that there is no convergence happening over time. Other sections, such as sections A (Human necessities), C (Chemistry, Metallurgy), and H (Electricity), also mostly cite patents from within their section but the third most frequently cited patents are from other sections (marked in blue). In sections D (Textiles, Paper) and E (Fixed constructions), only the most frequently cited patent classes are from within their section (marked in green). In section G (Physics), even the most frequently cited patent class stems from another section (marked in red).

In summary, only in two sections (B and F) do the three most cited patent classes stem from within the same section. Other sections cite patent classes from other sections to varying degrees, which offers strong indications for a gradual convergence of technology classes even at the highest, least granular hierarchical level.

4.3.2 Paper VIII: Innovation Networks and Digital Innovation: How Organizations Use Innovation Networks in a Digitized Environment[12]

The increasing dissolution of established organizational and industrial boundaries (Nambisan et al. 2017) creates the need for organizations to participate in innovation networks (Lyytinen et al. 2016). Due to the benefits of widespread digital technology use, including the dramatic drop in cost associated with communicating and coordinating, innovation networks that encompass various independent actors are becoming increasingly common. However, research that shows how organizations participate in which types of innovation networks is sparse until now. Paper VIII, therefore, carries out a multiple case study encompassing eleven cases and 27 interviews examining how incumbent organizations manage this shift towards innovation networks. Building upon the typology by Lyytinen et al. (2016), four types of innovation networks are conceptually distinguished, which differ regarding the level of heterogeneity of knowledge and resources (homogeneous vs. heterogeneous), and the distribution of coordination and control (centralized vs. distributed).

Project innovation networks are characterized by comparatively homogenous knowledge backgrounds and hierarchically integrated structures, which enable controlling the overall input and aim of the innovation efforts.

Clan innovation networks are also characterized by comparatively homogenous knowledge backgrounds but without hierarchical integration, which leads to a rather decentralized control over the aim of the innovation

[12] Hund, A., and Wagner, H.-T. 2019. "Innovation Networks and Digital Innovation: How Organizations Use Innovation Networks in a Digitized Environment," Proceedings of the 14th International Conference on Wirtschaftsinformatik (WI) (Siegen, Germany).

efforts.

Federated innovation networks are characterized by comparatively heterogeneous knowledge backgrounds and hierarchically integrated structures, enabling control over the innovation efforts' outcomes.

Anarchic innovation networks are characterized by heterogeneous knowledge backgrounds without hierarchical structure and thereby a distributed form of control.

The analysis reveals several examples of *project innovation networks* (i.e., intra-departmental cooperation and inter-departmental cooperation) and *federated innovation networks* (i.e., partnerships and cooperations, startups and fintechs, customer panels, and creation of platforms). Project innovation networks appear to be used predominantly for problem-solving and fostering the generation of new ideas, whereas federated innovation networks are predominantly used to generate insights into knowledge residing outside the organizational boundaries.

Furthermore, mixed forms of project and federated innovation networks exist, typically resulting from changes within existing structures, e.g.., when an organization moves from a project-style innovation network to a federated-style innovation network. Insights into the currently used innovation networks address the "need to examine to what extent organizations simultaneously engage in multiple different types of networks, and how the intensity and proportion of these engagements affects the level and nature of their innovation work" (Lyytinen et al. 2016, p. 69). However, there is no mention of clan or anarchic innovation networks within the sample of incumbent organizations. Thus organizations are open to engaging with new and more heterogeneous knowledge but refrain from participation in innovation networks with more distributed and less centralized control structures.

In summary, Paper VIII takes a closer look into the implications of increasingly dissolving organizational and industrial boundaries by analyzing how incumbents manage their role in innovation networks. While there is a clear shift towards more heterogeneous knowledge backgrounds, as illustrated by the increasing use of federated innovation networks, incumbents maintain tight control over the innovation efforts and avoid more distributed forms of control as would be the case in clan or anarchic innovation networks.

4.3.3 Paper IX: Digital Innovation Governance: A Theoretical Frame and Research Agenda[13]

Digital innovation creates competing concerns in which the changes necessary to pursue digital innovation are opposed to existing logics and routines (Svahn et al. 2017a). In an attempt to govern these competing concerns, organizations are changing established structures, processes, and relations to avoid jeopardizing existing strengths while simultaneously enabling the creation of digital innovation. Research on governance has already highlighted various mechanisms to address such competing concerns, yet these insights remain

[13] Hund, A., Wagner, H.-T., Beimborn, D., and Weitzel, T. "Digital Innovation Governance: A Theoretical Frame and Research Agenda," currently under review; A prior version has been presented and discussed at the DIGIT 2020 Workshop.

unsystematic and incomplete. Paper IX presents a structured literature review that considers 2424 articles from six research fields, determining a final sample of 39 articles to identify 49 specific governance mechanisms empirically proven to address tensions arising in (traditional) innovation management. In discussing their potential in the context of digital innovation management, Paper IX makes three key contributions:

First, regarding the IT governance literature, Paper IX highlights the importance of governance mechanisms to support innovation and provides an overview of 49 key governance mechanisms empirically linked to traditional innovation management. These governance mechanisms are organized along the established dimensions of structural, processual, and relational mechanisms (see de Haes and van Grembergen 2009; Wu et al. 2015).

Second, Paper IX links innovation and *digital* innovation management by theoretically developing the application of governance mechanisms related to innovation management to the four competing concerns that arise in the context of digital innovation.

Third, Paper IX conceptualizes *digital innovation governance* as an approach to unbalance the status quo within established organizations to enable change towards a new normal that aligns with the logic of digital innovation. A research agenda comprising four research questions with an associated set of three propositions is developed to outline an ambitious agenda for future research on digital innovation governance. Each research question targets one of the competing concerns of digital innovation (Svahn et al. 2017a) and links them to the three dimensions of structural, processual, and relational governance mechanisms.

Existing vs. requisite capabilities: How do specific types of governance mechanisms in the structural, processual, and relational dimensions affect the competing concern between the need to maintain existing innovation capabilities while simultaneously building up new, requisite innovation capabilities?

P1: Structural governance mechanisms that foster cross-functional exchange help address the competing concern about innovation capabilities by unbalancing toward developing more requisite innovation capabilities.

P2: Processual governance mechanisms that enable the exploration of new technologies through performance-based and activity-based evaluation criteria, and ensure continuous exchange between different departments, address the competing concern about innovation capabilities by unbalancing toward developing more new, requisite innovation capabilities.

P3: Relational governance mechanisms that foster shared assumptions across an organization help address the competing concern about innovation capabilities by unbalancing toward developing more new, requisite innovation capabilities.

Product vs. process focus: How do specific types of governance mechanisms in the structural, processual, and relational dimension affect the competing concern between a product versus a process focus?

P4: Structural governance mechanisms that enable more flexibility in an organization's structure, and influence the generation and selection of innovative ideas, address the competing concern about innovation focus by unbalancing toward a stronger process focus.

P5: Processual governance mechanisms that support ongoing adaptations and re-adjustments of innovation processes address the competing concern about innovation focus by unbalancing toward a stronger process focus.

P6: Relational governance mechanisms that foster mutual understanding and stress the importance of change address the competing concern about innovation by unbalancing toward a stronger process focus.

Internal vs. external collaborations: How do specific types of governance mechanisms in the structural, processual, and relational dimensions affect the competing concern between the need to collaborate internally versus the need to collaborate externally?

P7: Structural governance mechanisms that facilitate exchange with external actors by facilitating access to external actors on the organizational and team level address the competing concern about innovation collaboration by unbalancing toward a stronger focus on external collaboration.

P8: Processual governance mechanisms that enable the evaluation of external inputs to address the competing concern about innovation collaboration by unbalancing toward a stronger focus on external collaboration.

P9: Relational governance mechanisms that help balance the exchange with external actors address the competing concern about innovation collaboration by unbalancing toward a stronger focus on external collaboration.

Controlling vs. flexible governance: How do specific types of governance mechanisms in the structural, processual, and relational dimension address the competing concern between increasing flexibility without losing control?

P10: Structural governance mechanisms related to team structure, guidelines, and leadership structure enable an organization to change internal levels of control and flexibility to address the competing concern regarding governance.

P11: Processual governance mechanisms that allow for different levels of oversight and incentivize behavior in line with the organizational goals address the competing concern between flexibility and control.

P12: Relational governance mechanisms that create a shared vision and build trust address the competing concern between flexibility and control.

In a nutshell, Paper IX identifies different types of governance mechanisms related to innovation and discusses how they can address the competing concerns of digital innovation. Thereby, the first detailed

overview of governance mechanisms related to innovation is created and organized along with the standard framework of IT governance (structural, processual, and relational dimensions). Furthermore, the identified governance mechanisms are theoretically linked to the competing concerns of digital innovation, and an ambitious agenda for future research on digital innovation governance is developed. Rather than reinventing the wheel, examining the applicability of established governance mechanisms could enable our scientific community to offer informed suggestions to businesses and managers on navigating the volatile dynamics of a digitally renewing and transforming world.

4.3.4 Paper X: Managing Organizational Identity to Capitalize on Digital Technology: A Topic Modelling Analysis[14]

Digital technologies create various new opportunities, yet these opportunities are often missed due to an established organizational identity that hinders new perspectives. Therefore, organizations are actively framing their identity conducive to the changes that are necessary to notice and capitalize on new opportunities. However, there are few insights into potential approaches to frame organizational identity. To address this dearth, Paper X examines one of the most popular management tools - mission statements. Using topic modeling, a computational analysis approach, Paper X examines the mission statements of the top 1000 R&D spenders worldwide and makes two key contributions:

First, by focusing on the terms within mission statements with high discriminatory power (i.e., a comparatively high term frequency-inverse document frequency (tf-idf)), similarities and differences between industries in terms of the language and vocabulary used can be identified. While the average correlation between industries is 0.34, there are large differences between the ten industries. Figure 14 visualizes comparatively strong correlations (>.5) of the key terms with high discriminatory power across different industries. Each node represents one industry, and the lines' width indicates how strongly the key terms across industries correlate.

[14] Hund, A., Graser, H., Wagner, H.-T., and Beimborn, D. "Balancing Organizational Identity through Mission Statements: A Topic Modeling Analysis" currently under review; An initial analysis with a different focus and a different methodology was published at the 55th Hawaii International Conference on System Sciences; A prior version using LDA has been presented and discussed at the 81st Academy of Management Conference.

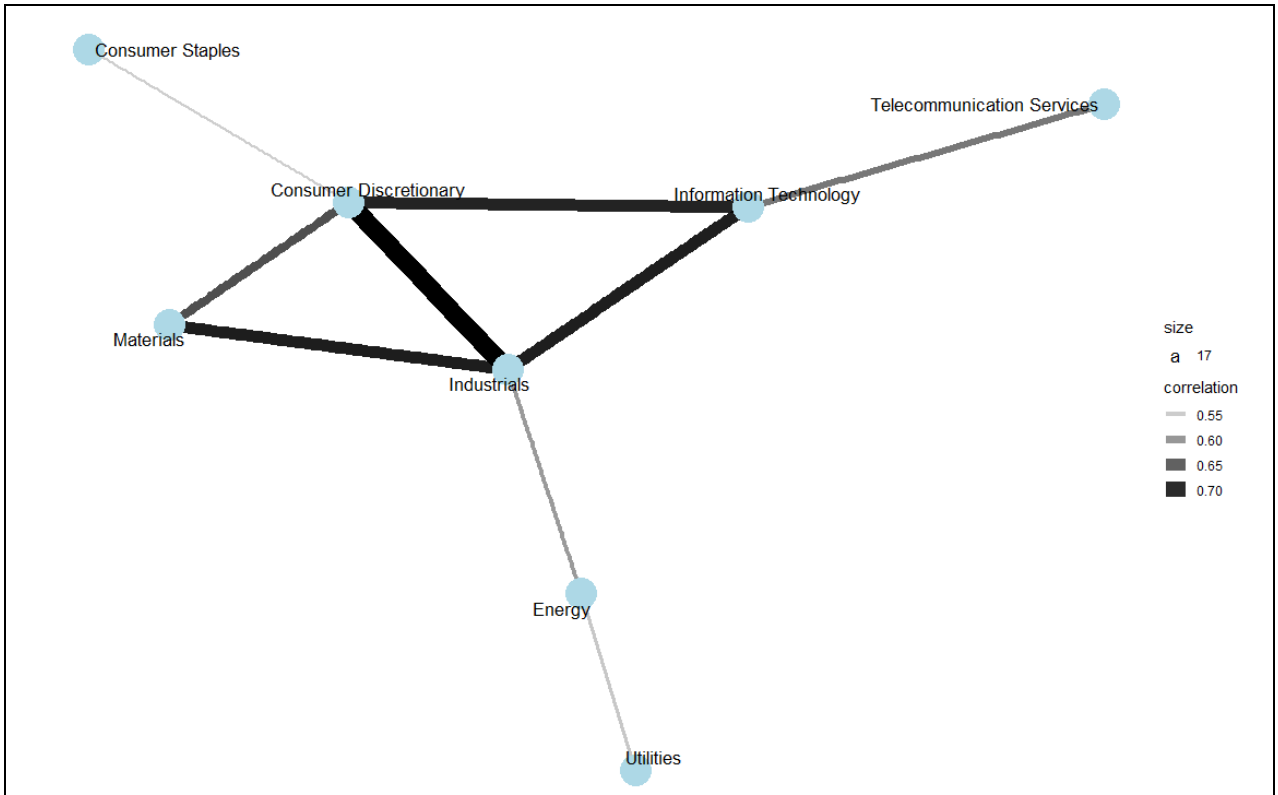

Figure 14. Results in Paper X:
Bivariate correlation (>.5) of terms with high discriminatory power

Second, particularly pronounced topics are identified using a latent Dirichlet allocation approach. Ten topics represent the most central themes discussed and highlighted in the mission statements of the 1,000 largest R&D spenders worldwide. Within these ten topics, there are three general themes, focusing on (1) Supply-side focus: The role of technology, (2) Demand-side focus: Customer-centricity, and (3) Sustainable development goals. While the topics are not mutually exclusive, they are collectively exhaustive and provide a good overview of the general focus within mission statements. The relative distribution of each topic within an industry is illustrated in Figure 15.

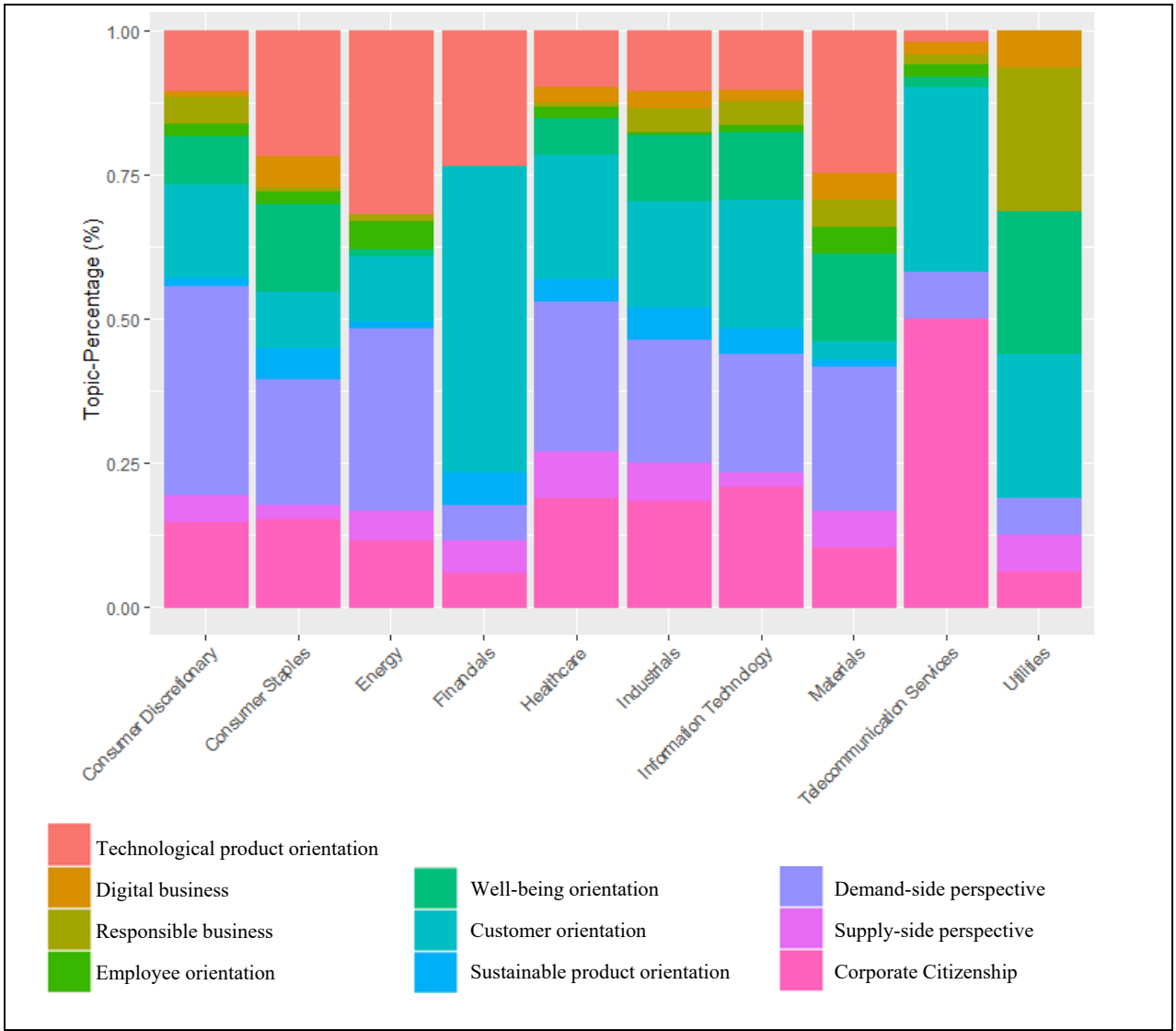

Figure 15. Results in Paper X:
Relative distribution of each topic per industry

The ten distinct topics present in mission statements support research stating that an organization's identity typically has several facets or that several identities are present within an organization. This suggests that "in addition to being multifaceted, an organization's mission may reflect a variety of approaches to balancing and integrating different pursuits" (Varendh-Mansson et al. 2020, p. 230).

In summary, Paper X takes a first step toward understanding the use of mission statements to communicate narratives about the organizaitonal purpose by analyzing the mission statements of the 1,000 largest R&D spenders worldwide. The findings (1) identify similarities and differences in highlighted concepts and language across industries and (2) uncover ten topics that are particularly salient across all ten industries. In discussing the implications of the findings, promising avenues for future research are developed.

4.3.5 PAPER XI: DIGITAL TRANSFORMATION AS PARADOXICAL PROCESS OF IDENTITY FORMATION: A SOCIOTECHNICAL PERSPECTIVE[15]

The pervasiveness of digital technology (Yoo et al. 2012) requires organizations to transform their processes and structures accordingly which is frequently met with resistance, leading to the emergence of various paradoxical tensions (Svahn et al. 2017a; Tripsas 2009; Vial 2019). Despite the attention that digital phenomena receive, there are substantiated doubts about whether existing theories can adequately capture them (e.g., Benner and Tushman 2015; Markus and Rowe 2021). Within this paper, four products of theorizing (questions, concept, framework, myth) (Hassan et al. 2022) are developed to take a first step toward the creation of next-generation IS-theories (Burton-Jones et al. 2021). In developing these products of theorizing, two key issues in current debates on digital transformation are addressed.

Disciplinary research **questions** outline "an object of study as a problem requiring a solution based on the field's rules of discourse and pattern of inquiry" (Hassan et al. 2022, p. 5). The first product of theorizing consists of two disciplinary research questions highlighting the sociotechnical nature of digital transformation and guiding the following considerations. The first research question ("How do social and technical identities change and interact during digital transformation?") builds upon recent insights that show that digital transformations lead to fundamental changes in established organizational identities (Wessel et al. 2021). This is necessary because the often radical opportunities afforded by digital technology cannot be understood within the context of existing frames and identities (Nambisan et al. 2017; Tripsas 2009). Yet, while changes in social identity (i.e., organizational identity) are often addressed (Tripsas 2009; Wessel et al. 2021), changes in technical identities (Faulkner and Runde 2013; Hund et al. 2021c) are largely ignored. To this end, the first research question focuses on social *and* technical identities. The second research question ("How can a sociotechnical perspective on paradoxes help navigate digital transformation?") brings together insights from extant research highlighting the frequent emergence of paradoxes in the context of digital phenomena and insights from question 1 regarding the interrelationship of social and technical identities in digital transformation.

A **concept** "is a set of ideas associated with the subject matter or elicited by a given word treated according to logical rules" (Hassan et al. 2022, p. 6). Building on findings from related but currently disconnected research areas, the concept of digital transformation is further developed. By introducing the distinction between social and technical identity, a deeper reading of the term "digital" is enabled, allowing a better understanding of the sociotechnical nature of digital transformation.

Additionally, the concept of "deep structure" (Tushman and Romanelli 1985) is used to highlight that changes in the activity domain of "core values and beliefs" as expressed in social and technical identities also trigger changes in all other activity domains.

[15] Hund, A., Wagner, H.-T., Beimborn, D., and Weitzel, T. "Digital Transformation as Paradoxical Process of Identity Formation: A Sociotechnical Perspective," currently under review. A prior version has been presented and discussed at the 2021 SIGPHIL@ICIS Workshop.

A **framework** is a "researcher's map of the territory being studied" (Hassan et al. 2022, p. 5). In addressing the research questions and advancing the concept of digital transformation, the framework put forward by Wessel et al. (2021) is developed further to highlight the sociotechnical nature of digital transformation, which comprises changes in the social and technical identity. Furthermore, the implications of digital transformation encompass all activity domains of the "deep structure" (Tushman and Romanelli 1985) and are linked to specific types of paradoxes (Smith and Lewis 2011), which are prone to arise during digital transformation. In particular, the elements of the deep structure are linked to the following paradoxes. Core values and beliefs are linked to the paradox of belonging; Business unit strategy is linked to the paradox of learning; power distributions and organizational structure are linked to the paradox of organizing; Nature and pervasiveness of control systems is linked to the paradox of performing. Figure 16 depicts the final framework. The dashed/dotted indicate newly developed components.

A **myth** is a narrative that underlies the understanding of the origin of the change of some imagined event (Hassan et al. 2022). The considerations regarding the sociotechnical nature of digital transformation regarding changes in the deep structure challenge the existing myth that paradoxes are an undesirable byproduct of digital transformation (cf. Smith and Beretta 2021; Svahn et al. 2017a) rather than an integral and necessary part of it. Challenging the status quo, Paper XI offers an alternative myth that frames paradoxes as an integral and necessary part of digital transformation.

In summary, Paper XI offers a fresh perspective on digital transformation by developing four products of theorizing (Hassan et al. 2022). Building upon insights developed in Paper I, Paper IX poses two disciplinary research questions and further conceptualizes the phenomenon of digital transformation by introducing a more precise vocabulary that distinguishes between technical and social aspects as well as different implications within the organizational deep structure. Furthermore, Paper XI challenges the widespread myth that emerging paradoxes during a digital transformation are an undesirable byproduct that should be minimized or, if possible, avoided altogether. Instead, an alternative myth is introduced that sees working through paradoxes as necessary for digital transformation.

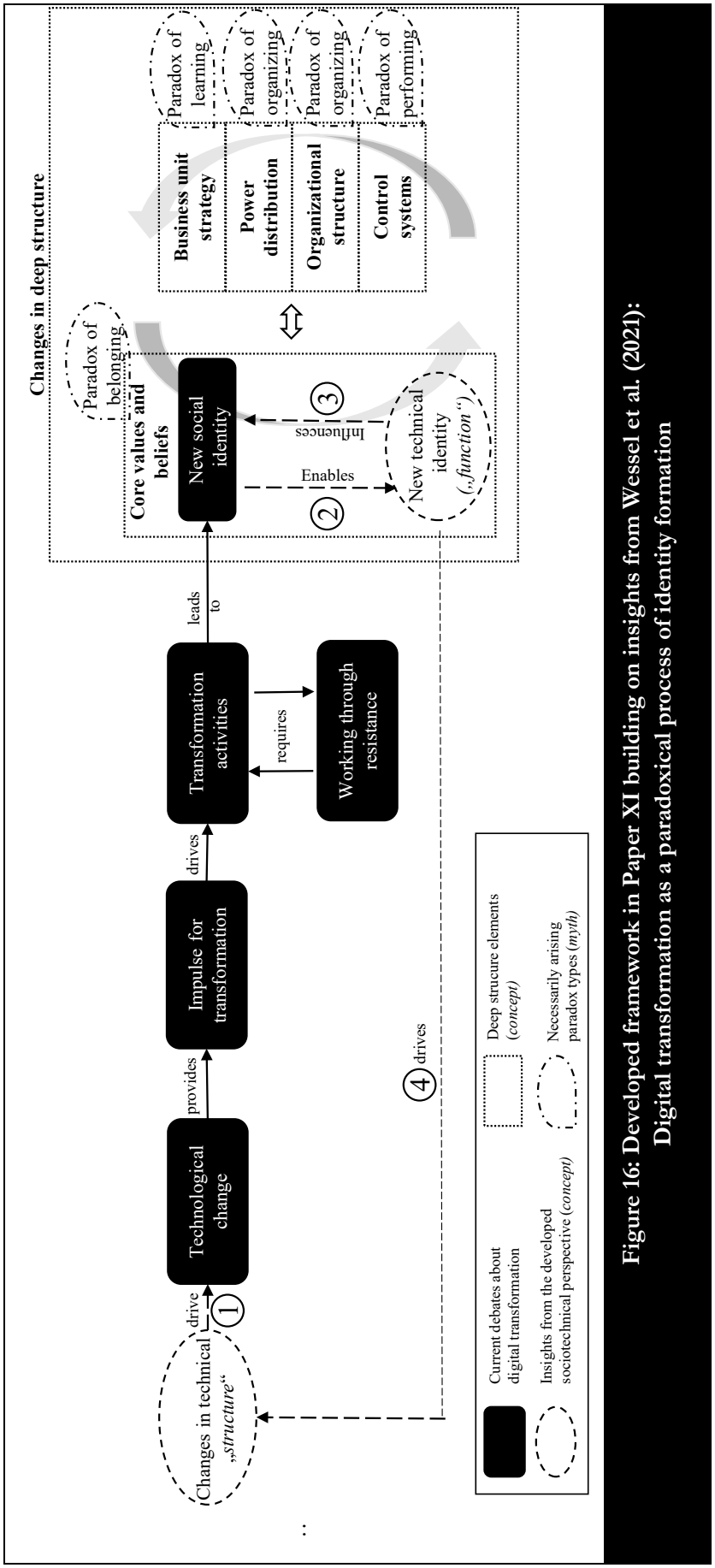

Figure 16: Developed framework in Paper XI building on insights from Wessel et al. (2021): Digital transformation as a paradoxical process of identity formation

5 CONTRIBUTIONS AND IMPLICATIONS

The findings of the eleven research papers make multiple contributions and hold important implications for theory and practice. In the following, the contributions to theory are discussed first, before the contributions to practice are addressed.

5.1 CONTRIBUTIONS TO THEORY

The contributions to theory are organized along the three main chapters and the key research questions. First, contributions regarding the theoretical conceptualization of digital innovation (5.1.1) are discussed before turning to the creation (5.1.2) and the management of digital innovation (5.1.3).

5.1.1 CONCEPTUALIZING DIGITAL INNOVATION

The first chapter, "Conceptualizing Digital Innovation", lays the theoretical foundation by focusing on the nature of digital innovation (RQ1) and key themes in research (RQ2).

5.1.1.1 The Nature of Digital Innovation

The first research question, "What constitutes the nature of digital innovation and simultaneously distinguishes it from traditional innovation?" lays the conceptual foundation of this dissertation and addresses one of the key challenges for research on digital phenomena, which is "the myriad ways in which 'digital' is understood and conceptualized across the disciplines" (Lyytinen et al. 2020, p. 280). While the prefix digital is frequently attached to existing concepts such as innovation, transformation, and entrepreneurship, there remain ambiguities about the term's meaning, making it difficult to clearly define what is new about a "digital" phenomena compared to its non-digital counterpart (see Avital et al. 2019; Wessel et al. 2021).

In the case of digital innovation, existing definitions suffer from several restrictions, such as conflating the impact of digital innovation with the definition of digital innovation (Nambisan et al. 2017), limiting the scope of the definition to outcomes only (Fichman et al. 2014), or including digital terms, which are not clearly defined (Yoo et al. 2010). **Paper I** and **Paper II** address this dearth by providing insights into the nature of digital innovation per se. While **Paper II** reports on a theoretical mismatch between extant innovation literature and digital innovation, **Paper I** carries out a semantic decomposition of 29 definitions in extant literature to identify and overcome existing conceptual weaknesses. Thereby, a clear definition of digital technology is developed by incorporating findings from research on digital objects. The definition highlights the sociotechnical nature of digital innovation by building on the concepts of digital objects and digital technology to define digital innovation (see Figure 7). Furthermore, to locate the developed conceptualization of digital innovation within the existing literature, central concepts such as the homogenization of data, reprogrammability, and self-reference (Yoo et al. 2010), digitization and digitalization (Tilson et al. 2010), and ontological reversal (Baskerville et al. 2020) are organized and linked to the developed definition (see Figure 8).

Thus, **Paper I** and **Paper II** contribute to existing research by first identifying a discrepancy between established innovation theories and the phenomenon of digital innovation and then developing a concise conceptualization of what constitutes "digital" per se, formulating definitions for digital technology and digital innovation, and conceptually linking these to key concepts.

5.1.1.2 Considering Key Themes and Opportunities for Future Research

The second research question, "What are key themes across extant research and avenues for future research on digital innovation across disciplines?" highlights the vast amount of research on digital innovation that is currently fragmented across various disciplines (e.g., Lyytinen et al. 2020).

Paper I inductively reviews and integrates 227 articles on digital innovation across eight disciplines to develop a conceptual framework highlighting five key themes in extant research around the developed conceptualization of digital innovation (Redefinition of boundaries, Digital systems, Digital innovation strategy, Organizational determinants, Arising tensions – as depicted in Figure 9). Additionally, two avenues for future research are developed that put forward specific research questions regarding paradoxes and knowledge recombination in digital innovation. **Paper II** provides an overview of initial literature on digital innovation, particularly focusing on the blurring of process and outcome and insights regarding individual, organizational, and environmental determinants. Based on the findings, several recommendations are made for future research, including the need to develop a better understanding and definition of digital innovation, which is addressed in **Paper I**.

Papers VII and **IX-XI** build upon the conceptual insights of **Paper I** by focusing on the identified key themes in current research on digital innovation. As the phenomenon of digital innovation leads to fundamental changes in numerous areas and blurs the boundaries of established industries and products, a better understanding of its nature also requires deeper insights into closely related phenomena. **Paper VII** addresses the first key theme *Redefinition of boundaries*, which is a direct result of pervasive digital innovation (Yoo et al. 2012), by initially developing a conceptualization of digital convergence based on the insights that digital phenomena require simultaneously considering social and technical aspects. **Paper IX** develops a theoretical frame for digital innovation governance and contributes to the key theme *Arising tensions*, by integrating established insights from research on IT governance with novel insights regarding the competing concerns that typically arise due to digital innovation. **Paper X** focuses on managing the organizational identity by comparing frequently addressed topics and concepts across different industries, thereby contributing to the key theme *Organizational determinants*. **Paper XI** develops a new conceptualization of digital transformation as paradoxical process of identity formation by building on the layered definition of digital technology and focusing on *Arising tensions* in the form of paradoxes.

Thus, **Paper I** and **Paper II** contribute to existing research by integrating and systemizing existing

knowledge on digital innovation. This includes the development of a clear conceptualization, the identification of key themes, and the development of promising avenues for future research. Table 5 summarizes the contributions and implications made in Chapter I:

Research questions	Contributions	Implications
RQ1: What constitutes the nature of digital innovation and simultaneously distinguishes it from traditional innovation?	(1) Explicating a theoretical mismatch between established innovation theories and digital innovation (see **Paper II**)	(1) Research must critically examine the fit of established theories for investigating digital innovation
	(2) Conceptualization and definition of "digital technology" and "digital innovation" (see **Paper I**; Figure 7)	(2) The term digital requires a sociotechnical perspective (i.e., social *and* technical aspects jointly); Digital technology is an integral part of the digital innovation itself
	(3) Synthesis and linking of central concepts to the conceptualization of digital innovation (see **Paper I**; Figure 8)	(3) Research on digital innovation must distinguish clearly between central concepts and their role in digital innovation
RQ 2: What are key themes across extant research and avenues for future research on digital innovation across disciplines?	(1) Development of five key themes in extant research on digital innovation (see **Paper I**; Figure 9)	(1) Overview and synthesis of current knowledge; Research on digital innovation can be located within the five identified key themes
	(2) Development of avenues for future research (see **Papers I** and **II**)	(2) Future research on digital innovation should focus on currently under-researched avenues such as paradoxes and knowledge recombination in digital innovation

Table 5. Contributions and implications of Chapter I: Conceptualizing Digital Innovation

5.1.2 Creating Digital Innovation

The second chapter, "Creating Digital Innovation", builds upon the conceptual insights from the first chapter to take a closer look into different factors that influence the creation of digital innovation focusing on the role of recombination (RQ3).

5.1.2.1 Role of Recombination

The third research question, "What role does recombination play in times of pervasive digitalization?" highlights the remarkable malleability of digital technology, enabling a nearly unlimited amount of potential recombinations as a source for innovation (Arthur 2009; Yoo et al. 2012).

Paper III inductively reviews and integrates 90 articles from eight different disciplines to identify differences between specific types of recombination and develop a typology of recombination, consisting of knowledge, structural, component, and use recombination. The typology of recombination breaks up the monolithic view of recombination by delineating different types from each other, particularly by pointing out differences regarding what is recombined. **Paper I** underscores insights from **Paper III** by developing

an avenue for future research, highlighting that most IS research focuses on component recombination (e.g., Henfridsson et al. 2018; Yoo et al. 2010 and less on knowledge recombination "even though it has been repeatedly emphasized across disciplines as essential for innovation" (Hund et al. 2021c, p. 14).

Paper IV addresses how organizational knowledge is affected by *structural recombination*, for example, in the form of internal reorganization, and argues that *knowledge recombination* is a central driver of creating digital innovation. **Paper V** and **Paper VI** investigate *knowledge recombination* in the context of DILs by drawing on existing insights from the literature on knowledge management (Alavi and Leidner 2001). **Paper V** focuses on identifying mechanisms that help understand how knowledge enters the DIL, is applied, recombined, and exchanged between units. **Paper VI** further investigates how knowledge is recombined by distinguishing five types of knowledge (declarative, procedural, causal, conditional, and relational) (Alavi and Leidner 2001). The more granular conceptualization of knowledge enables a closer look into strategies used by organizations to identify and access different types of knowledge. Additionally, specific knowledge recombination paths are identified that show when and how knowledge types are recombined.

Thus, **Papers III-VI** contribute to existing research by breaking down the monolithic view of recombination in general and knowledge recombination in particular. Moreover, **Paper IV** takes a first step toward understanding how different types of recombination (i.e., structural recombination and knowledge recombination) might interact. Table 6 summarizes the contributions and implications made in Chapter II:

Research question	Contributions	Implications
RQ 3: What role does recombination play in times of pervasive digitalization?	(1) Development of a typology of recombination, including knowledge, structural, component, and use recombination (see **Paper III**)	(1) Research should consider that recombination is not a monolithic concept; Different types of recombination and their interactions must be considered
	(2) Theorizing the interplay of different types of recombination for the creation of digital innovation (see **Paper IV**)	(2) Research should consider that different types of recombination influence each other and should be considered jointly
	(3) Uncovering mechanisms used to exchange and recombine knowledge between different units (see **Papers V**)	(3) Research should examine how specific mechanisms are used to overcome epistemic boundaries and recombine knowledge
	(4) Opening the black box of knowledge recombination by distinguishing between different types of knowledge and how to access and recombine them (see **Paper VI**; Figure 13)	(4) Research on knowledge recombination must distinguish between different types of knowledge to advance our understanding of knowledge recombination

Table 6. Contributions and implications of Chapter II: Creating Digital Innovation

5.1.3 MANAGING DIGITAL INNOVATION

The third chapter, "Managing Digital Innovation", turns toward the implications of digital innovation and how to manage them. Particularly the blurring of boundaries and convergence (RQ4), the role of social and technical identities (RQ5), and arising tensions such as competing concerns and paradoxes (RQ6) are in focus.

5.1.3.1 Digital Convergence

The fourth research question, "How can digital convergence be conceptualized, and what are the implications of the increasing dissolution of industrial and technological boundaries?" builds on the insight that digital innovation leads to a redefinition of established boundaries at various levels (e.g., Belk 2013; Nambisan et al. 2017; Seo 2017).

Paper I identifies the *Redefinition of boundaries* as a key theme of digital innovation research (see Figure 9) and provides an overview of current research, highlighting the increasing blurring of boundaries, on the one hand, and convergence, on the other hand. **Paper VII** addresses digital convergence by first conceptualizing it as a sociotechnical phenomenon that combines technological knowledge across social and technical boundaries. The conceptualization is operationalized by defining the social boundaries using the SIC and the technical boundaries using the IPC classification. Based on the developed operationalization, digital convergence is measured and discussed. Thereby, **Paper VII** contributes a better understanding of digital convergence per se and empirically validates the theoretical discussions surrounding convergence (e.g., Seo 2017; Tilson et al. 2010; Yoo et al. 2012).

Paper VIII addresses the *Redefinition of boundaries* by showing how organizations increasingly transcend their boundaries, leveraging digital technology to collaborate in different innovation networks (Lyytinen et al. 2016). Among the four types of innovation networks, the results indicate a strong shift toward federated innovation networks, which include various heterogeneous knowledge backgrounds, but not a shift towards more clan or anarchic innovation networks, which would require more distributed forms of control.

Thus, **Papers I**, **VII**, and **VIII** contribute to existing research by highlighting convergence as an important part of redefining boundaries and by developing a novel conceptualization of digital convergence that is consistent with the conceptualization of the term "digital" developed in **Paper I**. Furthermore, an operationalization for measuring digital convergence is developed, and empirical evidence for digital convergence and the use of different types of innovation networks is presented.

5.1.3.2 Social and Technical Identities

The fifth research question, "How do social and technical identities change and interact due to pervasive digital technology?" focuses on the interactions of various identities. The "filters imposed by an existing identity, as manifested in the routines and beliefs of organizational members, may blind those members to identity-challenging technological opportunities", which, over time, might turn the opportunities of a stable

organizational identity into a liability (Tripsas 2009, p. 442). For this reason, organizations that embrace digital innovation are typically confronted with rapidly changing identities on the individual and organizational levels (Svahn et al. 2017a).

Paper I places identity at the heart of digital innovation by interlinking the role of technical and social identities. Technical identities assign the specific use case and context for which a digital object is used (Faulkner and Runde 2013, 2019). Social identities encompass, among other things, individual or organizational identities (e.g., Wessel et al. 2021). **Paper X** closely looks at mission statements, which have been among the most popular management tools (Rigby and Bilodeau 2018), connecting an organization's identity to its actions (Grimes et al. 2019b). By uncovering ten prevalent topics addressed to varying degrees in mission statements across different industries, the results enable a better understanding of the use of identity-shaping narratives (see Figure 15). **Paper XI** develops the insights regarding identities developed in **Paper I** further by examining how changes in social identity are necessary to assign new technical identities, which in turn influence the social identity (see Figure 16).

Thus, **Papers I** and **X-XI** contribute to existing research by highlighting the importance of technical and social identities. In particular, ways to manage organizational identity and the interplay of social and technical identities are discussed.

5.1.3.3 Managing Arising Tensions

The sixth research question, "How can tensions and paradoxes in the context of digital innovation and digital transformation be navigated?" focuses on insights that pervasive digital technology (Iansitit and Lakhani 2014; Yoo et al. 2012), requires organizations to rethink established practices in light of the new logics associated with digital technology (Henfridsson et al. 2014; Henfridsson and Yoo 2014). Yet, challenging established norms often leads to arising tensions (Svahn et al. 2017a).

Paper I summarizes existing knowledge on arising tensions and introduces the distinction between competing concerns and paradoxes in the context of digital innovation. Competing concerns arise when changes "necessary to pursue digital innovation are opposed to existing logics," while paradoxes describe the enduring "opposition of interrelated elements" (Hund et al. 2021c, p. 12). Building on the existing evidence, **Paper I** develops an avenue for future research on paradoxes in digital innovation. In particular, it highlights the coping with paradoxes, the management of paradoxes, and the asymmetry between capacity and expectation.

Paper IX addresses *competing concerns* by focusing on the differences between traditional IT governance and digital innovation governance. After identifying established IT governance mechanisms in the existing literature, they are related to the four competing concerns that typically arise in the context of digital innovation. By theorizing how certain types of governance mechanisms can be used to unbalance the status quo and thereby achieve a new equilibrium conducive to digital innovation, a theoretical framework for the governance of digital innovation is developed.

Paper XI explores the interactions between technical and social identity in organizational change due to the pervasive use of digital technology. Based on the fundamental shifts in technical and social identity necessary to fully understand the potential of digital technology, *paradoxes* emerge as a result rather than a byproduct. In doing so, **Paper XI** develops a new perspective on paradoxes in the context of pervasive digital technology and highlights their value.

Thus, **Papers I**, **IX**, and **XI** contribute to existing research by highlighting different types of arising tensions as a key theme of research on digital innovation, developing approaches for managing competing concerns, and introducing a new perspective on paradoxes. Table 7 summarizes the contributions and implications made in Chapter III:

Research questions	Contributions	Implications
RQ 4: How can digital convergence be conceptualized, and what are the implications of the increasing dissolution of industrial and technological boundaries?	(1) Developing a novel conceptualization and operationalization of digital convergence (see **Paper VII**)	(1) Research on digital convergence should consider social and technical implications jointly
	(2) Validating current debates about digital convergence with empirical data (see **paper VII**; Table 4)	(2) Conceptual insights about digital convergence are empirically observable on the level of IPC sections
	(3) Empirical insights about the current use of different types of innovation networks and mechanisms to transition between them (see **Paper VIII**)	(3) Research should clearly distinguish between different types of innovation networks and investigate how and why they are used
RQ 5: How do social and technical identities change and interact due to pervasive digital technology?	(1) Introducing the concept of technical identity to research on digital innovation (see **Paper I**)	(1) Research on identity in the context of digital phenomena should consider not only social identities but also technical identities
	(2) Insights about the use of concepts and distribution of topics in narratives (i.e., mission statements) (see **Paper X**)	(2) Research should consider differences in identity-shaping narratives across industries and investigate their implications
	(3) Theorizing the interplay of social and technical identities (see **Paper XI**)	(3) Social and technical identities interact and can only be understood by considering them jointly
RQ 6: How can tensions and paradoxes in the context of digital innovation and digital transformation be navigated?	(1) Differentiating between different types of arising tensions (i.e., competing concerns and paradoxes) (see **Paper I**)	(1) Research on arising tensions should distinguish between different types of tensions
	(2) Identification of different mechanisms to manage competing concerns (see **Paper IX**)	(2) Established IT-governance mechanisms should be empirically tested for competing concerns in digital innovation
	(3) Developing a new theoretical perspective on paradoxes in a digital context (see **Paper XI**)	(3) Paradoxes are a necessary component of change and should not be conceptualized as an undesirable byproduct

Table 7. Contributions and implications of Chapter III: Creating Digital Innovation

5.2 IMPLICATIONS FOR PRACTICE

The findings of this cumulative dissertation also have implications for practice. In particular, with regard to understanding digital innovation as a sociotechnical phenomenon in order to enable its creation and management.

5.2.1 UNDERSTANDING DIGITAL INNOVATION AS SOCIOTECHNICAL PHENOMENON

Digital innovation is usually understood as a product that contains digital components (Porter and Heppelmann 2014; Yoo et al. 2010). However, to fully exploit the possibilities of digital innovation, a shift towards a sociotechnical understanding is required. The conceptualization of digital innovation developed in **Paper I** allows for a more nuanced view of digital innovation's technical and social dimensions. Practitioners involved in creating digital innovation or affected by the impact of digital innovation should therefore always consider both dimensions in their decision-making. For example, when evaluating the technical potential of a technology (i.e., the technical side), it is also important to consider the filter capacity (Tripsas 2009) that the own organizational identity has and how to introduce new perspectives (i.e., the social side).

Moreover, established insights about traditional innovation may not apply to the context of digital innovation (**Paper II**). For example, the central notion of innovation as outcome versus process (Crossan and Apaydin 2010) does not do justice to the inherently unbounded, never fully completed nature of digital innovation (Hund et al. 2021c; Nambisan et al. 2017). Recommendations derived from theories or practical experience related to traditional innovations may therefore no longer be applicable. For example, established organizations in particular, whose structures and processes were originally geared to the logic of the industrial age, should remain open to fundamental changes in established innovation practices that go beyond a greater preoccupation with digital technologies.

5.2.2 HARNESSING THE COMBINATORIAL POTENTIAL OF DIGITAL TECHNOLOGY

Digital technology, an essential component of digital innovation, has high combinatorial potential (Yoo et al. 2012). In fact, digital technology offers an almost unlimited number of potential new combinations, which in itself is a driver of innovation (Arthur 2009). Therefore, practitioners involved in creating digital innovations should focus on identifying new ways to exploit the combinatorial potential of digital technology. Recombination can occur in the context of different components (e.g., digital and physical), organizational structures, and between different knowledge domains (**Paper III**). Distinguishing between different types of recombination helps identify, access, and overcome type-specific barriers. For example, in the context of knowledge recombination, practitioners can draw on specific mechanisms identified for knowledge sharing and recombination between different entities (**Papers IV** and **V**). There are also strategies for identifying and accessing specific types of knowledge (**Paper VI**). The distinction between different types of knowledge also provides insights into the relevance of different types of knowledge during specific parts of the recombination process, as discussed in **Paper VI**.

5.2.3 Embracing Arising Tensions As a Necessary Component of Change

When "digital technologies intertwine with the routines, procedures, and beliefs of key constituents" (Svahn et al. 2017a, p. 239), practitioners often face different types of tensions. Competing concerns are about tensions that arise when the changes required for digital innovation are at odds with established logics (**Paper I**). IT governance mechanisms can help settle the issues underlying the various competing concerns. Practitioners can draw on the findings of **Paper IX**, which identifies 49 specific governance mechanisms and relates them to specific competing concerns of digital innovation, outlining a digital innovation governance framework.

Moreover, the introduction of digital innovations and thus the promotion of digital transformation requires established organizations to make fundamental changes in terms of their identity. Established tools such as mission statements are one approach to actively communicating specific narratives that clarify an organization's overall purpose and goal, which are at the heart of an organization's identity. Practitioners can draw on the findings of **Paper X**, which identifies similarities and differences between the highlighted concepts across industries and uncovers ten themes that provide insight into the most commonly used themes across industries.

Lastly, fundamental changes in identity lead to the emergence of paradoxes, which are about the enduring contradiction of coherent elements (**Paper I**). Practitioners confronted with paradoxes can draw on the insights from **Paper XI**, which highlights two key aspects in particular: First, to understand the arising of paradoxes due to digital technology, a sociotechnical perspective, considering social and technical identities is crucial. Where extant insights from academia and industry mainly focus on the social side, the picture is only complete by considering the social and technical sides together. Second, practitioners should not only expect paradoxes to arise but actively frame them as a necessary component of digital transformation rather than an undesirable byproduct.

6 Limitations

The results of this cumulative dissertation must be considered in light of their limitations. As with any research, there are limitations due to the methods chosen and the data sets available.

In terms of the methods chosen, there is always a trade-off between breadth and depth. In the case of the literature review, **Paper I** and **Paper III** conduct a broad theoretical review, favoring breadth over depth, while **Paper II** and **Paper XI** favor depth over breadth. While each approach has its merits, each also has its limitations. While broad theoretical reviews provide a valuable overview of broad research areas such as digital innovation (**Paper I**) or recombination (**Paper III**), they cannot discuss every aspect in depth. On the other hand, the assessing review and the specific theorizing review (i.e., **Paper II** and **Paper IX**) explore a more narrowly defined phenomenon in more detail but cannot include all relevant contributions closely

related to the phenomenon.

Similarly, the case studies in this dissertation (i.e., **Papers V**, **VI**, and **VIII**) all follow a multiple case study design that allows different cases to be examined simultaneously. However, this increase in breadth also means a decrease in the depth with which each case can be examined. The technological distance analysis (i.e., **Paper VII**) uses the IPC classification to determine technological distance. This risks overlooking nuanced differences that may not be detected under existing classification systems. In addition, **Paper VII** focuses mostly on the primary IPC class, which provides high-level insight into digital convergence, but prevents more specific insights at the second, third, and fourth IPC levels. Finally, the LDA analysis in **Paper X** overcomes many problems associated with manual coding (Debortoli et al. 2016) but at the same time introduces new problems, for example, due to the lack of standardized procedures.

Regarding the data, the literature reviews conducted in Papers **I-III** and **IX** had to balance comprehensibility and feasibility by defining boundary conditions. Therefore, only research results within the defined boundaries are considered. To mitigate the risk of overlooking relevant outlets, all structured reviews in this dissertation rely on established meta-rankings (see Harzing 2019) and clearly define the articles searched and identified. However, there could also be valuable insights outside the identified fields and outlets. The data included in the multiple case studies (i.e., **Papers V**, **VI**, and **VIII**) is also limited due to the industries included and because it comprises mainly data from individual and organizational informants of Western European origin. In addition, to ensure a clear focus on the phenomenon under study, theoretical sampling (i.e., careful selection of cases) was conducted, meaning that only particularly relevant cases were considered for detailed analysis in the papers. "Regarding choosing cases where the focal phenomenon occurs, theoretical sampling for this reason is often difficult for deductive researchers to accept because it is not random sampling. Yet it fits well with effective multi-case theory building" (Eisenhardt 2021, p. 149). In addition, the technological distance analysis focuses on the S&P500 index, which covers only a small portion of the patent data available worldwide. While limiting the analysis to a specific index is standard practice, the insights gained from this dataset cannot be generalized beyond the companies included in the S&P500. Finally, the boundary conditions for the LDA analysis were defined using the Strategy& 2018 Global Innovation 1000 ranking (Jaruzelski et al. 2018), which contains the 1000 largest R&D spenders in the world. Using the mission statements of the 1000 largest R&D spenders helps create a feasible dataset, but also excludes insights about organizations with lower R&D spending.

In conclusion, as with any other research, the findings of this dissertation are limited in terms of the methods chosen and the data available. Further research is needed to overcome these limitations. Therefore, recommendations for future research are provided in the following section.

7 FUTURE RESEARCH

Both the contributions and the limitations of this dissertation offer fruitful avenues for future research, not only for the study of digital innovation but digital phenomena more generally.

7.1 ONTOLOGY OF THE DIGITAL

As discussed in Section 2, understanding the ontology of the digital requires a sociotechnical perspective, comprising the social and the technical. The three-layer conceptualization of digital innovation developed in **Paper I** and illustrated in Figure 7 provides future research with a foundation to position their research along the sociotechnical continuum, which has been recommended for studying sociotechnical phenomena (Sarker et al. 2019).

While current research on digital phenomena mainly focuses on the social implications, for example, in the form of changes in the organizational identity (Wessel et al. 2021), considering the social and technical implications jointly enables a deeper reading of digital phenomena. Embracing digital technology does lead to a redefinition of social (e.g., organizational) identities, which in turn leads to changes in the technical identity assigned to digital technology, defining its purpose and area of application. Therefore, while social and technical identities influence each other, they are not equal since the concept of identity implies a recursive relationship where subjects create their own identities. This process is part of a collective process that leads to group identities, for example, on the organizational level. Yet, as of now, technology, by and large, lacks such a recursive structuring capacity. Rather, technology is interpreted by various social groups, leading to the identification of different use cases, which over time, lead to the assignment of a technical identity. Thus, the relationship between social and technological identity is not one of equality but is characterized by the recursive interaction of cognitive framings of digital technology that depend on evolving social identities. Put differently, it is not the digital technology itself that creates its technical identity through a recursive process, but rather the technical identity is contingent on the social identity, which works sort of as a filter that defines the confines of potential technical identities (Tripsas 2009).

Future research on digital transformation should consider the dynamic interactions between social and technical identities. While IT is traditionally ascribed a fixed identity, digital technology is in constant flux (Kallinikos et al. 2013) and remains open to the assignment of new technical identities. **Paper XI** offers the first step towards such a deeper reading of digital transformation by analyzing the case of Volvo Cars (see Svahn et al. 2017a), a company that transformed itself by embracing digital innovation from a sociotechnical perspective that considers both social and technical identities simultaneously.

Furthermore, the theoretical mismatch between established innovation theories and the phenomenon of digital innovation (see **Paper I** and **II**) should be further investigated in future research. While certain inno-

vation theories might prove valuable, others might have to be revised or are not applicable to digital phenomena.

7.2 CREATING DIGITAL INNOVATION

The recombinant nature of digital innovation also offers interesting avenues for research. While current research is predominantly focused on the recombination of digital and physical components (Henfridsson et al. 2018; Yoo et al. 2010) various perspectives can enrich extant insights. For example, focusing not only on the technical side (i.e., the recombination of physical and technical components) but also on the social side (i.e., the recombination of epistemically different areas of expertise) helps better understand success factors during recombination.

Paper III provides an overview of different types of recombination and, for example, distinguishes between structural and knowledge recombination. Organizations can break down established structures during structural recombination by creating or merging organizational units to overcome epistemic boundaries (Karim and Kaul 2015). Thus, organizational entities such as units or divisions are the unit of analysis for future research on structural recombination. Moreover, knowledge recombination, where different knowledge elements are combined in novel ways to create knowledge, offers new insights, as highlighted in **Paper I**. **Paper V** and **VI** take a closer look into the recombination of knowledge and highlight, among other things, the need to carefully distinguish between different types of knowledge to understand the recombination process better.

Thus, the findings of this dissertation enable future research to take a more granular perspective on recombination per se (see the typology of recombination in **Paper III**) and introduce established knowledge taxonomies to research on knowledge recombination (see **Paper VI**). Therefore, future research should examine different types of recombination in digital innovation, particularly in the case of knowledge recombination, by distinguishing between different types of knowledge. Doing so will provide new insights into the interplay of different types of recombination (e.g., how does structural recombination affect knowledge recombination?) and more detailed insights about the process of recombination itself (e.g., which type of knowledge is required and recombined during which part of the process?).

7.3 MANAGING DIGITAL INNOVATION

Future research should also examine how the effects of digital innovation can be managed. In particular, the emerging tensions that are a typical side effect of digital innovation are an important area for future research. By considering differences in competing concerns and paradoxes (see **Paper I**), future research can develop specific strategies for resolving tensions or, if that is not possible, how to govern them. **Paper IX** develops a framework for governing digital innovation that identifies specific governance mechanisms and links them to the competing concerns of digital innovation. Future research can draw on the framework

to identify applicable governance mechanisms and test them in different settings using quantitative approaches. At a more fundamental level, **Paper XI** looks at the deep structural changes that occur when established organizations embrace digital technologies and argues that working with arising paradoxes is a necessary component of successful change. Additionally, it links changes in different parts of the deep structure with various paradoxes (Smith and Lewis 2011; Tushman and Romanelli 1985) that can be explored in more detail in future research. For example, future research can examine how different types of paradoxes that arise because of digital technology can be managed or how reframing paradoxes as a necessary component of successful change helps to work with and through them.

Paper VII takes a first step in conceptualizing and operationalizing digital convergence and lends empirical support to current debates about convergence. Future research might build upon these insights to uncover more granular insights on the second, third, and fourth IPC levels, which could help understand which specific technology areas are converging and which role digital technology plays in convergence per se. Furthermore, by considering the convergence of social factors (e.g., industry boundaries) and technical factors (e.g., technology classes) jointly, future research can investigate the interplay of social and technical convergence and deduct, for example, interesting insights regarding industrial regulation in times of digital convergence.

In addition, there are findings in the existing literature that innovation networks are moving toward the inclusion of heterogeneous sources of knowledge and toward distributed forms of control (Boland et al. 2007; Lyytinen et al. 2016). While **Papers VII** and **VIII** emphasize the move toward more heterogeneous knowledge sources, **Paper VIII** also reports the retention of centralized control and coordination structures. Future research should examine whether incumbent organizations are considering more decentralized forms of control and coordination and, if so, under what conditions. Insights about changes in the use of innovation networks can inform incumbent organizations struggling to make sense of innovation contexts where "partners and their contributions are diverse, unknown or ill defined" (Nambisan et al. 2017, p. 226), as illustrated by the emergence of novel types of organization design (see Majchrzak et al. 2018; Majchrzak and Griffith 2020).

8 CONCLUSION

The initial quote succinctly summarizes the overall motivation and focus of this dissertation: "*The emergence of a wide range of digital technologies and the ever-expanding digital infrastructures they comprise […] is radically reshaping the nature, process, and outcomes of innovation*" (Nambisan et al. 2020, p. 2). By taking the prefix "digital" seriously, this dissertation shows how the nature, process, and outcomes of digital innovation differ from traditional innovation research and how to address the new challenges.

In particular, Chapter I: Conceptualizing Digital Innovation stresses the need for novel theorizing by

explicating the theoretical mismatch between existing theories and the phenomenon of digital innovation. Addressing the theoretical mismatch enabled the development of a novel theory of digital innovation that clearly defines its sociotechnical nature and delineates it from related phenomena.

Chapter II: Creating Digital Innovation takes a closer look into the creation of digital innovation by breaking up the monolithic view of recombination, defining four different types of recombination and linking them theoretically to the context of the digital era. The distinction between different types of recombination enables new insights into their interplay. Furthermore, the black box of knowledge recombination is opened by distinguishing between different types of knowledge and explicating the process of recombining them.

Lastly, Chapter III: Managing Digital Innovation examines how to manage the implications of digital innovation by producing insights into the ongoing digital convergence and the use of cross-industry innovation networks. Furthermore, the concept of technical identity is introduced to the literature on digital innovation, emphasizing that the intricate interplay of social and technical identities is an important factor in understanding and managing the arising tensions due to digital innovation.

As the second quote at the outset of this dissertation stated: "*It is not too much of a stretch to think we have entered a golden age of digital innovation*" (Fichman et al. 2014, p. 330). The results of this dissertation lay the foundation for overcoming the associated challenges to fully harness the opportunities offered by digital innovation.

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CHAPTER I: CONCEPTUALIZING DIGITAL INNOVATION

PAPER I

Digital Innovation:
Review and Novel Perspective

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PAPER II

The Current State and Future Opportunities of Digital Innovation:

A Literature Review

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CHAPTER II: CREATING DIGITAL INNOVATION

PAPER III

Recombination in Times of Pervasive Digitalization:

A Review

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PAPER IV

The Creation of Digital Innovation:

Internal Reorganization, External Networks and Organizational Knowledge

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The Creation of Digital Innovation:

Internal Reorganization, External Networks and Organizational Knowledge

ABSTRACT

Digital innovation already disrupted numerous industries and organizations are challenged to align their innovation efforts with the new reality of a digitized environment. We examine how internal reorganization and the external network of an organization are related to organizational knowledge and the eventual creation of digital innovation. To develop digital innovation, firms tap a variety of heterogeneous backgrounds to exploit the ease with which different knowledge fields can be accessed and recombined in a digitized environment. Therefore, the actors involved in the development process come from different sources from within and without the firm as the inclusion of digital technology challenges previously non-digital organizational innovation logics. We develop a conceptual model, which takes the characteristics of digital innovation into account.

Keywords: digital innovation, internal reorganization, knowledge recombination, external network, theory development

INTRODUCTION

Digital innovation is reshaping our world at an ever-increasing pace and is deeply embedded in most products, value chains and industries. The definition of digital innovation builds on the Schumpeterian concept of knowledge recombination (Schumpeter, 1934) and can be defined as the "carrying out of new combinations of digital and physical components to produce novel products (Yoo, Henfridsson, & Lyytinen, 2010: 725). The ability to recombine knowledge (Fleming, 2001) involves making new combinations either by combining previously unconnected elements or by developing novel ways of combining previously associated elements (Carnabuci & Operti, 2013). With digital innovations the combinatorial potential increases and the boundary of a product is not known upfront (Yoo, Boland, Lyytinen, & Majchrzak, 2012) because, after the product's first launch, different parties will extend the product, change its functionality, and in a way the product will never be finalized (Nambisan, Lyytinen, Majchrzak, & Song, 2017). Product design, development, and service are not confined within the boundaries of business units or companies (Lyytinen, Yoo, & Boland Jr., 2016; Nambisan et al., 2017). These tasks increasingly require distributed organizations, temporary structures that only exist until certain problem is solved, and structures with fluid boundaries, all of which embracing diverse knowledge sources with heterogeneous knowledge (Yoo et al., 2012). In that respect, firm-internal reorganization complements knowledge recombination by dissolving unit boundaries, thereby enabling intra-organizational knowledge synergies (Karim & Kaul, 2015). Following Karim et al. (2016: 792) we define "internal reorganization" as recombination of business units where "[a] 'recombined' unit is any unit that has experienced a change in boundaries through some addition or deletion of activities and resources that have been moved within the firm". This definition includes "merging units together" and "the formation of new business units by combining existing units" (Karim & Kaul, 2015: 441). We also subsume under internal

reorganization the change of design parameters of an organization's unit grouping (Mintzberg, 1980) such as switching from a business-line logic to a function centered logic (Girod & Karim, 2017).

Additionally, incumbents also leverage external knowledge by relying on their external network with other organizations but also with external individuals, e.g., through online communities (Afuah & Tucci, 2012). A common mechanism to leverage external knowledge is generally the formation of innovation networks (Lyytinen et al., 2016) in various forms, such as for example open innovation (Chesbrough, 2003), the acquisition of new entrants (Higgins & Rodriguez, 2006), or strategic alliances (Rothaermel, 2001).

However, with the notable exception of a few studies such as the work by Karim and Kaul (2015), there is a dearth of literature regarding the effect of internal reorganization on knowledge recombination and digital innovation. This void is even larger when simultaneously considering the interplay of external networks and internal reorganization. This is surprising because, in particular, the strategic management literature (e.g., Carlile, 2004; Harvey, 2014; Majchrzak, More, & Faraj, 2012) deals with sourcing knowledge and the ability of knowledge recombination related to innovative output (Carnabuci & Operti, 2013). Moreover, nowadays digital technology is deeply embedded in most products, processes and even entire business models (Nambisan et al., 2017; Yoo et al., 2010). The characteristics of digital technology such as reprogrammability and data homogenization (Yoo et al., 2012) enable new forms of recombination and challenge our current understanding of how digital innovation is created (Henfridsson, Nandhakumar, Scarbrough, & Panourgias, 2018). In that respect, Nambisan et al. (2017) recognize the influence of digital technology when considering knowledge recombination for digital innovation. Here, the interplay of internal reorganization and the external network might help explain the respective effect on digital innovation. Following their recent research call for developing new theories that explain how

digital innovation can be created (Nambisan et al., 2017), this article argues that digital innovation is contingent on an organization's knowledge, which is shaped by internal reorganization and the integration of a firm's external knowledge sources. Therefore, we formulate the following research question:

RQ: How are internal reorganization and the external network related to organizational knowledge and digital innovation?

In the following, we present insights from extant research on organization theory, knowledge recombination and digital innovation. Based on these insights we develop a theoretical model that depicts our considerations. Subsequently, we derive propositions, whose implications we discuss in the final section.

THEORETICAL BACKGROUND

Internal Reorganization

In order to understand what internal reorganization means, it is important to understand the concept of an organization first. Puranam et al. (2014: 163) summarize the insights of numerous scholars along four dimensions and conceptualize an organization "as (1) a multiagent system with (2) identifiable boundaries and (3) system-level goals (purpose) toward which (4) the constituent agent's efforts are expected to make a contribution […]". Hence, an organization is comprised of more than one agent and these agents are clearly distinguishable from agents outside of the organization. Furthermore, these individual agents are united under a shared purpose and are supposed to work towards its realization (Puranam et al., 2014). Furthermore, internal reorganization is an umbrella term that encompasses two different forms of reorganization. First, there is the more fundamental act of restructuring the core set-up of an organization such as switching from a business-line logic to a function centered logic (Girod & Karim, 2017). Second, there is the act of reconfiguration, which is

about internal changes such as creating, combining or dissolving units and segments without changing the underlying core structure (Girod & Karim, 2017). For this paper, we use the term internal reorganization and, thus, include both restructuring and reconfiguration into our considerations. Our definition follows Karim et al. (2016, p. 792) who define "internal reorganization" as recombination of business units where "[a] 'recombined' unit is any unit that has experienced a change in boundaries through some addition or deletion of activities and resources that have been moved within the firm". Organizations need to reconfigure their internal set-up to quickly align their processes and structures with the new conditions (Girod & Karim, 2017) brought about through an increasingly digitized world where changes are happening fast and the creation of digital innovation already creatively destroyed entire industries (Nambisan et al., 2017; Schumpeter, 1950). However, the reason why incumbents are successful in their industry is because they perfectly aligned their cost-structure with existing circumstances and altering these successful cost structures would signify losing a very lucrative market position in the pursuit of creating new, innovative markets. This predicament is known as the *innovators dilemma* (Christensen, 1997) and explains why reorganization efforts are often met with resistance until it is too late. Furthermore, firmly established structures and processes make existing networks more efficient, however, they can also hinder new recombination of current knowledge by separating individuals in different business units through epistemic differences (e.g., Brown & Duguid, 2001). Nonetheless, innovation is regarded as the ultimate raison d´être for organizations (Drucker, 1955) and internal reorganizations are recognized as a vital tool to boost innovation (e.g., Karim, 2009; Karim & Kaul, 2015). This is because reorganizations help "reduce "organizational cholesterol"—that is, the inertia, sticky routines, and fiefdoms that progressively undermine growth—or to change strategic direction in the face of major industry transformation" (Girod & Karim, 2017: 130). Thus, even though the extant literature

mainly investigates reorganization from a structural perspective (Eisenhardt & Brown, 1999; Helfat & Eisenhardt, 2004; Karim, 2006, 2009; Karim et al., 2016), the IT governance literature suggests that organizational arrangements unfold their impact on a firm's outcomes not merely through structural issues. In general, organizational theory deals with the dichotomy of differentiation and integration and their effects on organizational outcomes (Mintzberg, 1979). Differentiation describes the division of different tasks and responsibilities to gain specialization benefits, whereas integration is about the realignment of these different tasks in order to achieve the overarching organizational purpose (Mintzberg, 1979; Peterson, O'Callaghan, & Ribbers, 2000). The attempt to manage these diametrically opposed mechanisms (e.g., Venkatram, 2000) embodies the dilemma of organizational design. In an attempt to address the duality of differentiation and integration, the IT governance literature, subdivides organizational arrangements into three mutually exclusive and collectively exhaustive dimensions – structures, processes, and relational mechanisms (de Haes & van Grembergen, 2009; Peterson, 2003). Thus, reorganization efforts affect all three dimensions; for example, by relocating business units (structure) the workflows between those units are impacted (processes) as well as the interpersonal proximity between individuals (relational mechanisms).

Whether an internal reorganization leads to the desired boost of innovation depends on whether the reorganizations enables more novel knowledge recombination than it destroys valuable existing ones (Karim & Kaul, 2015). A reorganization is expected to be successful if a company has a lot of complementary, high-quality knowledge and low path dependence (Karim & Kaul, 2015). Furthermore, companies learn from previous reorganizations and need to experience numerous reorganizations before reaping increased innovation rates (Karim, 2009).

External Networks

For this article, we view external networks with regard to their ability to provide "access to relevant knowledge that is being created in the environment" (Eisenhardt & Santos, 2000: 14). Since the creation of digital innovation oftentimes requires expertise from various backgrounds, companies are incentivized to form networks with external players (Lyytinen et al., 2016). In general, organizations exchange various types of knowledge (e.g., managerial, market and technological knowledge) through inter-firm collaborations, thus, increasing the heterogeneity of the accessible knowledge (Sammarra & Biggiero, 2008). Extant literature discusses various forms of external networks in detail. There are rather permanent forms of accessing external knowledge such as merger and acquisition (de Man & Duysters, 2005; Hagedoorn & Duysters, 2002) with the aim of permanently merging with an external organization. Additionally, there are rather temporary forms of collaboration such as open innovation (Chesbrough, 2003, 2006; Chesbrough, 2015), crowdsourcing (Boudreau & Lakhani, 2013; Majchrzak & Malhotra, 2013), user innovation (Hippel & Katz, 2002) and strategic alliances (Osborn & Hagedoorn, 1997). While there is no consensus about which external cooperation form is most desirable for innovation purposes (e.g., Chesbrough, 2015), there exists a consensus about the importance of engaging with external knowledge sources to ensure high levels of innovation. Furthermore, the dramatic drop in communication and coordination costs (Altman, Nagle, & Tushman, 2015) due to digital technology facilitates the access to external knowledge (Lyytinen et al., 2016). For example, digital technology enables organizations to leverage customer involvement in the process of creating innovations (Hippel & Katz, 2002; Saldanha, Mithas, & Krishnan, 2017).

Organizational Knowledge

Knowledge is long recognized as a central resource for organizations (Alavi & Leidner, 2001). Entire literature strands conduct organizational research from a so-called knowledge-

based-perspective (e.g., Grant, 1996; Kogut & Zander, 1992; Nonaka & Takeuchi, 1995; Spender, 1996). The pervasive interest in organizational knowledge is justified by the notion that the ability to acquire more and create new knowledge are the central driver of competitive advantage and the ultimate raison d´être of organizations (Drucker, 1955; Karim & Kaul, 2015; Kogut & Zander, 1992; Spender, 1996). Despite the considerable amount of research about organizational knowledge, the concept of knowledge remains rather elusive. For example, in his seminal paper Grant (1996: 110) builds upon a rather pragmatic conceptualization of knowledge: “In terms of defining knowledge, all I offer beyond the simple tautology of 'that which is known' is the recognition that there are many types of knowledge relevant to the firm”. However, in order to gain a somewhat better understanding of what knowledge is, it is important to first understand the distinction between information, data and knowledge. While all three can be placed along the same continuum, they differ in terms of human involvement (Bell, 1999). Tsoukas and Vladimirou (2001: 976) build upon this insight by stating: “For Bell *data* is an ordered sequence of given items or events (e.g. the name index of a book). *Information* is a context-based arrangement of items whereby relations between them are shown (e.g. the subject index of a book). And *knowledge* is the judgement of the significance of events and items, which comes from a particular context and/or theory (e.g. the construction of a thematic index by a reader of a book)”. Thus, the main difference between data, information and knowledge is the level of human involvement and judgement (Tsoukas & Vladimirou, 2001). Organizational knowledge is when individuals not only judge significance based on context and theory but also consider generalized rules within an organization (Tsoukas & Vladimirou, 2001). Such generalized rules are oftentimes captured in organizational routines and processes, which foster collective understanding and represent the organizational knowledge (Davenport & Prusak, 1998). Thus, for this paper we define organizational knowledge as the sum of what individuals within the company know as

well as what is embedded in the codes and routines of the organization itself (Kogut & Zander, 1992). The established codes and routines such as shared language and meaning facilitate the transfer of knowledge within a company (Grant, 1996) which in turn might create competitive advantage, in particular, when dealing with complex, ill-structured problems (Macher, 2006).

Furthermore, organizations have to deal with both tacit and explicit knowledge (e.g., Alavi & Leidner, 2001; Nonaka & Takeuchi, 1995; Spender, 1996). Tacit knowledge exists on a personal level and is difficult to codify, whereas explicit knowledge is codified and readily accessible (Nonaka & Takeuchi, 1995). Since not all knowledge is created equal, organizations must figure out ways to efficiently access and transfer knowledge. In order to access knowledge from beyond the borders of the organization, external networks (as described above) are highly valuable (Lyytinen et al., 2016). Furthermore, since tacit knowledge is hard to transfer between different units (Brown & Duguid, 2001; Tushman & Katz, 1980) internal reorganization are oftentimes necessary (Karim & Kaul, 2015). Generally, internal recombination and external networks increase the access to and the connections between different knowledge elements. The more organizational knowledge a firm possesses the more opportunities for knowledge recombination emerge.

Organizational Ability to Recombine Knowledge

"The creation of any sort of novelty in art, science, or practical life—consists to a substantial extent of a recombination of conceptual and physical materials that were previously in existence" (Nelson & Winter, 1982: 1982). This notion of innovation being the result of novel recombination defined by Schumpeter (1934) is "[…] at the heart of innovation" (Henfridsson et al., 2018: 89) ever since. Thus, the ability of an organization for

recombination is highly important. For this paper, we define the organizational ability of knowledge recombination as the ability of a firm to integrate diverse knowledge sets to generate digital innovation (adapted from Harvey, 2014). This definition broadly matches the notion of recombinant capabilities which are defined as "ability to recombine existing technologies to generate technological innovations" (Carnabuci & Operti, 2013: 1591). The ability of knowledge recombination encompasses knowledge combinations new to the firm but also the refinement of known knowledge combinations and its adaptation to new uses (Carnabuci & Operti, 2013). Generally, it is unpredictable to anticipate when and how change through recombination will occur (Fleming, 2001). More importantly, in order to allow for truly groundbreaking innovation, inventors must increase this unpredictability even further by combining and recombining formerly unknown components (Fleming, 2001). In average, innovation created through experimentation with unknown components have a lower utility overall, however, it also increases the likelihood of breakthrough innovations to occur (Fleming, 2001). In contrast, Kaplan and Vakili (2015) find that in opposition to recombination theory, new topics mainly emerged as a result of local search, rather than heterogeneous knowledge from external sources. Interestingly, when investigating the recombinations of existing knowledge in the Web of Science Mukherjee et al. (2016: 224) found that: "[…] despite an ever-increasing frontier of possible new combinations of prior work, atypical combinations of prior work are becoming increasingly rare with time, while the distribution of conventional pairings is increasing with time". Thus, there appears to be a trend to engage more with knowledge from familiar backgrounds. Furthermore, there also exists the possibility for breakthrough innovation to occur by merely rearranging existing components (Henderson & Clark, 1990). In total, innovation can be conceptualized as either new combinations of previously unconnected components or as a new arrangement of already connected parts (Fleming, 2001).

In the realm of digital innovation, there is a special attention on the combination of digital and physical components (Yoo et al., 2010). Additionally, there is the argument that the characteristics of digital technology such as reprogrammability (Yoo et al., 2012) and malleability (Fichman, Dos Santos, & Zheng, 2014) enable two distinct types of recombination – namely design recombination and use recombination (Henfridsson et al., 2018). Design recombination occurs when companies recombine parts of their offering and use recombination occurs when users pick and choose different offerings and, thus, recombine them in use (Henfridsson et al., 2018). Hence, it appears that digital technology enables new forms of recombination and eventually new types of innovation.

Digital Innovation

In classic innovation literature there is a common distinction between innovation as a process and innovation as an outcome (Crossan & Apaydin, 2010). Innovation as a process describes *how* an innovation is created whereas innovation as an outcome describes *what* the eventual innovation is (Crossan & Apaydin, 2010). Yoo et al. build upon the Schumpeterian notion of recombination and define *digital* innovation as: "[…] the carrying out of new combinations of digital and physical components to produce novel products" (2010: 725). Thus, this definition views innovation with a focus on product innovation but builds upon an "innovation as a process"-logic, since it accentuates the constant combination and recombination (Kohli & Melville, 2018). Another widely cited conceptualization of digital innovation builds upon the "innovation as an outcome" view: "[…] digital innovation [is defined] quite broadly as a product, process, or business model that is perceived as new, requires some significant changes on the part of adopters, and is embodied in or enabled by IT" (Fichman et al., 2014: 330).

However, with the rapid proliferation of digital innovation this distinction is increasingly called into question (Nambisan et al., 2017). Digital innovations oftentimes encompass various iterations between process and outcome and enable the emergence of unexpected network connections and collaboration interactions (Boland, Lyytinen, & Yoo, 2007; Huang, Henfridsson, Liu, & Newell, 2017; Lyytinen et al., 2016). Thus, for this paper we focus on both innovation as a process and innovation as an outcome simultaneously. Furthermore, we understand the creation of digital innovation as an ill-structured problem (Macher, 2006). A problem is ill-structured if there is no full understanding about how the different components and knowledge sets interact with each other, which makes the search for solutions more complex and uncertain (Macher, 2006). Considering these caveats, we define digital innovation as the result of an iterative process of collective action between internal and external actors that search for novel solutions for ill-structured problems by leveraging digital technology (adapted from: Lyytinen et al., 2016; Macher, 2006; Nambisan et al., 2017).

CONCEPTUAL FRAMEWORK

We ground our conceptual framework in the beforehand described literature. Internal reorganization is expected to increase the overall organizational knowledge by enabling more knowledge exchange between formerly unconnected units and departments (Girod & Karim, 2017; Karim & Kaul, 2015). External networks are also expected to increase the organizational knowledge since they allow access to new knowledge from beyond the organizational boundaries (Lyytinen et al., 2016; Nambisan et al., 2017). Organizational knowledge is the prerequisite for digital innovation. Since digital innovation is generally created through novel recombination of existing knowledge elements (Schumpeter, 1934; Yoo et al., 2010) we expect organizational knowledge to have a positive effect on eventual digital innovation. In addition, a motivation to share resources is theorized to positively

moderate the transformation of organizational knowledge into realized digital innovation. Figure 1 depicts the corresponding theoretical considerations:

Insert Figure 1 here

In the following, the constructs and respective propositions are elaborated in more detail and substantiated with findings from extant research.

We first discuss the relationship between organizational knowledge and digital innovation. As mentioned in the previous section, digital innovation is defined as the result of an iterative process of collective action between internal and external actors that search for novel solutions for ill-structured problems by leveraging digital technology. Such digital innovation can be seen as the outcome of a recombination of existing, heterogeneous knowledge elements (Fleming, 2001; Schumpeter, 1934; Yoo et al., 2010) where "the convergence of pervasive digital technology intensifies the degree of heterogeneity and the need for dynamic balancing and integration of knowledge resources" (Yoo et al., 2012: 1401). Organizational knowledge is defined as the sum of what individuals within the company know as well as what is embedded in the codes and routines of the organization itself (Kogut & Zander, 1992). Since diverse elements of organizational knowledge represent the building blocks, which can be recombined in search for novel solutions, we expect to see more opportunities for such recombination with increasing organizational knowledge. Moreover, digital technology is nearly ubiquitous in modern organizations (Nambisan et al., 2017) and central to organizational knowledge management (Alavi & Leidner, 2001). Therefore, the characteristics of digital technology such as edit-ability (Kallinikos, Aaltonen, & Marton, 2013) and re-programmability (Yoo et al., 2010) give firms more flexibility to test different

combinations and recombinations until the product is released (Henfridsson et al., 2018; Henfridsson, Mathiassen, & Svahn, 2014). Additionally, communication and coordination costs are nearly vanishing (Altman et al., 2015) and digital content can be reproduced without any considerable cost (Fichman et al., 2014). Thus, organizational knowledge can be communicated and shared quickly across different units without any additional cost, which strongly incentivizes experimentation with novel recombinations. Furthermore, organizational knowledge is more heterogeneous since digital technology facilitates the cooperation with actors from various knowledge backgrounds (Lyytinen et al., 2016; Saldanha et al., 2017), which enables the convergence and recombination of various areas of knowledge (Yoo et al., 2010; Yoo et al., 2012). Since recombination is central to the creation of digital innovation (Henfridsson et al., 2018; Yoo et al., 2010) and the characteristics of digital technology facilitate the recombination of different sets of organizational knowledge, we propose the first proposition as:

P1: Organizational knowledge positively influences digital innovation.

We now turn to the relationship between the external network and organizational knowledge. A network can be understood as "a set of actors connected by a set of ties. The actors […] can be persons, teams, organizations, concepts, etc." (Borgatti, 2003: 992). The external network is defined as a focal firm's ego-network consisting of a set of ties to external actors, which are persons, teams, and organizations. An external network enables the access to knowledge that resides outside the organizational boundaries (Lyytinen et al., 2016; Nambisan et al., 2017). In the context of digital innovation external networks can have various shapes and forms (Lyytinen et al., 2016). For example, M&A, is the merging of two entities into one entity and is commonly used to permanently integrate external knowledge (de Man & Duysters, 2005). The digitization is rapidly changing traditional industries and creates the need for incumbents

to acquire knowledge about digital technologies (Hildebrandt, Hanelt, Firk, & Kolbe, 2015). Thus, incumbents use digital technology-related M&As to acquire and integrate organizational knowledge about digital technology (Hildebrandt et al., 2015). Another example is the use of crowdsourcing, which is the: "[…] act of outsourcing a task to a "crowd," rather than to a designated "agent" (an organization, informal or formal team, or individual), such as a contractor, in the form of an open call (Howe, 2006, 2008; Jeppesen & Lakhani, 2010)" (Afuah & Tucci, 2012: 355). The advent of digital technology transformed crowdsourcing form a rarely used mechanism into a more common tool (Afuah & Tucci, 2012). Crowdsourcing enables organizations to use knowledge that resides somewhere outside the organizational boundaries (Afuah & Tucci, 2012) and, thus, also increases the overall organizational knowledge. There are numerous other examples for how digital technology facilitates or even enables new ways to engage with the external network. Other widely-cited ones are open innovation (Chesbrough, 2003, 2006), strategic alliances (de Man & Duysters, 2005; Vanhaverbeke, Gilsing, & Duysters, 2012) and user innovation (Hippel, 2006; Hippel & Katz, 2002). All of them have in common that they enable the access to external, complementary knowledge, thus, increasing the overall organizational knowledge (Lyytinen et al., 2016; Yoo et al., 2012). Accordingly, the following proposition is put forward:

P2: The external network positively influences organizational knowledge.

We now turn to the relationship between internal reorganization and organizational knowledge. As mentioned in section two, we define internal reorganization as recombination of business units where "[a] 'recombined' unit is any unit that has experienced a change in boundaries through some addition or deletion of activities and resources that have been moved within the firm" (Karim et al., 2016: 792). When developing products that comprise

digital and physical aspects, digital innovation initiatives of incumbents often rely on an increased utilization of internal knowledge from individuals that have not been previously involved (Lyytinen et al., 2016). Thus, the digitization of products requires the convergence of various backgrounds of knowledge within an organization (e.g., engineering, programming, design, marketing) (Yoo et al., 2010; Yoo et al., 2012). Firms realize this by regularly reorganizing internally in order to bring together different types of knowledge (Karim, 2009). Hence, the act of internal reorganization involves identifying and allocating relevant knowledge within the organization (Girod & Karim, 2017) and creating connections between formerly unconnected knowledge elements within the organization (Karim & Kaul, 2015). In this context, internal reorganization provides access to further knowledge to find solutions for upcoming problems (e.g., Karim & Kaul, 2015). Additionally, in interdisciplinary teams which span diverse knowledge domains, decisions are more likely to encompass the full range of perspectives which affect the ability to recombine knowledge (van der Vegt & Bunderson, 2005) and create new additional knowledge in the process. Hence, organizations learn by identifying, distributing and interpreting knowledge (Huber, 1991; Karim, 2009). Therefore, internal reorganization increases the available organizational knowledge by (1) bringing together previously separated sources of knowledge and (2) creating new organizational knowledge by recombining existing knowledge.

P3a: Internal reorganization positively influences organizational knowledge.

However, internal reorganization may also decrease organizational knowledge (Karim & Kaul, 2015). Negative effects are connected to the disruption of the status quo as internal reorganizations also endanger valuable knowledge combinations embedded in tried-and-tested routines (Benner & Tushman, 2003; Puranam, Singh, & Zollo, 2006) and interpersonal networks (Dess & Shaw, 2001). Reorganization is also associated with increased ambiguity

and conflict (Luscher & Lewis, 2008) wherein tacit knowledge is especially vulnerable (Kogut & Zander, 1992; Nelson & Winter, 1982) as employees may choose to leave and take valuable tacit knowledge with them, which jeopardizes future firm profitability (Guthrie & Datta, 2008). Thus, internal reorganization can be viewed as: "[…] as creating new interconnections between units that in excess, beyond the threshold of stability, may be too complex […]" (Karim, 2009: 1241).

P3b: Internal reorganization negatively influences organizational knowledge.

Finally, motivation to share resources is expected to positively moderate the relationship between the organizational knowledge and digital innovation. Organizational resources can be thought of as knowledge, abilities and physical resources such as tools and materials. These organizational resources reside within the various parts of an organization and are accessible for actors connected with these parts of an organization. Thus, these organizational resources are only accessible for other actors if actors who have already access are motivated to share their resources (Etzioni & Putnam, 2001). Thus, the motivation to share resources is important to enable the flow of resources between actors (Kwon & Adler, 2014). In general terms, the motivation to share resources is based on deeply internalized norms through socialization and shared destiny with others as well as on norms based on obligations enforced by a community or obligations created in the exchange with others (Adler & Kwon, 2002). For this motivation to exist on an individual level, the actor must have trust in the abilities and objectives of the focal actor otherwise the fear of repercussions oftentimes leads to the decision not to share resources (e.g., Smith, 2005; Smith, Menon, & Thompson, 2012). On an organizational level, there is a similar mechanism at work – depending on whether the incentive system in the network is public-domain or for-profit, the motivation to share resources differs (Kwon & Adler, 2014; Owen-Smith & Powell, 2004). In public-domain

networks the motivation to share resources is equally high, whereas in for-profit networks only central organizations can leverage the full potential of their network (Owen-Smith & Powell, 2004). In conclusion, organizational resources such as knowledge can only be transformed into digital innovation if the various actors within the organization are motivated to share and recombine their resources (Adler & Kwon, 2002; Kwon & Adler, 2014), thus the following proposition is put forward:

P4: The motivation to share resources positively moderates the influence of organizational knowledge on digital innovation.

Insert Table 1 here

DISCUSSION

This paper theoretically investigates how the digital characteristics challenge our current assumptions about innovation and organization. We develop a conceptual model that takes into consideration the convergence and generativity of digital technology and take a first step towards a new theory development.

Digital innovation is rapidly changing entire industries (Nambisan et al., 2017; Yoo et al., 2012). Not only products are different (Yoo et al., 2010) but also the way organizations innovate (Henfridsson & Yoo, 2014) and cooperate (Lyytinen et al., 2016). Even the way users pick and recombine products and services is impacted (Henfridsson et al., 2018). Despite our knowledge about the digital revolution and how it challenges many of our core assumptions about innovation and organizational theory (Benner & Tushman, 2015; Nambisan et al., 2017) there is still a dearth in the literature about how exactly the

characteristics of digital technology alter established logics and routines. In the current literature, we observe two main trends:

(1) Digital technology dissolves the organizational boundaries, thus facilitating the cooperation with external actors (Nambisan et al., 2017). The cooperation with more heterogeneous actors leads to an overall higher heterogeneity of the accessible organizational knowledge (Lyytinen et al., 2016). Thus, digital technology triggers a convergence of various areas of expertise (Yoo et al., 2012). Striving to better understand the convergence of various areas of expertise, we theoretically investigate the interplay of the two constructs "internal reorganization" and "external network" and their effect on organizational knowledge.

(2) Digital technology is highly malleable (Fichman et al., 2014). The ease with which existing products and services can be reprogrammed, enables the repurposing of existing products and services towards a new end (e.g., Kallinikos et al., 2013). Thus, a product can be tweaked towards initially unforeseen directions and there is no real control over involved actors and the final outcome (Boland et al., 2007; Lyytinen et al., 2016). Furthermore, products are never finalized but are constantly developed further, which blurs the boundaries between process and outcome (Nambisan et al., 2017). Thus, digital technology enables a new form of generativity (Yoo et al., 2012), which is basically "a technology's overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences" (Zittrain, 2006: 1980).

In order to better understand the increasing generativity we theoretically examine how the increased amount of accessible "organizational knowledge" and the higher recombination potential affects the eventual creation of "digital innovation".

Generally, we contribute to theory by developing a conceptual model, which takes the characteristics of digital technology into consideration and signifies a first step towards new

theory development. Thus, future research can build upon our theoretical considerations and test them through confirmatory research.

Nonetheless, every research comes with inherent limitations. Our paper is no exception. First, the development of the presented conceptual model is based on purely theoretical considerations. Quantifying and confirming them will be a challenge, however, since there are notable advances in configurational analysis and computational social sciences as recommended by Nambisan et al. (2017), there are numerous tools to future research's proposal. Second, the field on digital innovation is growing quickly and for the scope of this paper we were not able to consider every single development (e.g., the competing concerns companies are facing as described by Svahn et al. (2017)).

There are numerous implications for practitioners. First, the increasing convergence of various areas of expertise forces organizations to expand their organizational knowledge. This is possible by engaging with their external network and accessing knowledge from beyond their traditional boundaries. Second, in order to benefit from the increased amount and heterogeneity of organizational knowledge, practitioners must make sure they are able to integrate and recombine the acquired knowledge. Thus, regular internal reorganizations are necessary to dissolve existing, obsolete connections and make room for the creation of new, productive ones.

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FIGURE 1

Conceptual Framework

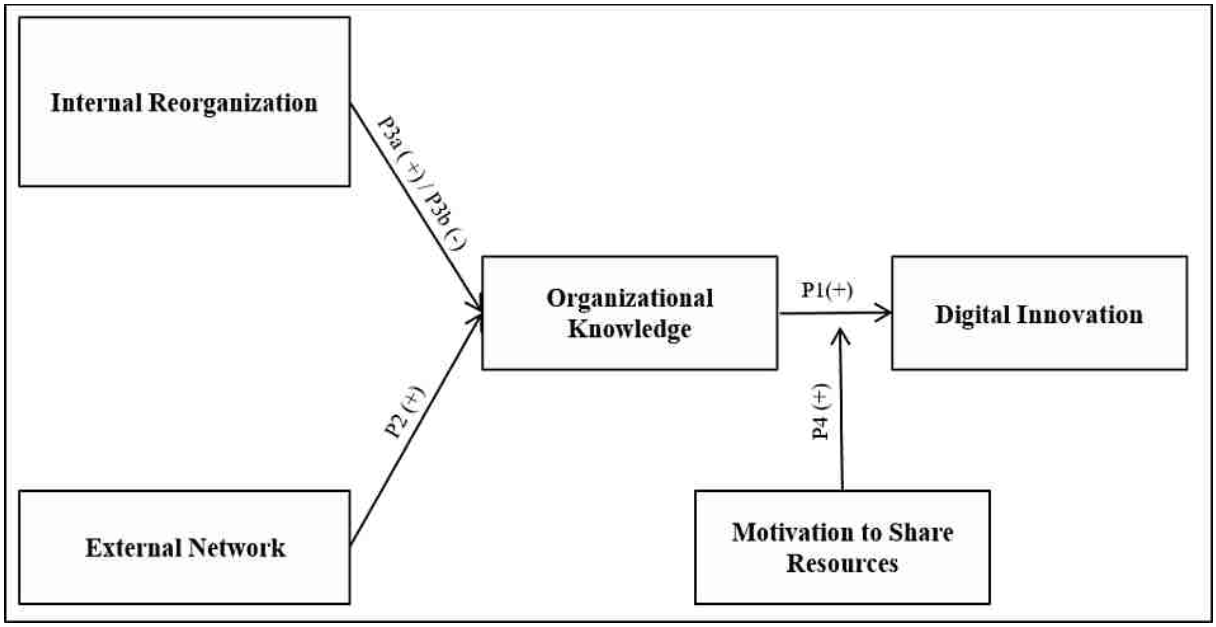

TABLE 1

Overview over Developed Propositions and Supporting Literature

Propositions	Supporting Literature
P1: Organizational knowledge positively influences digital innovation.	Alavi & Leidner, 2001; Altman et al., 2015; Henfridsson et al., 2014; Henfridsson et al., 2018; Kogut & Zander, 1992; Nambisan et al., 2017; Yoo et al., 2010; Yoo et al., 2012
P2: The external network positively influences organizational knowledge.	Afuah & Tucci, 2012; de Man & Duysters, 2005; Hagedoorn & Duysters, 2002; Hildebrandt et al., 2015; Lyytinen et al., 2016; Nambisan et al., 2017; Yoo et al., 2012
P3a: Internal reorganization positively influences organizational knowledge.	Girod & Karim, 2017; Karim, 2006, 2009; Karim et al., 2016; Karim & Kaul, 2015; van der Vegt & Bunderson, 2005
P3b: Internal reorganization negatively influences organizational knowledge.	Benner & Tushman, 2003; Dess & Shaw, 2001; Karim & Kaul, 2015; Kogut & Zander, 1992; Luscher & Lewis, 2008
P4: The motivation to share resources positively moderates the influence of organizational knowledge on digital innovation.	Adler & Kwon, 2002; Etzioni & Putnam, 2001; Kwon & Adler, 2014; Owen-Smith & Powell, 2004; Smith, 2005; Smith et al., 2012

PAPER V

Knowledge Management in the Digital Era:

How Digital Innovation Labs Facilitate Knowledge Recombination

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Hund, A., Holotiuk, F., Wagner, H.-T., and Beimborn, D. 2019b. "Knowledge Management in the Digital Era: How Digital Innovation Labs Facilitate Knowledge Recombination," *Proceedings of the 27th European Conference on Information Systems (ECIS)* (Stockholm-Uppsala, Sweden), https://aisel.aisnet.org/ecis2019_rp/149

PAPER VI

How Digital Innovation Labs Use Knowledge:

Access Strategies and Recombination Paths

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CHAPTER III: MANAGING DIGITAL INNOVATION

PAPER VII

Digital Convergence:

Examining the Dissolution of Industrial and Technological Boundaries

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Müller, L., Hund, A., and Wagner, H.-T. 2022. "Digital Convergence: Examining the Dissolution of Industrial and Technological Boundaries," *Proceedings of the 30th European Conference on Information Systems (ECIS)* (Timisoara, Romania), https://aisel.aisnet.org/ecis2022_rp/88

PAPER VIII

Innovation Networks and Digital Innovation:

How Organizations Use Innovation Networks in a Digitized Environment

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Hund, A., and Wagner, H.-T. 2019. "Innovation Networks and Digital Innovation: How Organizations Use Innovation Networks in a Digitized Environment," *Proceedings of the 14th International Conference on Wirtschaftsinformatik (WI)* (Siegen, Germany),
https://aisel.aisnet.org/wi2019/track06/papers/9/

PAPER IX

Digital Innovation Governance:

A Theoretical Frame and Research Agenda

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1 INTRODUCTION

Digital innovation, which is "the use of digital technology during the process of innovating" (Nambisan, Lyytinen, Majchrzak, & Song, 2017, p. 223), creates competing concerns in which the changes necessary to pursue digital innovation are opposed to existing logics and routines in organizations (Svahn, Mathiassen, & Lindgren, 2017). Kodak is a frequently cited, vivid illustration of a formerly excellent firm of the industrial era that failed to adequately implement these necessary changes (Lucas & Goh, 2009). Even today, and although the pressure to embed digital technology into products and innovation processes is high (Yoo, Henfridsson, & Lyytinen, 2010), only a minority of organizations is prepared to face the challenges related to digital innovation (Kohli & Melville, 2018). This is understandable, since overcoming these challenges requires a departure from established innovation practices and routines as well as profound changes of the organizational identity (Ciriello, Richter, & Schwabe, 2019; Lyytinen, Yoo, & Boland Jr., 2016; Tripsas, 2009).

There are four competing concerns which refer to the tensions between building up new innovation capabilities vs. sustaining existing product innovation practices, product vs. process focus, collaborating internally vs. externally, and favoring control vs. flexibility (Svahn et al., 2017). These competing concerns are not easily resolved since organizations are forced to address opposing forces while enabling profound changes (e.g., Henfridsson & Yoo, 2014; Lee & Berente, 2012). In that regard, the IT governance literature might help identify effective steps to address the competing concerns of digital innovation. While focusing on IT and non-IT parts of the organization, the literature on IT governance has identified mechanisms to balance and resolve tensions on the structural, processual and relational dimensions of organizational arrangements (de Haes & van Grembergen, 2009; Peterson, 2003). In that respect, initial research examines the impact of some governance mechanisms such as the centralization of control rights (Leonhardt, Hanelt, Huang, & Mithas, 2018) and hypothesize an influence of governance choices on digital innovation performance.

Nevertheless, extant research neglects the different roles that governance mechanisms might play in addressing the competing concerns of digital innovation. Thus, our understanding about how and why structural, processual, and relational governance mechanism can be used in the context of digital innovation remains unsystematic and incomplete. To better understand how different types of governance mechanisms address the underlying tension of specific competing concerns, the aim of this review is to: (1) identify different types of governance mechanisms related to innovation in extant literature and systemize them along the structural, processual, and relational dimensions; (2) build upon the insights of the review to theorize how governance mechanisms address the competing concerns of digital innovation; (3) develop promising avenues for future research. Our research question is therefore:

How, if at all, do different types of governance mechanisms address the competing concerns of digital innovation?

To answer our research question, we follow Leidner's (2018) recommendations regarding literature review and theory symbiosis. We first use the three governance dimensions (structural, processual, and relational) as a theoretical framework to identify and classify governance mechanisms in relation to traditional innovation management. In doing so, we uncover different types of governance mechanisms within each dimension and highlight the existing gap in literature on how to govern the competing concerns of digital innovation. Conducting a specific theorizing review (Leidner, 2018) of how different types of governance mechanisms address competing concerns, we develop promising avenues for future research in the form of four research questions and four sets of propositions. Table 1 provides an overview of the topics covered in this paper, the major derived insights, and specifies our contributions.

Topic	Major insight	Our contribution
(IT) Governance	Governance mechanisms (structures, processes, relations) are important to support innovation.	Detailed overview of governance mechanisms related to innovation, categorized along standard IT Governance framework (structural, processual, and relational dimension).
Digital Innovation	Digital innovation challenges established assumptions and creates 4 competing concerns need to be addressed.	We show how the identified governance mechanisms related to (traditional) innovation are applicable to digital innovation and are able to fully address the four competing concerns of digital innovation.
Digital Innovation Governance (this paper)	Digital Innovation Governance, based on set of proven governance mechanisms, can unbalance the status quo and reach a balance more conducive to digital innovation.	Development of a theoretical frame and research agenda for Digital Innovation Governance by putting forward four research questions and developing four sets of propositions that assess the current state of knowledge.

Table 1. Overview of contributions

The structure of this paper is as follows: The next section sets the stage by introducing the relevant concepts. Subsequently, we present the literature review method according to Leidner (2018) before presenting the identified governance mechanisms related to innovation, followed by an explanation about how these mechanisms address the competing concerns of digital innovation. We close by developing detailed research questions for future research on the governance of digital innovation.

2 CONCEPTUAL FOUNDATION

2.1 ORGANIZATION THEORY AND IT GOVERNANCE

To understand the rationale for IT governance, it is important to understand the concept of an organization first. Puranam et al. (2014, p. 163) summarize the insights of numerous scholars about the concept of organization along four dimensions and conceptualize an organization "[…] as (1) a multiagent system with (2) identifiable boundaries and (3) system-level goals (purpose) toward which (4) the constituent agent's efforts are expected to make a contribution […]". Hence, an organization is comprised of more than one agent and these agents are clearly distinguishable from agents outside of the organization. Furthermore,

these individual agents are united under a shared purpose and are supposed to work towards its realization (Puranam et al., 2014). To aid the realization of this purpose, organizations provide a setup, which helps bringing two interrelated problems on a common denominator: The necessity for division of labor while simultaneously ensuring integration of effort (March & Simon, 1993; Mintzberg, 1979). Hence, organization theory deals with the duality of division and integration and the effects on the organization (Mintzberg, 1979). Division of labor "refers to the breakdown of the organization's goals into contributory tasks and the allocation of these tasks to individual members within the organization" to gain specialization benefits (Puranam et al., 2014, p. 165). Integration of effort (or briefly, integration) addresses both cooperation by providing monetary and non-monetary rewards, and coordination by providing information needed to execute tasks and coordinate actions with others (Puranam et al., 2014). Thus, integration is about the realignment of divided tasks that are allocated to different entities of the organization to achieve the overarching organizational purpose (Mintzberg, 1979; Peterson, O'Callaghan, & Ribbers, 2000). The attempt to manage these diametrically opposed mechanisms (e.g., Venkatram, 2000) embodies the dilemma of organizational design.

In an attempt to address the duality of division and integration with particular focus on IT and non-IT parts of the organization, the IT governance literature subdivides organizational arrangements into three mutually exclusive and collectively exhaustive dimensions – structural, processual, and relational (de Haes & van Grembergen, 2009; Peterson, 2003). While there are various definitions of IT governance, which "differ on some aspects, they are all mainly focused to the same issues, such as the link between business and IT" (Van Grembergen, de Haes, & Guldentops, 2004, p. 4), these three dimensions are accepted in the literature as the "now-standard framework" of IT governance (Wu, Straub, & Liang, 2015, p. 506). Within all of these three dimensions, changes are required to embrace digital innovation. In that regard, Svahn et al. (2017) argue that, for example, by creating a new business unit entrusted with exploring digital innovation (structural dimension), workflows between the existing unit and the new unit (processual dimension) are affected as well as the interpersonal proximity between individuals from different units (relational dimension).

2.2 DIMENSIONS OF GOVERNANCE – STRUCTURAL, PROCESSUAL, RELATIONAL

Structural dimension. In its most basic form, the structural dimension is about the differentiation between different entities of the organization by formally establishing structures and hierarchies (Mintzberg, 1980). In addition, this dimension provides structural procedures and mechanisms to enable cooperation and coordination between the structural elements, i.e., entities of the organization (de Haes & van Grembergen, 2009; Peterson, 2003). Thus, the structural dimension refers to both the division of an organization into separate entities and the integration of effort across these separated entities, for example, by defining roles and responsibilities and establishing advisory boards and steering committees (Peterson, 2003; van Grembergen et al., 2004). The result of these activities is a certain organizational structure which directly affects the performance measures of a company as it determines whether units must compete for resources

or are aligned to work together (DeCanio, Dibble, & Amir-Atefi, 2000). Additionally, these authors state that structural changes alter how closely units are connected and how they communicate with each other.

Processual dimension. The processual dimension includes every measure or routine that facilitates the integration between the organizational entities through formalizing working routines, monitoring or decision-making (de Haes & van Grembergen, 2009; Mintzberg, 1980). Therefore, the focus is on facilitating and formalizing workflows by establishing mechanisms such as balanced scorecards or service level agreements (Peterson, 2003; van Grembergen et al., 2004). The processual dimension is particularly affected by characteristics of digital technology. For example, Lyytinen et al. (2016) describe how digital technology alters innovation processes by enabling different forms of innovation networks through cost-efficient communication and coordination (Altman, Nagle, & Tushman, 2015). In the same vein, Yoo et al. (2012) demonstrate the possibility of distributed innovation processes via the emergence of digital platforms bringing about new challenges for the integration of different organizational entities. Hence, companies are challenged to fully understand and manage the new logics of digitized innovation processes (Nylén & Holmström, 2015).

Relational dimension. The relational dimension embodies every effort that helps different entities within the organization not only to work together (formally) but also to better understand one another. Relational mechanisms are not directly aiming at value creation or process improvement but are rather "[…] explicitly intended to bring people together in an environment in which they can exchange ideas and learn both from each other and together" (Schlosser, Beimborn, Weitzel, & Wagner, 2015, p. 10) and, thus, serve the purpose of fostering collaborative relationships (de Haes & van Grembergen, 2009). Changes in other dimensions such as the structural dimension oftentimes go hand in hand with strategic realignment and create considerable uncertainty about resource allocation, thereby fostering competitive thinking between different entities (Galunic and Eisenhardt 1996; Galunic and Eisenhardt 2001). Thus, employees are not only confronted with functional but also with social changes (Amabile and Conti 1999) and managers oftentimes struggle with making sense out of the altered circumstances (Luscher and Lewis 2008). Therefore, even if the structural and processual dimensions are managed well, relational mechanisms are paramount to realign diverging perspectives among different entities (Callahan et al. 2004; Keil et al. 2002). Interpersonal relationships have been found to be especially important for successful coordination (Ferris et al., 2009). The increased use of digital technology alters how employees interact and coordinate with one another (e.g., outlook-calendar) and, thereby, reduces face-to-face interactions that are not mediated through digital technology (Claggett & Karahanna, 2018). For companies, it is paramount to understand how digital technology can be used to create and maintain connections between people, which create mutual understanding (Feldman & Rafaeli, 2002). Hand in hand with the ubiquity of digital technology, organizational day-to-day structures, processes, and relations are increasingly imbued with and shaped by digital technology (Lyytinen et al., 2016; Tripsas, 2009). Organizations strive to create new value offerings to their customers by embedding

digital technology into their products and services (Yoo et al., 2010).

2.3 THE FOUR COMPETING CONCERNS OF DIGITAL INNOVATION

Digital technology enables new ways for value creation and innovation, for example by embedding digital technology in physical products (Yoo et al., 2010). Doing so has already changed entire industries as illustrated by the widespread emergence of digitized products (e.g., smartphones, e-books), services (apps, automated investment algorithms) and entire business models (e.g., Netflix, Spotify) (Fichman, Dos Santos, & Zheng, 2014; Teece, 2010). Organizations that are not responsive to these opportunities are in danger of quickly losing their market position (Lucas & Goh, 2009). Yet, the competing concerns arising through digital innovation pose challenges which require new ways of governance. Svahn et al. (2017) outline four competing concerns, which arise when an organization embraces digital innovation and is forced to make organizational changes.

Capability: existing versus requisite. When embracing digital innovation, organizations experience a tension between existing innovation capabilities and the need to build up new innovation capabilities (Svahn et al., 2017). Developing novel capabilities is paramount in order to recognize new opportunities (Henfridsson & Yoo, 2014). To enable the development of novel innovation capabilities, organizations must find ways to "[…] break up the silo mentality, and cross-fertilize the organization" (Svahn et al., 2017, p. 248) with ideas from within the organization but also from external sources (Selander, Henfridsson, & Svahn, 2010). These changes oftentimes require the organizational culture (Lucas & Goh, 2009) as well as identity (Tripsas, 2009) to change.

Focus: product versus process. Another competing concern arises due to the tension between a focus on releasing digitized products and developing entirely new processes and designs to align with the possibilities of digital technology (Svahn et al., 2017). This tension is exacerbated since digital innovation thrives through the ease with which digital resources can be combined and recombined (Yoo et al., 2010). Since there are nearly endless opportunities for recombination the development of digital innovation usually lacks a long-term vision and products are perceived to remain incomplete (Yoo et al., 2012). For managers, this creates a tension between the necessity to focus on finalizing and offering products, while simultaneously focusing on the process of innovation (Svahn et al., 2017)

Collaboration: internal versus external. Additionally, the necessity to foster collaboration within the organization while simultaneously engaging with expertise from beyond the organizational boundaries creates another competing concern (Svahn et al., 2017). Since digital innovation is oftentimes created through the convergence of previously disparate parts or expertise (Yoo et al., 2012), collaborating only internally bears the risk of missing opportunities that only exist when collaborating across firm boundaries (e.g., Lyytinen et al., 2016). Thus, embracing digital innovation leads to increasingly blurring organizational boundaries, thereby, exacerbating the competing concern between internal and external collaboration (Nambisan et al.,

2017).

Governance: control versus flexibility. Lastly, in order to explore the potential of digital technology, organizations must allow for sufficient flexibility while simultaneously maintaining control. This creates another competing concern (Svahn et al., 2017). Hence, organizations must "[…] "establish governance mechanisms that appropriately bound participant behavior without excessively constraining the desired level of generativity" (Wareham, Fox, & Cano Giner, 2014, p. 1195). This is a delicate balance, since high levels of flexibility are necessary to enable exploration and collaboration with external actors, yet simultaneously organizations must remain control over the value appropriation (Boudreau, 2010; Svahn et al., 2017).

3 METHOD

Our study follows Leidner's (2018) recommendations about review and theory symbiosis. To answer our research question (How, if at all, do different types of governance mechanisms address the competing concerns of digital innovation?), we first carried out an assessing review to identify governance mechanisms in the extant literature. While there are numerous articles that focus on governance of innovation, there is a gap regarding the governance of digital innovation. This gap then formed the starting point for the specific theorizing review. In the following, we will describe our methodology in detail.

In assessing reviews, "theory is used as an a priori organizing device […] to identify those areas of the theory that have been understudied and those that have been overstudied" (Leidner, 2018, p. 556). We use the three dimensions of governance (structural, processual and relational) as an a priori theoretical framework and adopt a positivist stance to identify and classify governance mechanisms and potential gaps in the literature (Leidner, 2018; Paré, Trudel, Jaana, & Kitsiou, 2015). To get a broad overview of relevant fields of research, we began by running different combinations of keyword-based searches (e.g., "govern*", "organi*", "innovat*") in popular meta-databases (EBSCO Business Source Ultimate, Google Scholar, Web of Science). After having a broad overview of the literature and identifying relevant fields of research, we used the 65th edition of the Journal Quality List, which is a meta-ranking, summarizing the results of 12 internationally acclaimed rankings such as Financial Times 50 and ABDC (Harzing, 2019) to identify other top journals in each field. In the end, we selected 18 journals from six different fields of research, all of which are ranked as leading within their fields across the majority of the 12 rankings. Since the influence of pervasive digitization and innovation is a rather contemporary topic, we limited the period of our initial search to the last decade. A paper was deemed relevant if it included the keyword 'innovat*' in combination with one or more keywords centering on governance or organization-related aspects (see Figure 1) in the title or in the keywords. We compiled this list of keywords by focusing on the three dimensions of governance mechanisms related to innovation and iteratively refined the keywords, until the final search criteria became manifest. The initial search returned 61 articles, which the first and second authors read entirely to identify rele-

vant governance mechanisms. Within these 61 articles, we identified 18 articles that address such mechanisms. After discussing our insights with all four authors, the 18 articles were then used as basis for a full backward (1554 articles) and forward (1032 articles) search (Webster & Watson, 2002) in the Web of Science database. From these we excluded 162 duplicates and non-peer-reviewed articles and then ran a keyword search on the remaining 2424 articles (based on the same keywords as used in the initial search), which returned 21 relevant articles. Hence, our final sample consists of 39 articles and represents a comprehensive overview of relevant articles on governance mechanisms related to innovation. Figure 1 depicts the entire search process:

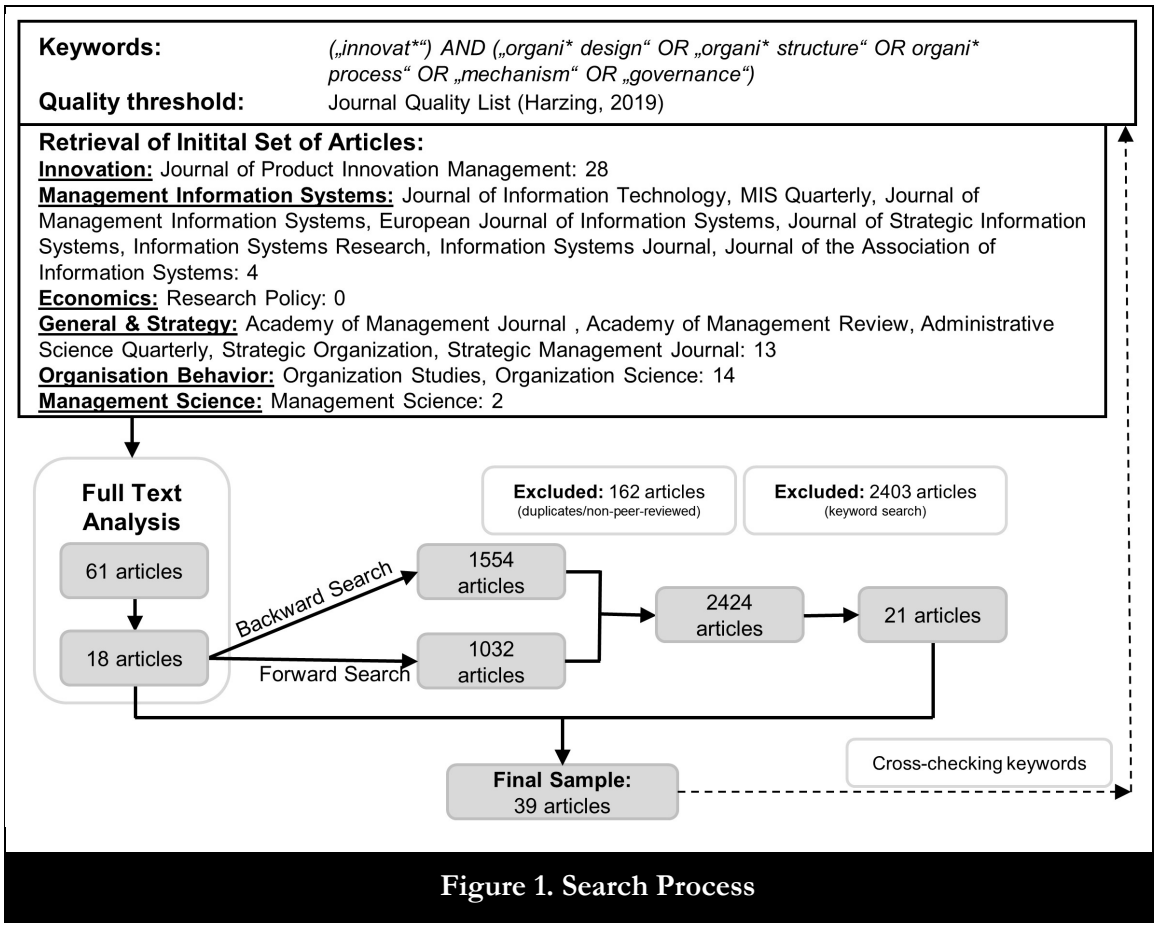

Figure 1. Search Process

The first and second author then read the 39 articles in detail, identifying and coding governance mechanisms related to innovation. Subsequently, each identified mechanism was discussed amongst all four authors to ensure a shared understanding and a consistent categorization. To determine whether specific governance mechanisms relate to the structural, processual, or relational dimension, we established coding rules based on seminal works in the IT governance literature (e.g., de Haes & van Grembergen, 2009; Mintzberg, 1979, 1980; van Grembergen, 2004) as depicted in Table 2.

Structural dimension	Mechanisms in the structural dimension affect the formally established organizational entities or hierarchy levels within an organization.
Processual dimension	Mechanisms in the processual dimension affect the coordination or the cooperation between the organizational entities, e.g., through formalizing working routines, monitoring or decision-making.
Relational dimension	Mechanisms in the relational dimension affect efforts that help different entities within the organization to develop mutual understanding.

Table 2. Coding Rules – Structural, Processual, Relational Dimension

After categorizing each identified governance mechanism into one of the three dimensions, we grouped mechanisms within each dimension into different types. Mechanisms within one type are similar to one another because they address the same aspects of governance and vice versa. For example, all four of the mechanisms of the "Team Structure" type (see Table 3) address the basic structure of a team in terms of who leads it and how the team relates to the rest of the organization. The "Team Characteristics" type, on the other hand, contains only mechanisms that define how a team performs its work, for example by defining the number of goals a team pursues or by determining the degree of diversity of perspectives within the team. An overview of all 49 identified governance mechanisms related to innovation – differentiated by 15 types and the structural, processual, and relational dimensions – is shown in Tables 3, 4, and 5 (see results section below). While these tables depict numerous detailed accounts about how to govern the challenges related to traditional innovation, our results highlight that there is a gap in extant literature regarding the governance of digital innovation.

The identified gap is the starting point for a specific theorizing review in which we bring together insights from our review and insights from the extant literature on digital innovation. This is in line with Leidner (2018, p. 556), who recommends to use "a separate stream of literature [...] with a specific focus on extracting insights relevant to filling the gap". These relevant insights come from Svahn et al. (2017), who have identified four competing concerns, which refer to the tensions between building up new innovation capabilities vs. sustaining existing product innovation practices, product vs. process focus, collaborating internally vs. externally, and favoring control vs. flexibility. These four competing concerns arise when organizations embrace digital innovation (Svahn et al., 2017). To conceptually distinguish between the four competing concerns, we first identified the respective underlying tensions of each competing concern. Based on these insights, we then derived four research questions that have to be addressed to better understand how the competing concerns of digital innovation can be governed. Within each research question the "assessment of what we know […] leads to a set of principal propositions summarizing knowledge accumulation", which is similar to the approach of Melville et al. (2004, p. 299). In our case, we develop four sets of propositions that theorize how specific types of governance mechanisms address each competing concerns of digital innovation.

4 RESULTS: GOVERNANCE MECHANISMS RELATED TO INNOVATION

The findings of our literature review are depicted in Tables 3, 4, and 5. Since our interest is in synthesizing knowledge about governance mechanisms related to innovation, each table summarizes our findings within one of the governance dimensions (structural, processual, relational) and shows the identified types of governance mechanisms within the respective dimension. In total, we identified 20 structural mechanisms, 20 processual mechanisms, and 9 relational mechanisms. The first column of Tables 3, 4, and 5 contains the type of governance mechanisms, the second column states the name of mechanism highlighted in bold, briefly explains the mechanism, and clarifies how it relates to innovation.

4.1 STRUCTURAL GOVERNANCE MECHANISMS

Table 3 contains governance mechanisms related to innovation categorized in the structural dimension. As stated above, mechanisms in the structural dimension affect the formally established organizational entities or hierarchy levels within an organization.

Governance Mechanism Type	Name of Structural Mechanism and Explanation
Organization structure	**Flat organizational structures** reduce the need for vertical coordination and enable close connection between R&D and the market. For innovation, flat organizational structures are found to help reacting to market turbulence and lower process time (Buganza et al. 2009). **Creation, deletion, or recombination of entities** are mechanisms to change the structural makeup of an organization. Each mechanism can lead to new knowledge networks and increase innovative power, but it can also destroy valuable existing networks and decrease innovative power (Karim and Kaul 2015). **Multi-location.** Geographic location is about the physical location of units and departments. Multi-location – the dispersion of innovation activities across various locations - has a positive impact on imitative innovation and facilitates sourcing of external knowledge (Leiponen and Helfat 2011).
Leadership structure	**Centralized leadership** is a mechanism that bundles the decision rights of a CEO and board chairman in one person. For innovation, centralized leadership is found to have a positive effect on sustainable innovation capability (Xu and Bai 2019). **Team leadership structure** indicates whether a project lead is implemented full-time or part-time. Full-time is associated with radical-innovation projects, whereas part-time is associated with incremental-innovation (Holahan et al. 2014).
Team structure	**Autonomous teams** are independent from the main organization. Members are co-located and follow a project leader who controls resources and performance evaluation. They are freed from organizational bureaucracy and excel in projects involving radical innovations and novel technology (Patanakul et al. 2012). **Functional teams** recruit members according to their discipline. The different disciplines are coordinated by the manager of the respective department. For innova-

	tion, this enables bringing together experts from one field, yet hinders cross-functional exchange (Patanakul et al. 2012). **Lightweight teams** are comparable to functional teams, with the difference that some cross-functional exchange is enabled by a project manager. The project leader functions mainly as liaison person but not as project leader. For innovation, lightweight teams offer the same advantages as functional teams and additionally some level of cross-functional exchange (Patanakul et al. 2012). **Heavyweight teams** are led by a project leader with high levels of authority. Team members are focused and closely located. For innovation, heavyweight teams facilitate cross-functional exchange but have to compete for resources within the organization. Heavyweight teams are best suited for incremental innovation (Patanakul et al. 2012).
Team characteristics	**Identifiable innovation team** is about delineating who is in charge of pursuing innovation. This enables focus on innovation, the accumulation of knowledge and assessment of the results with fitting criteria (O'Connor 2008). **Amount of objectives** a team has to juggle and, thereby, the level of complexity. While certain levels of complexity are unavoidable, overwhelmingly complex projects can lead to disengaging team members (Edmondson and Nembhard 2009). **Diversity of perspectives** within a team. High levels enable broader perspectives, yet also entail different mental models, which impede team communication. The level of cross-functionality within a team must be governed according to the pursued innovation outcome (Edmondson and Nembhard 2009). **Team membership duration** is a mechanism to determine the amount of time that individuals work together in a team setting. Up to three years improves the work dynamics within a team. Beyond three years, the increasing stability deteriorates innovation outcomes (Edmondson and Nembhard 2009). **Fluidity of team boundaries.** High levels make collaboration within the team more difficult but help avoid groupthink while also allowing to building a broader network. For innovation, governing the level of boundary fluidity when designing a team is important (Edmondson and Nembhard 2009). **Level of embeddedness** in organizational structure. High levels lead to competition for resources, yet also enables building up boundary-spanning capabilities. For innovation, governing the level of embeddedness when designing a team is important (Edmondson and Nembhard 2009). **Level of autonomy** is a mechanism for clarifying the level of autonomy when making decisions about issues such as pace or method of work in larger groups or teams. For innovation, higher work autonomy is found to a create work environment, which is important for innovation activities (Cho et al. 2019).
Reporting line	**Structural hierarchy** is about the level of managerial oversight necessary to carry out work. Higher levels of managerial oversight reduce the generation of innovative ideas but improves the selection of ideas (Keum and See 2017). **Direct supervision** involves defined restrictions on and close monitoring of employees who are only allowed to perform predefined tasks. With a high level of direct supervision, the supervisor bears full responsibility for every performance (Dekoulou and Trivellas 2017).

Flexibility injecting structures	**Alliances** are a mechanism that enables firms to respond more flexibly to changing environments. For innovation, such flexibility enables faster development (Eisenhardt et al. 2010). **Quality circles** provide a structure in which employees can alternate between organic and bureaucratic structures. For innovation, this helps addressing non-routine and routine tasks (Raisch et al. 2009).

Table 3. Structural Governance Mechanisms Related to Innovation

4.2 PROCESSUAL GOVERNANCE MECHANISMS

Table 4 contains governance mechanisms related to innovation which are categorized in the processual dimension. As stated above, mechanisms in the processual mechanisms affect the coordination or the co-operation between the organizational entities, e.g., through formalizing working routines, monitoring or decision-making.

Governance Mechanism Type	Name of Processual Mechanism and Explanation
Leadership style	**Directive leadership** is characterized by high levels of manager's engagement in the operative work. Thereby, causing higher levels of formalization and lower levels of autonomy amongst team members. For innovation, directive leadership is associated with more knowledge integration (Gebert et al. 2010). **Delegative leadership** is about lower levels of direct manager engagement, which enables team members to make decisions more autonomously. For innovation, delegative leadership is associated with more knowledge generation (Gebert et al. 2010). **Leadership commitment** facilitates innovation processes by demonstrating commitment to innovation through mechanisms such as long-term investments and allocating resources to innovation teams. Leadership commitment is related to higher innovativeness (Holahan et al. 2014).
Process flexibility	**Skipping and overlapping stages** within the innovation process is a mechanism used to enable changing between different development stages. For innovation, this increases the process flexibility, which is found to be particularly helpful for incremental innovation processes (Holahan et al. 2014). **Delay of concept freezing point** enables changes in the product up until the final release. For innovation, delaying the concept freezing point helps managing market and technology turbulences (Buganza et al. 2009). **Rapid project iterations** are possible by using flexible technologies, overlapping process phases etc. For innovation, rapid project iterations are particularly helpful in managing technological turbulence (Buganza et al. 2009). **Use of heuristics** are simple rules that give guidance for problem solving, while allowing for highly flexible processes. For innovation, the use of heuristics enables more improvisation and generally higher levels of flexibility within an organization (Eisenhardt et al. 2010).

Evaluation	**Lead users** increase the likelihood of identifying and recognizing new opportunities. For innovation, mechanisms related to the recognition of new opportunities are found to strengthen a firm's value innovation ability (Berghman et al. 2012). **Early idea management** describes the level of formality in idea development. Informal mechanisms are e.g., slack time to develop ideas. Formal mechanisms include e.g., brainstorming or competitor analysis. For innovation, formal mechanisms are associated with radical innovation, informal mechanisms with incremental innovation (Holahan et al. 2014). **Experiments with customer involvement** enable the consideration of customer knowledge from beyond the organizational boundaries during development. For innovation, such experiments are helpful in addressing market turbulence (Buganza et al. 2009). **Go/Kill decisions** represent the initial evaluation stage for innovation projects. Following real-options theory, a go/kill decision can improve investment decisions and, thereby, improve innovation processes (O'Connor 2008). **Appropriate metrics** are necessary to enable requisite processes and efficient budget allocation. To support innovation, performance- as well as activity-based metrics are required (O'Connor 2008). **Project reviews** ensure the regular analysis of what made a project a success or failure. This helps highlighting what has been learned and facilitates communicating the learnings (Tsai et al. 2015).
Incentives	**Managerial equity ownership** is an incentive-based governance mechanism. In innovative firms, incentive-based governance is helpful in motivating managers and improving resource usage (He and Wang 2009). **Compensation based on firm performance** is an incentive-based governance mechanism. In innovative firms, incentive-based governance is helpful in motivating managers and improving resource usage (He and Wang 2009). **Director compensation** is a mechanism to directly motivate and steer director behavior in a specific direction. For innovation, director compensation is found to have a positive impact on sustainable innovation capability (Xu and Bai 2019).
Coordinative linking activities	**Joint decision-making and planning** about resource deployment are mechanisms that link different activities, which is critical to enable firms to independently explore new technologies while simultaneously staying in touch with extant complementary assets (Taylor and Helfat 2009). **Cross-functional discussions** help clarify and assimilate information about markets and customers. For innovation, mechanisms related to the assimilation of information are found to strengthen a firm's value innovation ability (Berghman et al. 2012).
Talent management	**Identification of key positions** is a mechanism to identify systematically important positions, which enable a competitive advantage for the organization. For innovation, mechanisms related to talent development are found to positively influence the effectiveness of innovation processes (Cho et al. 2019). **Talent pool development** is a mechanism to develop and ensure the continued commitment of high-potentials, which are needed to fill key positions. For innovation,

	mechanisms related to talent development are found to positively influence the effectiveness of innovation processes (Cho et al. 2019).

Table 4. Processual Governance Mechanisms Related to Innovation

4.3 RELATIONAL GOVERNANCE MECHANISMS

Table 5 contains relational governance mechanisms related to innovation. As stated above, mechanisms in the relational dimension affect efforts that help different entities within the organization to develop mutual understanding.

Governance Mechanism Type	Name of Relational Mechanism and Explanation
Organization-wide mechanisms	**Tying innovation goals to business strategy** helps align the objectives between innovation and business unit, which increases cross-functional integration. Cross-functional integration can facilitate innovation process between different functions (Holahan et al. 2014). **Create shared vision** in order to align the mental models, language and culture. For innovation, a shared vision facilitates communication between employees and enables better innovation outcomes (Crockett et al. 2013). **Transformational leadership** inspires employees, transforms their personal values, and expectations. For innovation, transformational leadership is found to have a positive influence on organizational learning (Gumusluoğlu and Ilsev 2009; Sattayaraksa and Boon-itt 2016). **Incentivizing personal relationships,** for example through promotion criteria, is a mechanism to enable meaningful knowledge exchange with sources beyond the organizational boundaries. Such exchanges are related to successful innovation (O'Connor 2008).
Inter-team mechanisms	**Boundary-spanning team training** helps integrate different teams in a cross-functional way. Cross-functional integration can facilitate understanding between different functions and improve innovativeness (Holahan et al. 2014). **Participation in personal discussions and transferal of documented insights** are mechanisms that help units in charge of exploration to stay in touch with extant units and increases mutual understanding. For innovation, mechanisms related to the communication between teams is found to be important to successfully transition towards new technologies (Taylor and Helfat 2009). **Interaction with project teams.** Regular, informal interaction between decision-making boards and project teams increase the mutual trust. For innovation, trust-based relationships are found to enable higher levels of creativity and, thus, innovativeness (Robeson and O'Connor 2013).
Intra-team mechanisms	**Team coaching** is about interacting directly with a team to improve team coordination and the use of resources. Team coaching has a direct impact on the support for innovation (Rousseau et al. 2013). **Reducing physical distance** as mechanism to improve team proximity, which im-

	proves team communication when teams experience challenging time pressure. For innovation, higher levels of communication between team members positively influences innovation (Chong et al. 2012).

Table 5. Relational Governance Mechanisms Related to Innovation

In summary, the findings of our literature review provide an overview of 15 types of governance mechanisms containing 49 specific structural, processual, and relational mechanisms related to innovation. Building upon these findings, we now set out to better understand the role that these types of governance mechanisms play in resolving the competing concerns of digital innovation.

5 DISCUSSION: DIGITAL INNOVATION GOVERNANCE TO UNBALANCE AND REBALANCE A FIRM'S STATUS QUO

As explained above, digital innovation involves four competing concerns. Each competing concern is caused by the need to embrace digital innovation while working with structures, processes and relations, originally designed for industrial era manufacturing (Svahn et al., 2017). We discuss the underlying tension within each competing concern and derive four questions relevant for future research that must be addressed to understand how the challenges that arise when embracing digital innovation can be governed. By assessing what we already know within each question, we develop four sets of propositions (see Melville et al., 2004 for a similar approach) that theorize how different types of mechanisms within the structural, processual, and relational dimension address the four competing concerns of digital innovation.

Since organizations tend to "drift toward efficiency, […] balancing efficiency and flexibility comes, counterintuitively, through unbalancing to favor flexibility" (Eisenhardt et al., 2010, p. 1263). The notion that unbalancing the status quo is necessary before rebalancing and finding a new equilibrium is in line with Lewin's seminal writings that assert that change is managed by unfreezing the status quo before changing and refreezing (cf. Cummings, Bridgman, & Brown, 2016; Lewin, 1947). In the same vein, we argue that digital innovation governance requires addressing the underlying tension of each competing concern individually, by unbalancing the existing status quo and finding a new balance between the extremes of a competing concern through favoring those sides that are conducive to digital innovation. First, the competing concern of innovation capability with its tension between existing innovation capabilities and the need to build up new innovation capabilities needs to be unbalanced toward building more requisite capabilities. Second, the competing concern of focus with its tension between product and process focus needs to be unbalanced toward becoming more process-oriented. Third, the competing concern of innovation collaboration with its underlying tension between internal and external collaboration needs a shift toward more external collaboration. Fourth, the competing concern of governance with its underlying tension between control versus flexibility needs to be unbalanced to favor flexibility in order to explore the potential of digital technology. While unbalancing the status quo can lead initially to increasing tensions, these changes are

necessary to overcome existing rigidities and find a new balance within each competing concern that is conducive to the requirements of digital innovation.

5.1 UNBALANCING CAPABILITY: EXISTING VERSUS REQUISITE

When embracing digital innovation, organizations experience a competing concern between already existing capabilities and the need to build up new, requisite capabilities. "This creates tensions between employees who seek to bring about change and those whose capabilities have become core rigidities. Such rigidities cause competency traps, inhibiting effective responses to digital options" (Svahn et al., 2017, p. 239). To overcome these rigidities, organizations must gradually unbalance towards the creation of new, requisite capabilities. Developing such requisite capabilities is paramount in order to recognize new opportunities (Henfridsson & Yoo, 2014). Since digital innovation typically requires input from various areas of expertise (Yoo et al., 2012), most firms participate in innovation networks (Lyytinen et al., 2016) and platforms (Tiwana, Konsynski, & Bush, 2010) to tap into skills and knowledge beyond the organizational boundaries. Particularly, in the context of digital innovation the cross-disciplinary input from various areas of expertise is necessary to support the ongoing reinterpretation of outcomes and processes to identify new opportunities (Nambisan et al., 2017). Yet, while the access to cross-disciplinary expertise is important for digital innovation (Yoo et al., 2012), firms must find ways to foster it without jeopardizing existing capabilities (Svahn et al., 2017). Furthermore, since established routines and beliefs filter how new technological opportunities are interpreted, profound changes, which "necessitate a shift in the firm's identity—a potentially traumatic and disruptive process", are necessary (Tripsas, 2009, p. 442). Since such shifts typically create strong tensions between existing organizational entities and new entities that follow other logics, organizations are experimenting with setting up new structures (Holotiuk & Beimborn, 2019) and processes (Henfridsson, Mathiassen, & Svahn, 2014) to "[…] break up the silo mentality, and cross-fertilize the organization" (Svahn et al. 2017, p. 248). These insights lead to research question 1:

How do specific types of governance mechanisms in the structural, processual, and relational dimension affect the competing concern between the need to maintain existing innovation capabilities while simultaneously building up new, requisite innovation capabilities?

In the following, we develop three propositions that theorize how governance mechanisms from the structural, processual, and relational dimension can help govern the competing concern between already existing capabilities and the need to build up new, requisite capabilities.

Structural dimension. To build up requisite capabilities, organizations must transcend the functional silos and foster cross-functional cooperation, for which three types of structural governance mechanisms are particularly suited. First, if an organization encounters high levels of inertia and resistance to cross-functional exchange, mechanisms that alter the organization's structure such as the creation, deletion or recombination

of entities (Karim & Kaul, 2015) can help shake up and unbalance established "structures to reduce 'organizational cholesterol'" (Girod & Karim, 2017, p. 130). Second, team structure mechanisms such as heavyweight teams and autonomous teams (Patanakul et al., 2012) both enable high degrees of cross-functionality and disturb the previously found balance with its focus on existing capabilities. While autonomous teams are the better choice for rather radical innovation projects involving novel technology, heavyweight teams excel in incremental innovation (Patanakul et al., 2012). Third, when setting up such teams, team characteristic mechanisms are particularly important to ensure a high diversity of perspectives as well as a high fluidity of team boundaries. By including a broad diversity of perspectives within a team the access to and integration of new knowledge is facilitated (Edmondson & Nembhard, 2009). Fluidity of team boundaries also ensures higher levels of boundary-spanning cooperation and, thereby, cross-fertilization (Edmondson & Nembhard, 2009). Additionally, organizations may set up an identifiable innovation team as a dedicated structure, which creates a space to accumulate knowledge about innovation (O'Connor, 2008).

P1: Structural governance mechanisms that foster cross-functional exchange help address the competing concern about innovation capabilities by unbalancing toward the development of more requisite innovation capabilities.

Processual dimension. To support changes in the structural dimension, there are two types of processual mechanisms that are particularly suited. First, mechanisms related to evaluation such as the development of appropriate metrics (O'Connor, 2008) are necessary when setting up an innovation team to provide alternative success criteria when commercial success is infrequent. Here, performance-based as well as activity based metrics are recommended (O'Connor, 2008). This is especially true for digital innovation since the monetary value does oftentimes not determine the level of success adequately (Brynjolfsson & Oh, 2012). Second, coordinative linking activities such as joint decision-making and planning about resource deployment (Taylor & Helfat, 2009) will support the successful pursuit of higher levels of cross-functionality. Coordinative linking activities facilitate staying in touch with extant departments, while not restricting the exploration of new technologies (Taylor & Helfat, 2009). It is therefore important that organizations gradually increase the levels of cross-functionality and must be prepared to address tensions between extant and newly built-up structures & processes (Svahn et al., 2017).

P2: Processual governance mechanisms that enable the exploration of new technologies through performance- and activity-based evaluation criteria and ensure continuous exchange between different departments address the competing concern about innovation capabilities by unbalancing toward developing more new, requisite innovation capabilities.

Relational dimension. To address the competing concern between already existing capabilities and the need to build up new, requisite capabilities, three types of relational mechanisms are particularly suited. First, since shared beliefs and assumptions among different parts of the organization are critical for continued

exchange between different organizational entities, mechanisms relating to organization-wide mechanisms such as tying innovation goals to business strategy and the creation of a shared vision are important. While tying innovation goals to business strategy helps align the objectives between innovation and business units and, thereby, increases cross-functional integration (Holahan et al., 2014), a shared vision fosters aligned mental models and a shared language (Crockett et al., 2013). Second, mechanisms related to inter-team initiatives such as boundary-spanning team trainings help integrate different teams in a cross-functional way, which enhances the understanding between different functions (Holahan et al., 2014). Third, mechanisms related to intra-team initiatives such as team coaching and the reduction of physical distance can improve team coordination and communication, which can lead to a generally higher support for innovation (Chong et al., 2012; Rousseau et al., 2013).

P3: Relational governance mechanisms that foster shared assumptions across an organization help address the competing concern about innovation capabilities by unbalancing toward the development of requisite innovation capabilities.

5.2 UNBALANCING FOCUS: PRODUCT VERSUS PROCESS

Organizations typically have a "prevailing product focus [, which makes] managers ask about the specific functions", while digital innovation oftentimes requires a shift towards focusing on ongoing processes and designs without specifying functions upfront (Svahn et al., 2017, p. 241). Since digital innovation thrives through the ease with which digital resources can be combined and recombined (Yoo et al. 2010), organizations must remain flexible and harness the opportunities of digital technology (Henfridsson et al., 2014). Since there are nearly endless opportunities for recombination, the development of digital innovation usually lacks a long-term vision and remains "somewhat incomplete and in a state of flux where both the scale and scope of the innovation can be expanded by various participating innovation actors" (Nambisan et al., 2017, p. 225). Moreover, digital technology enables the creation of digital prototypes, which facilitates constant iterations at unprecedented low costs (Austin, 2016). For managers, this creates a competing concern between the necessity to focus on finalizing and offering products, while simultaneously focusing on an ongoing innovation process to further improve and expand digital offerings (Svahn et al. 2017). Put differently, to embrace digital innovation, a stronger focus on continuous product evolution is necessary, which goes against the prevailing focus on specifying and finalizing products (Svahn et al., 2017). This leads to research question 2:

How do specific types of governance mechanisms in the structural, processual, and relational dimension affect the competing concern between a product versus a process focus?

In the following, we develop three propositions that theorize how governance mechanisms from the structural, processual, and relational dimension can help govern the competing concern between a focus on releasing digitized products and developing entirely new processes and designs.

Structural dimension. Since organizations have typically a stronger focus on products rather than processes, they experience tensions when shifting their focus more strongly on processes (Svahn et al., 2017). In the structural dimension, there is often a "fundamental mismatch between the existing organizational structures" and the more flexible, ongoing approaches necessary to harness the opportunities offered by digital technology (Henfridsson et al., 2014, p. 35). Thus, there are oftentimes changes in the underlying organization structure necessary to shift the focus more towards processes. To enable ongoing innovation processes, three types of structural governance mechanisms are particularly promising. First, mechanisms that enable changes of an organization's structure such as setting up flat organizational structures reduce the need for coordination, increase flexibility, and help maintain close contact to market changes (Buganza et al., 2009), which allows continuously evaluating (and thus further developing) products accordingly. Furthermore, since digital innovation typically requires insights from various areas of expertise (Yoo et al., 2012) employees need support from structures that enable them to deviate from routine tasks and engage in ongoing digital innovation processes. Here, mechanisms that aim at flexibility injecting structures such as quality circles are therefore a valuable addition, since they provide a structure for employees to switch between routine and non-routine tasks (Raisch et al., 2009). Moreover, to support ongoing innovation processes, organizations rely on governance mechanisms that affect the generation and selection of innovative ideas. Here, mechanisms related to reporting line such as the structural hierarchy, which determines the level of managerial oversights, can help balance the generation and selection of innovative ideas (Keum & See, 2017). Therefore, depending on what is needed to increase continuous product evolution, the level of oversight has to be adjusted. More oversight is "detrimental to idea generation but beneficial to selection performance" (Keum & See, 2017, p. 661). Hence, if an organizations requires more innovative ideas generation, the level of managerial oversight should be decreased; if a better selection of ideas is desirable, then the level of managerial oversight should be increased.

P4: Structural governance mechanisms that enable more flexibility in an organization's structure and influence the generation and selection of innovative ideas address the competing concern about innovation focus by unbalancing toward a stronger process focus.

Processual dimension. There are three types of processual mechanisms that appear to be particularly important to shift towards a stronger focus on the process of innovation. First, mechanisms related to leadership style such as leadership commitment, which is expressed through long-term investments in innovation and those pursuing it, support a continuous approach to development. Thereby, sufficient resources are provided and the pressure of immediately realizing financial gains is alleviated (Holahan et al., 2014), which is necessary for a stronger focus on ongoing processes. Second, process flexibility mechanisms can foster a stronger process focus by enabling greater development flexibility. For example, mechanisms such as rapid project iterations and delaying concept freezing points allow organizations to continuously alter the product up until release and to react to changes in the market (Buganza et al., 2009). This enables a stronger focus

on design patterns, which is especially important for digital innovation and prolongs the time window in which functionality can be altered (Henfridsson et al., 2014). Similarly, the mechanism skipping and overlapping stages within the innovation process enables a higher level of flexibility, which is found to be particularly helpful for incremental innovation (Holahan et al., 2014). Third, mechanisms that ensure targeted evaluation are important to support ongoing innovation processes. Here, mechanisms such as regular project reviews ensure continuous learning from ongoing innovation projects and facilitate communication (Tsai et al., 2015).

P5: Processual governance mechanisms that support ongoing adaptations and re-adjustments of innovation processes address the competing concern about innovation focus by unbalancing toward a stronger process focus.

Relational dimension. The arguably biggest challenges for employees looking to embrace digital innovation by shifting from a mindset rather focused on products towards a mindset rather focused on processes is the necessity to "[…] gain support from the organization they [are] about to change and disrupt" (Svahn et al., 2017, p. 248). Here, particularly relational, organization-wide mechanisms provide tools to foster mutual understanding und stress the importance to change. For example, the mechanism transformational leadership style is geared to inspire employees to transform personal values and opinions is such a relational mechanism (Gumusluoğlu & Ilsev, 2009). Transformational leadership goes beyond classic leadership styles by addressing the individual needs of employees and creating a vision that inspires employees to broaden their scope of interest and approach problems in different ways (Gumusluoğlu & Ilsev, 2009), which can foster the required support from employees that might be critical towards the changes necessary for a process focus. Since transformational leadership goes beyond determining areas of responsibility and improving workflows (structural and processual dimensions) but explicitly focuses on fostering relationships between employees and between managers and employees, it represents a relational mechanism. Furthermore, since organizations' efforts to embrace digital innovation are oftentimes hindered by a risk-averse middle management (e.g., Lucas & Goh, 2009), top management can create a shared vision in order to align the mental models, language and culture. A shared vision facilitates communication between employees and enables better innovation outcomes (Crockett et al., 2013), which can help gain support towards ongoing innovation processes. To support the effects of a shared vision, mutual trust between leadership and projects teams is crucial. Hence, regular, informal interactions with project teams (Robeson & O'Connor, 2013) help ensure support from the entire organization and mitigate concerns about the personal consequences of focusing on the process of innovation.

P6: Relational governance mechanisms that foster mutual understanding and stress the importance to change, address the competing concern about innovation focus by unbalancing toward a stronger process focus.

5.3 UNBALANCING COLLABORATION: INTERNAL VERSUS EXTERNAL

Pursuing collaboration within the organization while simultaneously engaging with external actors from beyond the organizational boundaries creates another competing concern (Svahn et al., 2017). Since digital innovation is oftentimes created through the convergence of previously disparate areas of expertise (Lyytinen et al., 2016; Yoo et al., 2012), collaborating only internally bears the risk of not realizing opportunities available through collaborating with experts from outside the organizational and industrial boundaries. Such external collaboration is paramount since in an increasingly digitalized environment competitors oftentimes stem from other industries and are equipped with a different set of knowledge and experience (Seo, 2017). Thus, embracing digital innovation leads to increasingly blurring organizational and industrial boundaries, thereby exacerbating the competing concern between internal and external collaboration (Nambisan et al., 2017). Yet, while internal collaboration must be preserved to maintain existing competitive advantages, organizations must shift towards a stronger focus on external collaboration (Svahn et al., 2017). Therefore, organizations are challenged to identify ways to change the existing status quo towards a stronger focus on collaboration with external actors without excessively straining internal work arrangements (Svahn et al., 2017). This leads to research question 3:

How do specific types of governance mechanisms in the structural, processual, and relational dimension affect the competing concern between the need to collaborate internally versus the need to collaborate externally?

In the following, we develop three propositions that theorize how governance mechanisms from the structural, processual, and relational dimension can help govern the tensions between pursuing collaboration within the organization, and simultaneously engaging with external actors from beyond the organizational boundaries.

Structural dimension. Here, we identify three types of structural mechanisms that are particularly suitable. First, mechanisms related to an organization's structure such as multi-location – the dispersion across various locations – of innovation activities enable more exchange with a broad set of external actors and access to knowledge from beyond the organizational boundaries (Leiponen & Helfat, 2011). By determining the level of dispersion, an organization can therefore balance the reliance on rather internal or external arrangements. Moreover, mechanisms related to flexibility injecting structures such as alliances provide an organization not only with more flexibility to react to a changing external environment but also offer opportunities to engage with external expertise to improve existing businesses (Eisenhardt et al., 2010). Alliances can therefore be helpful governance mechanisms to balance the amount of internal and external expertise that is involved in innovation processes. Third, on the team level, mechanisms related to team characteristics such as the determination of a broad diversity of perspectives and fluid team boundaries, can help teams to include more external points of view to avoid groupthink (Edmondson & Nembhard, 2009). Yet, both mechanisms have

to be used carefully, since a broad diversity of perspectives and fluid team boundaries can also impede communication within the team due to conflicting mental models and fluid team boundaries can hinder communication and collaboration within the team more difficult (Edmondson & Nembhard, 2009)

P7: Structural governance mechanisms that facilitate exchange with a broad range of diverse actors and allow to flexibly engage with required expertise address the competing concern about innovation collaboration by unbalancing toward a stronger focus on external collaboration.

Processual dimension. In the processual dimension, mechanisms related to evaluation are promising to balance the competing concern between internal and external innovation collaboration. Mechanisms related to evaluation are important to avoid information overload when engaging with external actors and expertise, particularly since digital technology enables organizations to access unprecedented amounts of external knowledge (Majchrzak, Griffith, Reetz, & Alexy, 2018). Lead users are a processual mechanism that can help organizations to recognize new opportunities (Berghman et al., 2012). Similarly, other mechanisms such as experiments with customer involvement enable organizations to involve external actors directly in the innovation process, which is especially useful when addressing turbulence in the market (Buganza et al., 2009). By strictly evaluating any external input, organizations can filter out any unnecessary or unproductive opportunities for collaboration and balance the level of internal and external collaboration. Thus, both mechanisms can help harnessing the agnostic nature of digital technology (Henfridsson, Nandhakumar, Scarbrough, & Panourgias, 2018) by reframing existing assumptions about digital technology by highlighting, for example, new use contexts (Nambisan et al., 2017).

P8: Processual governance mechanisms that enable the evaluation of external inputs address the competing concern about innovation collaboration by unbalancing toward a stronger focus on external collaboration.

Relational dimension. In the relational dimension, we find two types of mechanisms particularly promising to balance the competing concern between internal and external innovation collaboration. Relational mechanisms related to organization-wide mechanisms such as incentivizing personal relationships through promotion criteria stand out as valuable tools to balance between internal and external collaboration. By incentivizing personal relationships, an organization can foster the informal exchange with external actors which is related to successful innovation and enables meaningful knowledge exchange with sources beyond organizational boundaries (O'Connor, 2008). Additionally, promotion criteria that require conferences attendance and publications can foster relationships to sources outside the firm and, thereby, provide similar opportunities for exchange as informal personal relationships (O'Connor, 2008). Second, mechanisms related to inter-team initiatives such as boundary-spanning team training can similarly help balancing between internal and external collaboration. If an organization wants to open up team boundaries, more boundary-spanning team trainings can help and vice versa.

P9: Relational governance mechanisms that help balancing the amount of exchange with external actors address the competing concern about innovation collaboration by unbalancing toward a stronger focus on external collaboration.

5.4 UNBALANCING GOVERNANCE: CONTROL VERSUS FLEXIBILITY

Lastly, in order to explore the potential of digital technology, organizations must allow for sufficient flexibility while simultaneously maintaining control over the eventual outcome (Svahn et al., 2017). Hence, organizations must "[…] "establish governance mechanisms that appropriately bound participant behavior without excessively constraining the desired level of generativity" (Wareham et al. 2014, p. 1195). This is a delicate balance, since high levels of flexibility are necessary to enable exploration and collaboration with external actors, yet simultaneously organizations must maintain control to appropriate value (Boudreau 2010; Svahn et al. 2017). Organizations that embrace digital innovation are typically part of innovation networks (Nambisan et al., 2017), in which control is increasingly distributed and less centralized (Lyytinen et al., 2016). Thus, depending on the current state of the organization, there are mechanisms available to gradually unbalance the existing status quo. This leads to research question 4:

How do specific types of governance mechanisms in the structural, processual, and relational dimension address the competing concern between the need to increase flexibility without losing control?

In the following, we develop three propositions that theorize how governance mechanisms from the structural, processual, and relational dimension can help govern the competing concern between allowing for sufficient flexibility, while simultaneously maintaining control over the eventual outcome.

Structural dimension. There are four different types of structural governance mechanisms that are particularly suitable to increase flexibility without losing control. First, mechanisms related to team structure help unbalance the existing status quo. Since autonomous teams are not encumbered by existing formalities and are allowed to define their own routines and strategies (Patanakul et al., 2012), they rather increases flexibility. In comparison functional teams and lightweight teams are indirectly controlled by managers from the line (Patanakul et al., 2012) and therefore rather increase control. In the same vein, determining the level of autonomy that teams have in decision-making (Cho et al., 2019), which is a mechanism related to team guidelines, can be used to either accentuate control or flexibility to find a suitable balance between the two. Third, mechanisms related to leadership structure such as team leadership structure, which indicates whether a project lead is allocated full-time or part-time (Holahan et al., 2014), also directly influence levels of control and flexibility in the formal development process. An organization that chooses to implement a full-time team lead lowers the flexibility within the team and increases the control in the development process, whereas part-time team leadership has the opposite effect (Holahan et al., 2014). Fourth, mechanisms related to reporting line such as direct supervision can be used to explicitly define how tasks are to be carried out and therefore increase control (Dekoulou & Trivellas, 2017).

P10: Structural governance mechanisms related to team structure and guidelines as well as leadership structure enable an organization to change internal levels of control and flexibility and addresses the competing concern regarding governance.

Processual dimension. On the processual level, there are three types of mechanisms that allow unbalancing the existing status quo towards a new balance between control and flexibility. First, there are different leadership styles, which accentuate either flexibility or control. Directive leadership is characterized by high levels of managers' engagement in the operational work causing higher levels of formalization and lower levels of autonomy amongst team members (Gebert et al., 2010), thereby accentuating control. Delegative leadership is about lower levels of managers' personal engagement. This enables team members to make decisions more autonomously (Gebert et al., 2010), thereby accentuating flexibility. Moreover, instead of developing detailed frameworks and rulebooks, mechanisms related to process flexibility such as heuristics provide simple rules that give guidance for problem solving while allowing for highly flexible processes (Eisenhardt et al., 2010). The use of heuristics enables more improvisation and generally higher levels of flexibility within an organization (Eisenhardt et al., 2010). Additionally, mechanisms related to incentives help organizations align the interests of managers and employees with the goals of the organization. Mechanisms such as managerial equity ownership and compensation based on firm performance (He & Wang, 2009) and director compensation (Xu & Bai, 2019) allow the organization to control and align resource deployment according to established goals, while simultaneously provide flexibility and motivation for efficient resource usage.

P11: Processual governance mechanisms that allow for different levels of oversight and incentivize behavior in line with the organizational goals address the competing concern between flexibility and control.

Relational dimension. We find two types of relational governance mechanisms that are particularly useful to balance the competing concern between flexibility and control. Mechanisms related to organization-wide mechanisms such as transformational leadership and the creation of a shared vision can inspire employees and align goals and mental models across the organization (Gumusluoğlu & Ilsev, 2009; Robeson & O'Connor, 2013; Sattayaraksa & Boon-itt, 2016). Similarly, inter-team initiatives such as informal interactions with projects teams help building up trust between leadership and project teams (Robeson & O'Connor, 2013). By creating a shared vision and fostering trust, diverging mental models can be aligned. According to stewardship theories, this allows relaxing "monitoring and control mechanisms in favor of a more organic approach driven by the assumption that the goals of all parties are aligned" (Robeson & O'Connor, 2013), which enables a balance between flexibility and control.

P12: Relational governance mechanisms that create a shared vision and build up trust address the competing concern between flexibility and control.

As any research, our work has limitations that have to be considered when interpreting the results. First, our review focuses on leading journals across six different fields of research. While this ensures that the identified articles adhere to high quality standards, it is possible that there are valuable insights in less established outlets. Future research might therefore identify additional governance mechanisms, which can complement our findings. Second, our search criteria focus on governance mechanisms related to innovation only. While the link to innovation provides a good starting point, it is possible that general governance mechanisms also provide valuable insights. Hence, future research could complement our findings by examining general governance mechanisms in relation to innovation. Despite these limitations, our results allow us to make some suggestions to practitioners. First, innovation is challenging and always requires a delicate balance between exploring novel ideas and exploiting established ones as described in the classic innovators dilemma (Christensen, 1997). Here, the results of our literature review provide a comprehensive, systematic overview of governance mechanisms that have been shown to actually work in the context of innovation (tables 3, 4 and 5). Second, particularly when embracing digital innovation, organizations face four competing concerns that are not easy to manage. Practitioners can repurpose governance mechanisms related to (traditional) innovation in the context of a Digital Innovation Governance. We show how these governance mechanisms are applicable to digital innovation in general and discuss how specific governance mechanisms can be used to fully address the four competing concerns of digital innovation.

6 CONCLUSION

This review identifies different types of governance mechanisms related to innovation in extant literature and discusses how they can be used to address the competing concerns of digital innovation. Doing so allows us to contribute to the extant literature in three ways: (1) we take stock of extant literature and contribute the first detailed overview of governance mechanisms related to innovation, categorizing them along the standard framework of IT governance (structural, processual, and relational dimension); (2) we show how the identified governance mechanisms related to innovation are applicable to digital innovation; (3) building upon the insights of our review, we develop four research questions and four sets of propositions that theorize how specific types of governance mechanisms can be used to unbalance the status quo and rebalance the firm to reach a new equilibrium more conducive to digital innovation. We encourage researchers to target those research objectives, as this will deepen our understanding about how governance mechanisms can help to address the arising challenges associated with digital innovation. Thus, our scientific community will be increasingly able to make informed suggestions to firms and managers on how to navigate through the volatile dynamics of a digitally innovating and transforming world.

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PAPER X

Organizational Identity in the Digital Era:

A Topic Modeling Analysis

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1 INTRODUCTION

Organizational identities define how organizations are perceived within and beyond their organizational boundaries (Hsu and Hannan 2005). Internally, organizational identities are long known to provide a common understanding of the organization's core values and goals (Albert and Whetten 1985). Externally, organizational identities summarize how an organization is perceived by different stakeholders (Gioia et al. 2000). Since organizational identity is deeply embedded in a firm's routines and processes (Kogut and Zander 1996), a continuous identity provides stability (Hannan 2006; Hannan and Freeman 1984). Yet, the "filters imposed by an existing identity, as manifested in the routines and beliefs of organizational members, may blind those members to identity-challenging technological opportunities", thereby turning the stability of organizational identity into a liability (Tripsas 2009, p. 442).

Since digital technology is nearly ubiquitous (Iansitit and Lakhani 2014), organizational identities must enable and support the successful identification of new opportunities related to novel digital technologies (Tripsas 2009). This also involves addressing the unprecedented openness of digital technologies, enabling constant reinterpretations (Henfridsson et al. 2018; Kallinikos et al. 2013). Thus, to make sense of digital technology, organizational identity must promote constant deframing and re-framing of digital technologies to identify and make sense of potential use cases across various contexts (Henfridsson et al. 2018), which makes changes in the organizational identity a fundamental part of any digital transformation (Wessel et al. 2021). To enable such changes, a delicate balancing act is required, in which actors continuously form, communicate, and change their understanding of digital technology. If, on the one hand, the organizational identity only allows re-framing "within current frames, the radical opportunities afforded by the technology may not be understood" (Nambisan et al. 2017, p. 229). If, on the other hand, the organizational identity heralds digital technology only as an opportunity, it may lead to negative consequences for existing products, capabilities, and processes (Grégoire et al. 2010).

In order to promote a balanced identity, narratives might help organizations to communicate an ideal identity (Ibarra and Roxana 2010) and promote a balanced approach by plotting "sets of social and material elements from the past, present, and future into a comprehensible narrative" (Garud and Giuliani 2013, p. 159). Organizations can actively frame their own identity by communicating such narratives, for example, in the form of mission statements (Blair-Loy et al. 2011; Tripsas 2009), which serve "as a sociocognitive bridge between [an organization's] identity and its actions by specifying why the organization should exist and how it should act" (Grimes et al. 2019b, p. 819). However, there is a lack of research on how organizations use narratives to manage and frame their identity in the context of rapid changes due to digital technology (e.g, Svahn et al. 2017a; Tripsas 2009). Since we have little to no insights about the way narratives are used to frame organizational identity, we need, in a first step, a more granular understanding of (1) how narratives differ across industries in terms of key concepts and (2) which different topics are actively highlighted and communicated across industries. To do so, we strive to gain "more clarity about the nature of organizational

mission(s)" (Grimes and Williams 2020, p. 235), which are widely used to communicate a socio-cognitive bridge between an organization's actions and its identity. Our research question is, therefore:

RQ: How are organizational identities framed in terms of highlighted concepts and content across different industries?

To answer our research question, we first provide an overview of relevant literature in the next section. We then describe our methodology in detail before presenting our findings. We conclude by discussing the implications of our findings and developing fruitful avenues for future research.

2 THEORETICAL BACKGROUND

2.1 MISSION STATEMENTS AS ORGANIZATIONAL NARRATIVES

Organizations actively manage and communicate their identity through mission statements (Cheney et al. 2008). Mission statements can be seen as organizational narratives that help organizations communicate and shape their identity (Tripsas 2009), thereby providing a frame of reference for important decisions (Blair-Loy et al. 2011). For several decades, mission statements have been among the most popular management tools (Rigby and Bilodeau 2018) and are known to connect a firm's identity to its actions (Grimes et al. 2019b). Due to the amount of research on mission statements in different contexts (e.g., Baetz and Bart 1996; Blair-Loy et al. 2011; Williams 2008), there exist various conceptualizations of mission statements, focusing on different aspects such as statements about mission, vision, or values (Braun et al. 2012). However, differentiating between these three aspects is difficult and, therefore, rarely applied both in research (Bartkus and Glassman 2008) and in practice (Blair-Loy et al. 2011).

Instead, these conceptualizations are seen as meta-components that are part of any mission statement (Braun et al. 2012). Furthermore, research has linked mission statements to firm performance (Williams 2008) and organizational practices (Blair-Loy et al. 2011). The effect of mission statements arguably lies in the public commitment to a certain goal and identity that communicates a standard by which an organization's reputation is judged (Basdeo et al. 2006). Not living up to this standard may jeopardize the organization's overall reputation (Bartkus and Glassman 2008) and, therefore, motivates organizations to "walk the talk" (Cheney et al. 2008; Weiss and Piderit 1999). Thus, if an organization departs from its communicated identity and the associated expectations, there are typically negative reactions (Benner 2007).

2.2 ORGANIZATIONAL IDENTITIES IN THE DIGITAL ERA

Due to the rapid changes caused by digital technology, organizations are forced to transform their identities (Wessel et al. 2021) to harness, among other things, the malleability of digital technology and its implications (Kallinikos et al. 2013). The remarkable malleability of digital technology enables continuous developments and improvements, even after a product has been purchased and is used by the customer, which

gives rise to never fully finished digital innovation (Nambisan et al. 2017). Digital innovation is defined as "the creation or adoption, and exploitation of an inherently unbounded, value-adding novelty (e.g., product, service, process, or business model) through the incorporation of digital technology" (Hund et al. 2021c, p. 6). Digital innovations typically emerge by converging insights from different industries (Yoo et al. 2012), forcing companies to collaborate with actors beyond their established organizational and industry boundaries (Lyytinen et al. 2016; Seo 2017). In addition, digital innovation allows users themselves to combine and recombine different offerings at will, creating and capturing value virtually independent of the manufacturer (Henfridsson et al. 2018).

These developments force organizations to change and transform their organizational identity (Wessel et al. 2021), which functions as a filter that determines how employees make sense of and frame digital technologies and innovations (Tripsas 2009). To this end, a better understanding of socio-cognitive sensemaking is central to exploring how innovation agents, i.e., individuals or organizations, interact with digital technologies such as digital artifacts or platforms (Nambisan et al. 2017). Since digital technology is simultaneously understood by an individual innovator and the innovator's social system, there may arise different framings about potential use cases (Faulkner and Runde 2019; Henfridsson et al. 2018). As digital innovations are used across various traditional product categories (Yoo et al. 2012), they may be framed and used differently by different innovation participants so that each understands and uses them in a different way (Boland et al. 2007). If one dominant frame emerges from the various individual frames, which prevents innovators from perceiving new frames and opportunities for innovation (Kaplan and Tripsas 2008). However, when different frames are socially communicated so that existing frames fall apart, individuals may see new opportunities to innovate because of a new cognitive frame (Verganti 2009).

To better understand how socio-cognitive frames related to digital technology are formed and shared, narratives play a central role (Nambisan et al. 2017). Narratives result from previous experiences and interactions between innovative actors (Garud and Giuliani 2013). Thereby, "narratives, and other rhetorical strategies form an important part of this arsenal for identity work" (Ibarra and Roxana 2010, p. 135) by allowing to frame a particular occurrence and make sense of it. Innovators that de-frame and re-frame digital technologies to identify new use cases do so by creating and sharing new narratives about problems and potential solutions, which might lead to new products or services (Nambisan et al. 2017). Therefore, an organizational identity must encourage different actors to shape, communicate, and change their understanding of new technologies and innovation processes, outcomes, and associated markets through de- and re-framing (Nambisan et al. 2017; Tripsas 2009).

3 METHOD

To identify the mission statements of relevant organizations, we followed the best practices of extant research by relying on established rankings (e.g., Bart and Baetz 1998; Blair-Loy et al. 2011; Williams 2008).

For this project, we are interested in the mission statements of large organizations dealing with the implications of digital technology across various industries. Hence, we chose the "Strategy& 2018 Global Innovation 1000" ranking, which is based on listed public companies that together account for 40% of all global research and development (R&D) spending (Jaruzelski et al. 2018). The ranking is conducted annually since 2005 and was already used in several scientific publications across disciplines (e.g., Kim and Park 2010; Shin et al. 2009).

In total, the ranking comprises 1000 companies from 36 different countries and ten industrial sectors. The ranking methodology is as follows: First, the 1,000 public companies with the highest R&D investments worldwide during the past fiscal year are identified and compiled in a list, including key financial metrics such as sales, profit, historical R&D expenditures, and market capitalization. Subsequently, every company is allotted to one of ten industry sectors (consumer discretionary, consumer staples, energy, financials, healthcare, industrials, information technology, materials, telecommunication services, and utilities).

3.1 DATA COLLECTION

Since mission statements are mostly available online (e.g., Blair-Loy et al. 2011; Grimes et al. 2019a), we thoroughly searched each company's website listed in the ranking to identify its mission statement. Two separate coders collected a preliminary sample between August and September 2019 to get a first overview of the availability and presentation of different mission statements. After it became apparent that there exist various forms of mission statements, such as statements focusing on values, vision, or mission, the initial data was used to define a nine-step coding guideline, based on our insights and the definition of Braun et al. (2012). Based on these guidelines, the second author then repeated the data collection between November to December 2019, regularly discussing unclear cases with the first author. In the following paragraphs, we discuss the nine steps of the coding guideline.

First, as mission statements are composed of the meta-components of mission, vision, and values (Braun et al. 2012), every article on a company's website that contained one, two, or all three of these terms in the headline or, if it was labeled "about us" or "our company" and included a passage somewhere in the text like "our mission/vision …" or "our values are … " was considered. In order to achieve interpretable results, the identified names were categorized across the meta-components mission, vision, and values as defined by Braun et al. (2012). We defined how specific terms or phrases relate to each meta-component to ensure a transparent categorization process.

Second, if a mission statement contained all three meta-components, we only kept all three if they stemmed from the same section of the website. For example, if the three meta-components mission, vision, value were taken from ".../philosophy/mission.html", ".../philosophy/vision.html", and ".../philosophy/values.html", all three were considered for the final data set. If, on the other hand, a company's mission was found under "…/about/mission.html" but the firm also presented its values in the "Careers" subpage,

these values were only included if the mission statement was explicitly referenced, such as in "these values are the foundation of our mission… ". If not, they were excluded.

Third, if only the mission statement of a subsidiary could be identified, but not the overarching mission statement for the entire conglomerate, then we ignored the subsidiary mission statement (Ingenhoff and Fuhrer 2010), as it could distort the results. Instead, the "About us" or a similar text was taken from the conglomerate's website.

Fourth, mission statements for specific purposes were ignored, e.g., diversity visions or CSR mission statements were not included (Ingenhoff and Fuhrer 2010), as these could also distort the results.

Fifth, if a company's website did not contain a mission statement, its annual report, if available, was searched for statements about "our mission", "mission is", "mission of", "mission for" and equally with "vision" (Blair-Loy et al. 2011; Chun and Davies 2001).

Sixth, in the event that no mission statement could be identified, other contents, if available, of the company's investor relations pages were analyzed to see whether these pages contain statements such as "our mission/vision is …" and if so, they were taken as the mission statement.

Seventh, if still no mission statement was identified, descriptive texts about the company were searched for statements about "company profile", "about us", "what we do", "our business" or similar.

Eighth, if steps one to seven were not successful, we relied on secondary sources, for example, from www.reuters.com, www.comparably.com and www.linkedin.com, to identify a mission statement.

Ninth, as the ranking is based on a sample from 2018, a small number of mergers and acquisitions were carried out by the end of 2019 (the time of data collection). In a few cases, the acquired company's mission statement was still available online and was used. Where it was not, data from the secondary sources mentioned above were used. If neither approach provided a mission statement, the mission statement of the new owner company was used. Following the above-discussed nine steps, a mission statement or text deemed equivalent could be obtained for each firm in the sample. In the next subchapter, the applied data analysis method is illustrated.

3.2 DATA CLEANING AND ANALYSIS

Data cleaning. Once the entire data set was collected, we started data cleaning by removing words without semantic meaning or only describing the company's legal form. We then performed the usual data cleaning procedures by converting all words to lowercase and removing special characters such as "/" and "@", common stop words and topic-specific stop words, as well as all punctuation and numbers (cf. Debortoli et al. 2016). The remaining words were then stemmed. For example, words such as "innovation", "in-

novative" and "innovate" become "innov". To further increase the data quality, we calculated the *term frequency – inverse document frequency (tf-idf),* which is calculated by dividing the number of occurrences of a specific term in a specific document ($n_{documents}$) by the number of occurrences of the term in the entire collection of documents ($n_{documents\ containing\ term}$) to refine our stop word list (Silge and Robinson 2016).

$$tf - idf(term) = \ln\left(\frac{n_{documents}}{n_{documents\ containing\ term}}\right)$$

Data analysis. After data cleaning, we started data analysis by exploring the specific concepts and vocabulary used across different industries to frame the organizational mission and identity. Therefore, we excluded terms with low discriminatory power, only including "those terms whose tf-idf exceeds the median of all tf-idf values" (Antons and Breidbach 2018, p. 20), thereby reducing the total number of terms from initially 15,865 to 7,925. We then explored similarities and differences across industries regarding the used language by exploring pairwise correlations of the terms with a high tf-idf power, as Silge and Robinson (2016) recommend. Our results for this initial analysis are displayed in Figure 3.

After having gained a better understanding of the key concepts and language used across different industries, we employed topic modeling based on a Latent Dirichlet Allocation (LDA), which is a "three-level hierarchical Bayesian model, in which each item of a collection is modeled as a finite mixture over an underlying set of topics" (Blei et al. 2003b, p. 993) on the entire set of 15,865 terms. Topic modeling is regularly used in the information systems (IS) literature (e.g., Adamopoulos et al. 2018; Müller et al. 2016) and represents an unsupervised machine learning method.

It is based on the distributional hypothesis derived from linguistics (Firth 1957; Harris 1954), which suggests that words occurring in the same contexts tend to have similar meanings (Turney and Pantel 2010a). For example, the simultaneous occurrence of the words "striker", "ball", "foul" and "goal" in an article can be interpreted such that these words belong to the common category "football" (Debortoli et al. 2016). LDA, in specific, is based on an imaginary generative process that takes it for granted that authors compile *d* documents, selecting a discrete distribution of *t* topics to report on, and simultaneously extract *w* words from a discrete distribution of words typical of each topic. Gamma (γ) represents the per-document-per-topic probabilities, whereas beta (β) represents the per-topic-per-word probabilities (Silge and Robinson 2016).

Bottom-up, this approach may be described as a limited vocabulary of words determining each topic, while a probability distribution over a fixed set of topics determines each document (Debortoli et al. 2016). In the current setting, each mission statement represents a separate document. Each document is represented

by varying proportions of topics, ranging from 0 percent if a particular topic is not represented in a document at all to 100 percent if a document refers exclusively to a particular topic (Debortoli et al. 2016).

The most important parameter in topic modeling is the parameter k, which determines the number of topics that the LDA algorithm extracts from the underlying documents. If, on the one hand, k is too high, the resulting topics are too similar; if, on the other hand, k is too low, the exploratory potential of LDA is not fully exploited (Debortoli et al. 2016).

To determine k, we followed extant best practices by varying the "number of topics […] to evaluate the quality of the resulting models" (Debortoli et al. 2016, p. 118). After testing different values for k ranging from 5 to 30, we determined $k = 10$ as the best fit. After selecting k, the LDA analysis provided us with the most probable words for each topic which two authors then interpreted by assigning "descriptive labels to topics to assist readers in interpreting topics" (Debortoli et al. 2016, p. 7). Thereby, we examined the most likely terms of each topic (i.e., terms with the highest β value per topic) and also examined the distribution of topics per document (i.e., the overall γ value per document or industry) to get a sense of the focus of each topic and its relevance across industries. Each topic and the assigned label were discussed in detail until an agreement was reached.

4 RESULTS

In the following, we present our findings regarding the similarities and differences between the industries in terms of key concepts and vocabulary before presenting the specific topics used within our sample.

4.1 SIMILARITIES AND DIFFERENCES BETWEEN INDUSTRIES

By focusing only on terms with high discriminatory power (i.e., a comparatively high *tf-idf*), we analyzed similarities and differences between industries in terms of the language and vocabulary used. While the average correlation between industries is 0.34, there are large differences between the ten industries. Figure 3 below visualizes comparatively strong correlations (>.5) of the key terms with high discriminatory power across different industries. Each node represents one industry, and the lines' width indicates how strongly the key terms across industries correlate.

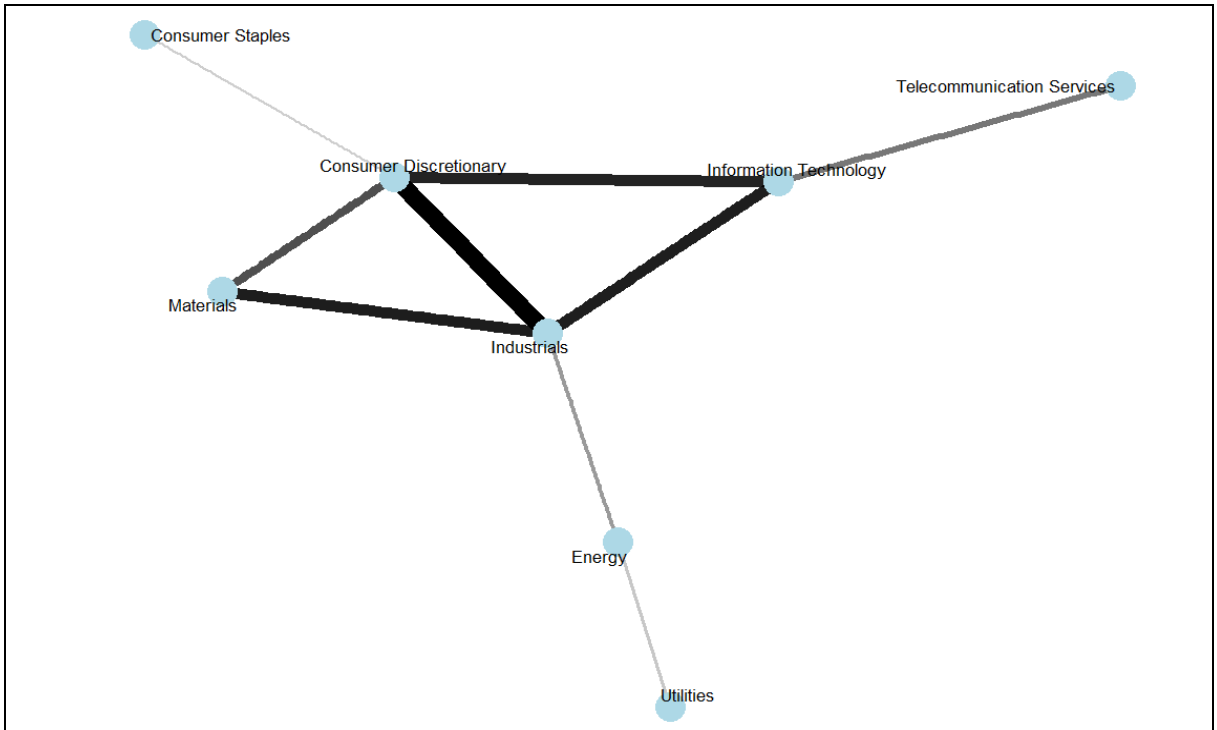

Figure 3. Bivariate Correlation (>.5) of Terms with High Discriminatory Power

On the one hand, some industries, such as *Consumer Discretionary* and *Industrials*, have correlations above .7, indicating very similar wording and language used to describe organizational identity. On the other hand, other industries have very weak correlations or even no single correlation above .5, as is the case with the *Financials* industry. Table 1 below provides an overview of the ten terms with the highest discriminatory power per industry. Importantly, only the top ten words are listed, whereas the LDA analysis considers all of the words contained in a document.

Industry	Top *tf-idf* terms per industry
Information Technology	softwar, semiconductor, network, digit, data, cloud, connect, payment, comput, platform
Telecomm. Services	digit, network, converg, connect, comservic, board, evolve, telecom, telecommun, uk
Consumer Discretionary	sport, motor, brand, automobile, car, automot, mobil, tyre, move, light
Consumer Staples	food, beauty, consum, brand, seed, snack, eat, reflect, ownership, care
Energy	gas, energy, oil, forc, manner, russian, meticul, discipline, demand, major
Financials	trade, credit, privat, equity, gross, wealth, client, remain, investor, fund
Healthcare	patient, diseas, medicin, therapy, cancer, pharmaceut, clinic, care, medic, hear
Industrials	supplier, autom, advantage, field, construct, defenc, flexibl, sector, project,

	leadership
Materials	steel, materi, iron, chemistry, role, manner, harmoni, pipe, chemic, abil
Utilities	wast, water, energy, wastewat, franc, anticip, drink, electr, tonn, emiss

Table 1. Top tf-idf terms per industry

4.2 TEN TOPICS THAT ARE FREQUENTLY ADDRESSED IN MISSION STATEMENTS

In the following, we present the results of the LDA analysis. There are ten topics that represent the most central themes discussed and highlighted in the mission statements of the 1,000 largest R&D spenders worldwide. Table 2 below provides an overview of each topic, including the topic number, assigned label, and the ten most probable words (in their stemmed form) per topic.

No	Label	15 most probable words per topic (stemmed)
1	Technological product orientation	technolog, solut, product, custom, industri, innov, world, servic, network, system, compani, secur, global, market, provid
2	Digital business	data, custom, busi, digit, service, experi, softwar, platform, innov, cloud, transform, manag, world, enterpris, company
3	Responsible business	busi, corpor, compani, activ, manag, custom, respect, employe, societi, product, conduct, develop, environ, global, respons
4	Employee orientation	peopl, compani, employe, respect, life, respons, hear, live, solut, world, busi, commit, product, creat, trust
5	Well-being orientation	Patient, innov, live, diseas, develop, peopl, health, medicin, care, pharmaceut, improve, medic, healthcar, commit, life
6	Customer orientation	peopl, world, custom, innov, commit, compani, deliv, integr, team, respect, creat, purpos, idea, passion, challeng
7	Sustainable product orientation	product, energi, world, peopl, compani, food, water, sustain, live, consum, million, creat, resourc, purpos, experi
8	Demand-side perspective	custom, innov, product, busi, employe, success, compani, qualiti, commit, sustain, develop, integr, perform, servic, solut
9	Supply-side perspective	compani, product, china, develop, industri, servic, market, brand, steel, oper, technolog, enterpris, manufactur, electr, world
10	Corporate citizenship	corpor, societi, creat, innov, custom, develop, continu, contribut, philosophi, peopl, compani, technolog, product, futur, busi

Table 2. Overview of topics and the 15 words with the highest β value per topic

Within these ten topics, there are three general themes, focusing on (1) Supply-side focus: The role of technology, (2) Demand-side focus: Customer-centricity, and (3) Sustainable development goals. While the topics are not mutually exclusive, they are collectively exhaustive and provide a good overview of the general focus within a mission statement. We briefly explain each topic along the three general themes in the following.

Supply-side focus: The role of technology. The first two topics highlight the relevance of innovative digital technologies from a supply-side point of view: The first topic, "Technological product orientation", exhibits a strong focus on innovative technological products (technolog, product, innov) that solve customer needs (solut, custom, provid) in the context of global markets (world, global, market). The second topic focuses on the core topics of digital transformation (digit, transform) by highlighting the abundance of data that is created (data, custom, digit, softwar) through digital technologies (platform, cloud). Therefore, we labeled it "Digital business". Similarly, topic nine, which we labeled "Supply-side perspective", focuses on products and technologies (product, technolog) from a suppliers point of view (compani, enterpris) but more in the context of traditional manufacturing industries (steel, electr, manufactur).

Demand-side focus: Value and Customer-centricity. Topics six and eight take more of a demand-side perspective with a strong focus on values and customers. Topic six, "Customer orientation", focuses on respectful conduct with customers and people in general (custom, peopl, respect) by committing to integrity and delivering new solutions to existing challenges (commit, purpos, integr, deliv, challeng). Topic eight "Demand-side perspective" highlights what a demand-side focus implies for organizations in terms of offering services and solutions to customers (custom, busi, product, servic, solut) and also underscores the role of integrity and a commitment to quality (integr, qualiti, commit).

Sustainable development goals. Topics three, four, five, seven, and ten shift the overall focus towards the responsibilities of organizations by highlighting different aspects of the sustainable development goals. Topic three, "Responsible business" particularly focuses on the active management and generally respectful conduct with society (activ, manag, respect, societi). Topic four, "Employee orientation", highlights the importance of employees and suitable working conditions (employe, hear, respect, life, respons, commit, trust). Topic five, "Well-being orientation" represents a strong focus on healthcare products (patient, health, medicine, pharmaceut, medic) with an emphasis on an overall humanistic purpose (people, care, commit, life). Topic seven, "Sustainable product orientation", also exhibits a product orientation but strongly emphasizes overall sustainability (energy, world, people, food, water sustain, resource). Topic ten summarizes specific aspects of good "Corporate citizenship", which focuses on creating a corporate philosophy that contributes to society in the long-term (corpor, philosophi, societi, contribut, futur). While the LDA analysis was conducted at the level of each individual document (i.e., mission statement), aggregating the results at the industry level reveals the relative distribution of each topic across the ten industries (Figure 4).

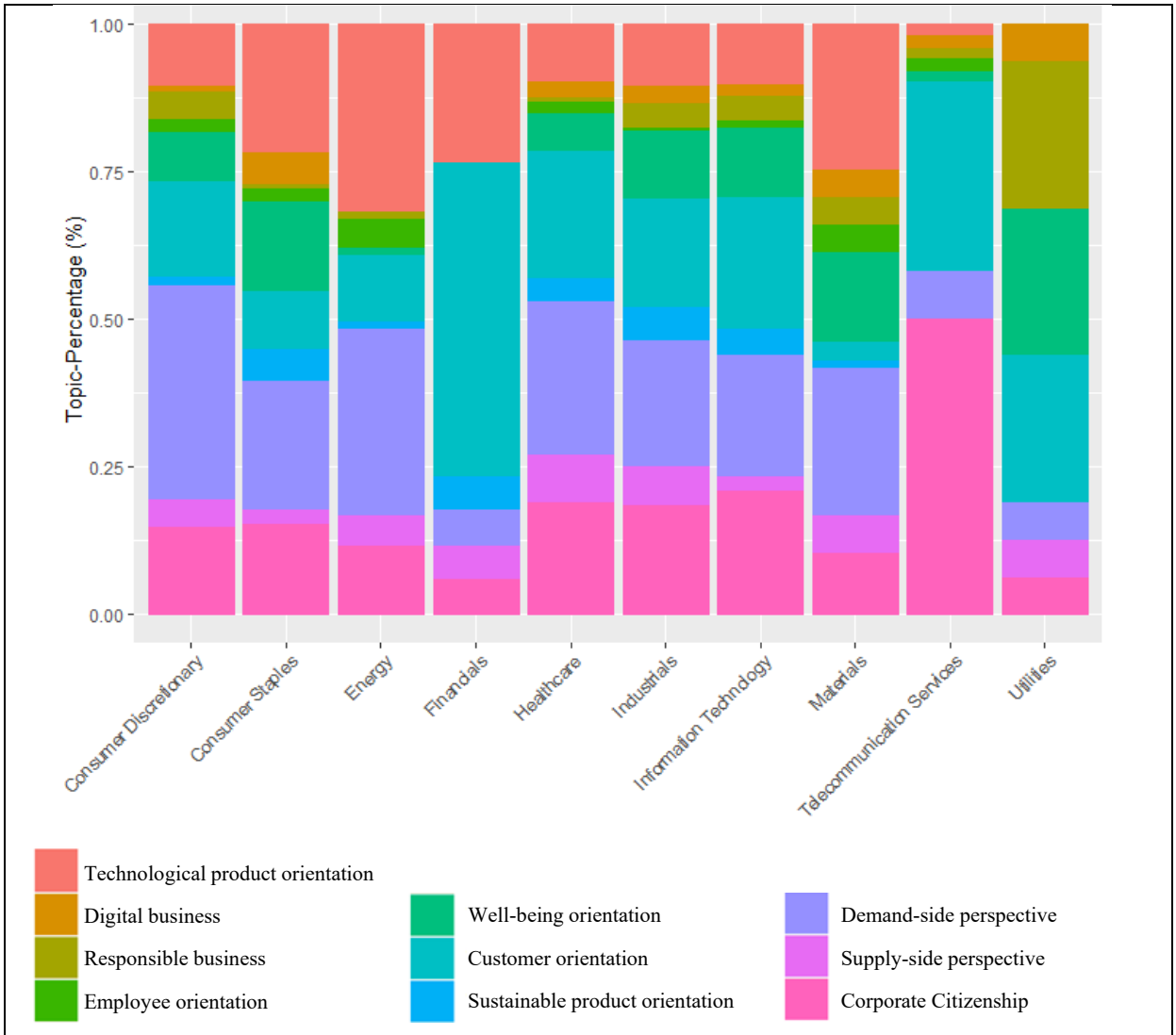

Figure 4. Overview of the Relative Distribution of Each Topic per Industry

5 Discussion

We began by noting that the ubiquity of digital technology requires fundamental changes in organizational identity (Wessel et al. 2021). These changes are necessary since organizational identity serves as a filter that determines how the potential of digital technologies is interpreted (Tripsas 2009). In order to identify novel ways of applying and combining digital technology, organizational identity must therefore promote constant deframing and re-framing of digital technologies to identify new use cases across contexts (Henfridsson et al. 2018; Nambisan et al. 2017). Since we know very little about how organizational identity can be managed to promote such openness to re-framing, we analyzed mission statements, which serve "as a sociocognitive bridge between [an organization's] identity and its actions by specifying why the organization should exist and how it should act" (Grimes et al. 2019b, p. 819). Our findings allow us to make two key contributions.

5.1 THEORETICAL CONTRIBUTIONS

First, we highlight the differences between industries regarding the key concepts and language used, which are particularly important for defining an industry and distinguishing it from other industries (Table 1). Furthermore, we use the words with the highest discriminatory power to show how similar the industries are (Figure 3). Interestingly, the concepts and words used in the IT industry to frame their organizational identity are relatively similar to three industries: Consumer Discretionary, Industrials, and – albeit less strong –the Telecommunication Services. The terms with the highest discriminatory power in the IT industry, such as "softwar", "network", "digit", "data", "cloud", "connect", "comput", and "platform" focus predominantly on technical applications, that can be applied to various contexts. This intersects with the argument that we, as a field, "need to distinguish carefully *digitizing* - a technical process—from *digitalization*—a sociotechnical process of applying digitizing techniques to broader social and institutional contexts" (Tilson et al. 2010, p. 749). By emphasizing general-purpose technologies (i.e., digitizing) that can be interpreted and applied differently across different contexts (i.e., digitalizing), organizations might align their identity more with an open view regarding the reinterpretation of such digital technologies and their "use, and 'fit' generally within the social world" (Faulkner and Runde 2019, p. 5).

Second, we uncover ten topics discussed within all 1,000 mission statements across all industries (Table 2) and derive three overarching themes to which these topics relate. Furthermore, we show the relative distribution of these topics across all ten industries (Figure 4). In terms of theoretical implications, our results enable us to take a more granular look into the topics present in identity shaping narratives, such as mission statements (e.g., Grimes et al. 2019b; Tripsas 2009). We thereby take a first step towards addressing the call for research in extant literature to "theorize mission as a nuanced and variegated construct" (Varendh-Mansson et al. 2020, p. 230). Since there are ten distinct topics present in mission statements, our findings support research stating that an organization's identity typically has several facets or even several identities present within an organization (Pratt and Kraatz 2009). This suggests that "in addition to being multifaceted, an organization's mission may reflect a variety of approaches to balancing and integrating different pursuits" (Varendh-Mansson et al. 2020, p. 230).

To demonstrate the implications of our findings, we now discuss how they relate to two key concepts in research on the impact of digital technologies: (1) blurring boundaries between process and outcome and (2) a more distributed innovation agency (e.g., Boland et al. 2007; Lyytinen et al. 2016; Nambisan et al. 2017). (1) When embracing digital innovation, companies experience conflicting demands (Svahn et al. 2017a), due to, for example, the increasingly blurring boundaries between innovation processes and outcomes. The blurring boundaries between process and outcome require firms to consider both process and outcome simultaneously (Nambisan et al. 2017), which is in contrast to traditional innovation research in which there exists a strict distinction between process and outcome (Crossan and Apaydin 2010). Our results reflect both streams of literature. On the one hand, topics such as Topic 5 and topic 10 appear to be more focused on

innovation as a process. Topic 5 is designated "Well-being orientation", including likely terms such as "innov", "develop", "improv", suggesting a stronger focus on continuous developments that are never quite finished rather than a fixed product thinking. Topic 10 "Corporate citizenship" is associated with likely terms such as "innov", "develop", "continu", "futur" and "product", thereby framing product innovation as an ongoing, incremental process. On the other hand, some topics such as topic 1 "Technological product orientation", refer to words such as "technolog", "produc", and "solut", thereby mostly using terms that describe the eventual innovation outcomes rather than ongoing processes.

(2) Digital innovation also leads to more distributed and less predefined innovation agency (Boland et al. 2007; Nambisan et al. 2017), requiring firms to engage with external actors within innovation networks (Lyytinen et al. 2016). This need for a more distributed innovation agency also creates conflicting demands between a focus on internal versus external collaboration (Svahn et al. 2017a). It appears that no topic has an exclusively internal focus. The only topic that can be interpreted as having an internal focus is topic 4 "Employee orientation", due to its strong employee focus (i.e., "employe", "compani") but even here there are several external aspects highlighted (i.e., "world", "peopl"). All other topics have a more distributed and therefore external focus. For example, Topic 2 "Digital business", due to likely words such as "platform", "custom", "world" or Topic 6 "Customer orientation" with most likely terms such as "peopl", "world", "custom", "team" highlight a major trend in digital innovation. Here, customers are seen as a central part of creating innovation, since they create trace data while using a digital services (Yoo et al. 2010; Yoo et al. 2012) or combine digital offerings in unforeseen ways (Henfridsson et al. 2018), which then provides new opportunities for further developments.

5.2 LIMITATIONS AND FUTURE RESEARCH

The results of this study have to be interpreted in light of their limitations. First, access to several company websites was difficult during data collection due to language barriers or outdated websites. While we tried to mitigate the problem as much as possible, in some cases, we had to rely on secondary data or translation services such as Google Translate. This issue can be addressed in future studies by contacting all firms for which no mission statement or equivalent is available via email or by web-scraping a sufficiently large pool of firms so that inaccessible mission statements can be ignored. Second, potential biases compared to manual coding of qualitative data are reduced, although not completely eliminated, by applying the LDA algorithm, as the resulting topics still need to be interpreted by individuals (Indulska et al. 2012). To mitigate the risk of confirmation bias, several coders that are not primed to identify topics related to the challenges created through digitalization might solve the problem if they achieve high inter-coder reliability (Indulska et al. 2012). Furthermore, future studies can rely on larger amounts of data via web-scraping methods (Grimes et al. 2019b), which, once implemented, can also be used to collect longitudinal data. Despite these limitations, our results allow us to suggest some suggestions to practitioners.

Our analysis uncovers ten topics that a company can use to identify relevant topics and associated terms in line with the respective industry and strategy of the company. The identified topics serve as a kind of dictionary for topic-specific terms and even entire mission statements that a firm might be interested in when (re)writing its mission statement. Moreover, when (re)writing a mission statement, our findings should complement previous research. For example, companies should always be truthful in their mission statements (Bartkus and Glassman 2008). In the same vein, if a company also aims to improve organizational performance by (re)writing its mission statement, then the measures described by Bart et al. (2001) and Braun et al. (2012) could help guide the process.

Our findings also point to several fruitful avenues for future research. Most existing research on mission statements focuses on the relationship between various components/topics within mission statements and various measures of organizational outcomes, such as organizational financial performance (e.g., Williams 2008) or stakeholder management (e.g., Blair-Loy et al. 2011). Our study provides more granular insight into existing topics by analyzing the mission statements of the 1,000 largest R&D spenders worldwide, which provides an opportunity to examine the extent to which different topics are associated with different performance indicators. It would be interesting to examine whether there are specific types of mission statements that highlight specific combinations of topics. Such types might differ and lead to different outcomes across different industries.

In particular, since organizations often hold numerous identities and their associated goals/missions through segregation and integration (Albert and Whetten 1985; Grimes et al. 2019b), three different types of organizational missions are derived by Varendh-Mansson et al. (2020): An organization's identity can be *singular* if it has only one mission, *segregated* if it pursues numerous missions but isolates them in different operational units, or *integrated* if it has multiple missions and tries to integrate them into a consistent overall picture.

Future research could classify whether a firm's identity is singular or integrated if it scores relatively high in one or many topics describing divergent firm identities by exceeding a gamma threshold. Table 3 below provides an overview of two particularly promising avenues for future research with exemplary research questions for each:

Future research avenues	Exemplary research questions
Mission statements: How are they written and communicated and what is actually communicated?	➢ How do singular, segregated, or integrated mission statements differ in terms of their relative topic distribution? ➢ How, if at all, can the relative distribution of topics in mission statements be used to identify a new classification of organizations independent of traditional industry boundaries? ➢ How, if at all, do the differences and/or similarities in mission statements between industries influence their overall behavior and performance? ➢ How and why are mission statements changing over time (i.e., mission drift)? How do such changes influence internal and external organizational perception?
Organizational identity: How can mission statements be used as a tool to manage organizational identity?	➢ How can mission statements be communicated to help shaping organizational identity? ➢ How, if at all, does a focus on specific topics in mission statements influence organizational identity? ➢ How, if at all, do prevailing themes in mission statements, such as those related to the sustainable development goals, influence strategic decisions? ➢ If organizational identity has to be transformed during digital transformation, what role do mission statements play in supporting such a change?

Table 3. Avenues for Future Research

6 CONCLUSION

In this paper, we take a first step toward understanding how organizational identity can be managed by analyzing the mission statements of the 1,000 largest R&D spenders worldwide. Our findings allow us to contribute by (1) identifying similarities and differences in highlighted concepts and language across industries and (2) uncovering ten topics that are particularly salient across all ten industries. We also discuss the implications of our findings and conclude by developing promising avenues for future research. We hope that our findings will help future research identify concrete approaches to managing organizational identity change in light of the digital transformation.

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PAPER XI

Digital Transformation as Paradoxical Process of Identity Formation:

A Sociotechnical Perspective:

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1 INTRODUCTION

The far-reaching implications of digital transformation have attracted the interest of academia and industry alike (e.g., Fitzgerald et al. 2013; Mousavi Baygi et al. 2021; Sebastian et al. 2017). While interest in organizational transformation, understood as "a process that engenders a qualitatively different organization" (Besson and Rowe 2012, p. 103), has been high for decades, the prefix *digital* implies that there is something new (Avital et al. 2019; Baskerville et al. 2020).

Digital transformation is mainly studied on the organizational level and is viewed as an ongoing process that relies on digital technologies to improve certain aspects of an entity (see Vial 2019). While adopting information and communication technologies (ICT) is known to lead to organizational transformations (Besson and Rowe 2012), it has typically reinforced existing logics and processes. In contrast, *digital* transformation implies a more fundamental change, including the redefinition of the organizational identity itself (Wessel et al. 2021), which is not surprising since using and interpreting digital technologies requires deviating from established "expectations associated with an organization's identity" (Tripsas 2009, p. 442). Since "firms must shift their identity as digital technologies intertwine with the routines, procedures, and beliefs of key constituents" (Svahn et al. 2017a, p. 239), digital transformation is, per definition, a sociotechnical phenomenon that requires the consideration of technical *and* social aspects jointly.

However, there remain doubts about whether existing theories can adequately capture sociotechnical phenomena (e.g., Benner and Tushman 2015; Hund et al. 2021c). To advance the development of next-generation IS theories (Burton-Jones et al. 2021) that more adequately address sociotechnical phenomena, we propose four products of theorizing (Hassan et al. 2022)[16] by extending current debates on digital transformation through an in-depth definition of the *concept* of "digital" in digital transformation and the development of a *framework* that illustrates the interrelationship between technical and social identities. By addressing the implications of these sociotechnical identities, we also challenge the existing *myth* that paradoxes are an undesirable byproduct rather than an integral and necessary part of successful digital transformations. To this end, we first motivate and pose two disciplinary research *questions*.

Research on digital transformation has only focused on the transformation of social identities (predominantly at the organizational level) so far (Tripsas 2009; Vial 2019; Wessel et al. 2021). Yet, when social actors, such as individuals or organizations, identify new ways of using and combining existing digital technologies (Henfridsson et al. 2018; Yoo et al. 2010), they also assign new meanings and interpretations to digital technologies (Faulkner and Runde 2009, 2013). Hence, "the identity of digital objects, their use, and 'fit' generally within the social world" (Faulkner and Runde 2019, p. 5) is *also* changing during a digital transformation. For our purposes, *technical identity* describes what "kind of thing [an] object is within some community"

[16] Products of theorizing "represent interim struggles in which people intentionally inch toward stronger theories" as defined by Weick (1995). Please refer to Appendix A for a brief introduction of discussion of the products of theorizing per se.

(Faulkner and Runde 2013, p. 807). Thus, to pay tribute to the sociotechnical nature of digital transformation and the interweaving of digital technologies and social actors (Mousavi Baygi et al. 2021; Sandberg et al. 2020), we need to consider changes in social identities *as well as* in technical identities. Thus, our first research question is:

RQ1: How do social and technical identities change and interact during digital transformation?

Furthermore, since identities fundamentally define how individuals or organizations perceive themselves, identity changes are complex and often met with resistance (Hannan 2006; Tripsas 2009). When embracing digital technology, organizations challenge fundamental aspects of their identity and experience serious tensions between, for example, the need to build up new, requisite capabilities without jeopardizing existing capabilities or between enabling increasing levels of flexibility without giving up control (Svahn et al. 2017a). While the intertwining of digital technologies and social routines is prone to lead to paradoxes (e.g., Brunswicker and Schecter 2019; Ciriello et al. 2019; Eaton et al. 2015; Tilson et al. 2010), the continuous emergence of paradoxes during the process of digital transformation is typically viewed as an undesirable byproduct (see Smith and Beretta 2021; Svahn et al. 2017a; Svahn et al. 2017b). For example, organizations are increasingly ceding decision-making power and thus autonomy to digital innovation teams (e.g., squads in Scaled-Agile organizations), but at the same time need to ensure that these teams follow and deliver on the company's overall strategy, leading to paradoxical tensions in managing digitally oriented organizations. We argue that paradoxes, defined „as contradictory yet interrelated elements that exist simultaneously and persist over time“ (Smith and Lewis 2011, p. 382), are neither a byproduct of digital transformation nor a problematic outcome, but that the continuous emergence of paradoxes is an integral and necessary part of digital transformation. To better understand how to navigate the challenges arising through the sociotechnical nature of digital transformation, we consider the technical as well as social perspective on paradoxes by posing our second research question:

RQ2: How can a sociotechnical perspective on paradoxes help navigate digital transformation?

In a nutshell, we pose two disciplinary research *questions* that lead to an extension of current debates on digital transformation by proposing a deeper reading of the *concept* "digital" and by developing a *framework* that takes into account its sociotechnical nature, which, as a result, challenges the *myth* that paradoxes during the process of digital transformation are an undesirable byproduct:

(1) **Identities:** Extant research focuses on the transformation of *social identities* such as organizational (Wessel et al. 2021) and individual (Belk 2013) identities. Yet, *technical identities* (Faulkner and Runde 2013) are also transformed during digital transformation, which is currently not addressed by extant research. Particularly the interaction between social and technical identities is rarely considered. To fully understand the sociotechnical nature of digital transformation, we, as a field, need to address both social and technical aspects.

(2) **Paradoxes:** Research highlights that digital technologies lead to paradoxical situations where the changes needed to fully understand the potential of a new digital technology run counter to existing logics and routines (Ciriello et al. 2019; Svahn et al. 2017a; Tripsas 2009). In the context of research on digital transformation, however, paradoxes are rarely addressed and, if they are, seen as an undesirable byproduct that stands in the way of successful digital transformation. We argue that because of the fundamental changes in identity caused by digital transformation, paradoxes emerge as a necessary part of digital transformation and not a byproduct.

In the following, we develop our argument by first delineating the concept of digital transformation from related concepts such as organizational transformation and IT transformation. We then take a closer look at the role of identities in digital transformation before examining specific paradoxes that arise due to the interaction between social and technical identities in the context of digital transformation. We conclude by discussing the four products of theorizing (Questions, Concept, Framework, Myth) (Hassan et al. 2022) developed within this paper.

2 WHAT IS DIGITAL TRANSFORMATION?

2.1 ORGANIZATIONAL TRANSFORMATION

It is helpful first to discuss the more general concept of organizational transformation (OT), which "is generally understood as a process that engenders a qualitatively different organization" through changes in the deep structure (Besson and Rowe 2012, p. 103). The deep structure can be understood as a "set of fundamental 'choices' a system has made of (1) the basic parts into which its units will be organized and (2) the basic activity patterns that will maintain its existence" (Gersick 1991, p. 14). Five critical activity domains make up an organization's deep structure (Tushman and Romanelli 1985). Table 1 below offers an overview:

Critical Activity Domains	Defined by Tushman and Romanelli (1985, p. 175) as:
(1) Core values and beliefs	"… set constraints as to where, how and why a firm competes."
(2) Business unit strategy	"… defines the nature of products produced and markets served and establishes general time and technological constraints."
(3) Power distributions	"… control the allocation of scarce resources."
(4) Organizational structure	"… formalizes hierarchy, role relations and competitive emphases."
(5) Nature and pervasiveness of control systems	"… indicate a firm's emphasis on efficiency."

Table 8. Critical Activity Domains

In the context of OT, the first activity domain – core values and beliefs – is particularly important since "(c)hanges in core values will be associated with cascading effects in strategy, power, structure and controls"

(Tushman and Romanelli 1985, p. 175). Shared social beliefs about distinctive organizational attributes are the core of an organization's identity and the most general activity area of an organization's deep structure, as it sets the boundaries for all other deep structure activities (Tushman and Romanelli 1985). Changes in the organizational identity, therefore, impact the deep structure of an organization by altering core values and beliefs (Tushman and Romanelli 1985), leading to "profound implications for how individuals, groups, and organizations think about who they are and what they do" (Wessel et al. 2021, p. 105).

2.2 TECHNOLOGY-ENABLED TRANSFORMATION

Due to its sociotechnical core (Sarker et al. 2019), the IS field is particularly interested in technology-enabled OT, which requires the consideration of both technical and social factors (Robey and Sahay 1996). The first stream of thought examining the role of technology during organizational transformation is *IT (or IS) transformation* (e.g., Besson and Rowe 2012; Crowston and Myers 2004; Orlikowski 1996). Proponents of this stream of thought refer to technology primarily as information technology (IT) and view IT units as separate units that cooperate with business units. This conceptual separation leads to the need for alignment between both worlds to improve business performance, as discussed in various seminal contributions (e.g., Chan and Reich 2007; Henderson and Venkatraman 1999).

Recently, a second stream of thought has emerged labeled *digital transformation* (e.g., Hanelt et al. 2020; Vial 2019; Wessel et al. 2021). Proponents refer to technology primarily as digital technology, arguing that the rapid proliferation of technologies in almost all areas of our lives makes existing frameworks that assume a separation of technology and business incapable of capturing the whole picture. Instead, they see digital technologies as deeply embedded into the business world and vice versa (Bharadwaj et al. 2013; El Sawy et al. 2010).

Hence, while both streams examine the role of technology in organizational transformation, they offer different perspectives regarding the meaning of technology-enabled transformation. While the term "IT" traditionally implies a stronger focus on the implementation of technology, the term "digital" often highlights a stronger focus on the associated social implications (e.g., new agile work routines). To characterize the differences between both views, Table 2 summarizes key differences highlighted in extant literature[17]:

[17] We are aware that these two perspectives are not always as clear-cut as portrayed here. Yet, while there certainly exists conceptual overlap, clearly distinguishing between both perspectives will help disentangling existing conceptual ambiguities.

Perspective on…	IT transformation	Digital transformation
Conceptualization of technology	• IT is a tool to carry out and reinforce business objectives (i.e., strategy, identity). • IT is understood along with its material properties (Boudreau and Robey 2005; Hanelt et al. 2020).	• Digital technology is an integral part of the business world (i.e., strategy, identity). • Focuses on digital properties such as generativity, convergence, and malleability (Kallinikos et al. 2013; Yoo et al. 2012).
Level of analysis	• IT systems such as ERP systems are developed and/or adopted within an organization, requiring an organization/team level of analysis (Hanelt et al. 2020; Volkoff et al. 2007). • Typically focusing on practice-level changes caused by technology-enabled transformation (Orlikowski 2000).	• Digital technologies transcend the boundaries of organizations and even industries, requiring a network/ecosystem level of analysis (Lyytinen et al. 2016; Tilson et al. 2010; Wang 2021b). • Typically focusing on organizational level changes, including fundamental changes as illustrated by developing new digital business models.
Organizational identity	• IT helps reinforce the existing organizational identity by supporting existing value propositions (Wessel et al. 2021).	• Digital technology requires the development of a new organizational identity due to the creation of new value propositions (Wessel et al. 2021).
Strategy-making	• IT strategy is "aligned but essentially always subordinate to business strategy" (Bharadwaj et al. 2013, p. 472)	• Digital business strategy as a fusion of IT and business strategy (Bharadwaj et al. 2013)

Table 2. Delineating the concepts of IT and Digital transformation

In summary, both views on technology-enabled transformation offer valuable yet distinct perspectives. Fundamental differences in the conceptualization of technology per se – as highlighted by the different terminology used – lead to different requirements regarding the level of analysis, organizational identity, and strategy-making (c.f., Bharadwaj et al. 2013; Kallinikos et al. 2013; Wessel et al. 2021). The impact on organizational identity appears to be a decisive difference in conceptually distinguishing between IT transformation and digital transformation. While IT transformations leverage technology to reinforce the organizational identity, digital transformations leverage technology to establish a new organizational identity (Wessel et al. 2021). Thus, the phenomenon of digital transformation conceptually differs from IT transformation, requiring us to avoid the "tendency to follow existing scripts" (Burton-Jones et al. 2021, p. 309) by taking a fresh theoretical perspective on digital transformation (Markus and Rowe 2021).

3 THE ROLE OF IDENTITIES IN DIGITAL TRANSFORMATION

In the following sections, we first discuss how digital technology changes social identities at the organizational and individual level (e.g., Belk 2013; Svahn et al. 2017a; Wessel et al. 2021) before introducing the currently missing focus on technical identities in more detail (e.g., Faulkner and Runde 2009, 2013, 2019; Hund et al. 2021c).

3.1 SOCIAL IDENTITIES

We first provide an overview of extant research regarding the role of identity in digital transformation before discussing the concept of social identity in more detail. Figure 1 provides a simplified illustration of the role of social identities in the current literature on digital transformation:

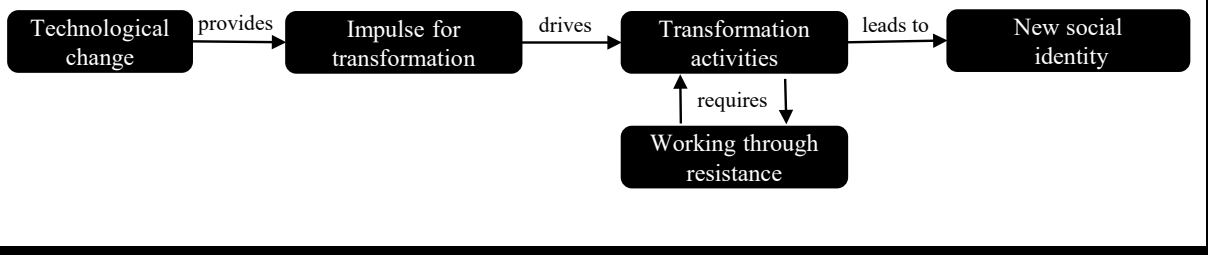

Figure 17. Role of social identity in current research on digital transformation based on Wessel et al. (2021)

Wessel et al. (2021) see the starting point for digital transformation in *technological change*, including the environmental and organizational context. For example, the need to meet standards defined by an external authority (environmental context) requires a hospital to go paperless and therefore drives the overall transformation agenda within the organization. Once the *impulse for transformation* is there, a transformation agenda emerges in which the preexisting organizational identity initiates a new identity claim. The new identity claim then drives various transformation activities that include using digital technology to transform the organization's overall value proposition. In the case of IT transformation, technology reinforces the existing value proposition, while in the case of digital transformation, technology redefines the existing value proposition (Wessel et al. 2021). Thus, activities in digital transformation require changes to existing practices, which also require *working through resistance* to achieve alignment. Ultimately, in the context of digital transformation, these activities lead to a *new organizational identity*.

In general, an organizational identity denotes "the attributes deemed central and distinctive to the organization" (Grimes et al. 2019b, p. 819) from an internal as well as external point of view (Hsu and Hannan 2005; Pólos et al. 2002). Being defined as "members' shared beliefs about the distinctive, central, and relatively enduring attributes of the organization (Albert & Whetten, 1985), an organization's identity answers fundamental questions, such as 'Who are we as an organization?' […]" (Piening et al. 2020, p. 327). Thus,

organizational identity serves as a social "guidepost, directing the development of some routines and capabilities over others and reinforcing some beliefs over others" (Tripsas 2009, p. 442).

Individuals' social identity may include organizational values and norms, loyalty and pride toward the organization, and a willingness to support the organization (Ashforth and Mael 1989). When the individual's values and beliefs are consistent with the organizational identity, this is referred to as deep-structure identification[18], which strengthens the sense of belonging and is associated with "increased involvement and cooperation among members of a collective, leading to ever-greater levels of identification over time" (Fiol 2002, p. 656). While organizational identity influences an individual's social identity, there is a reciprocal relationship as the individual's social identity also influences the overall organizational identity. According to Albert and Whetten (1985), the shared social understanding of what constitutes an organization determines the organizational identity as a whole as reflected in shared values and beliefs. Thus, an organization as a social group exhibits an organizational identity based on its members' shared understanding of values and beliefs. These group members exhibit a social identity at the individual level, including the shared values and beliefs at the organizational level.

3.2 TECHNICAL IDENTITIES

Our first research question relates to the sociotechnical nature of digital transformation. Guided by this question, we now extend the current debates by defining the *concept* of 'digital,' which enables developing a *framework* that embraces the sociotechnical nature of digital transformation. To this end, we first introduce relevant insights about the nature of 'digital' per se. In the context of sociotechnical phenomena, it is evident that social aspects as defined in individual or organizational identities are changing, *and* the role and identity of technology itself (Faulkner and Runde 2019; Hund et al. 2021c). To address the current 'pretheoretical understanding' of technology (Ekbia 2009)[19], we synthesize insights from the literature examining the nature of the 'digital' per se with the literature on digital transformation to introduce the vocabulary needed to describe our sociotechnical considerations.

3.2.1 DIGITAL OBJECT

Whether digital or non-digital, an object must be structured and enduring (Faulkner and Runde 2013). For our purposes, an object is "structured" when it consists of various parts organized in a certain way to make up the object. It is "enduring" when these organized parts persist over the entire time of the object's existence. "Objects are, therefore, distinct from other kinds of entities, such as events, that are occurrents and whose different parts occur at different points in time" (Faulkner and Runde 2013). Furthermore, there are material as well as nonmaterial objects. While material objects are characterized by attributes such as volume, mass, and a specific location, nonmaterial objects are not since they do not possess any spatial

[18] Please note that the term "deep-structure identification" does not relate to the term "organizational deep structure". These terms are used in different strands of literature.
[19] For a detailed discussion of the "pretheoretical understanding of technology" in IS research, please refer to Appendix B.

attributes (Faulkner and Runde 2019).[20]

A specific type of nonmaterial object – *digital object* – is especially relevant to understanding digital transformation. Digital objects are "objects whose component parts include one or more bitstrings" (Faulkner and Runde 2019, p. 7). Bitstrings "are one of the cornerstones of the digital revolution, since the information stored and manipulated on almost all silicon-based von Neumann computers, including traditional transistor-based digital PCs, is encoded in bitstrings" (Faulkner and Runde 2019, p. 7). Bitstrings themselves fulfill the requirements of objecthood since they consist of organized parts (thus being structured), and each part exists simultaneously throughout time (thus being enduring). In the case of bitstrings, the distinct parts are the 0's and 1's that follow the syntactical rules of specific file formats. Notably, while bitstrings are always nonmaterial, digital objects might also be hybrids that combine nonmaterial objects (i.e., bitstrings) with material objects (i.e., transistors).

3.2.2 Digital Technology

In the industrial era, analog product designs followed a modular logic, which allowed to specify the product architecture and function before production (Henfridsson et al. 2014). Due to the high malleability of digital objects (e.g., Kallinikos et al. 2013), product designs can no longer be defined upfront but are "inductively enacted by orchestrating an ensemble of components from a set of heterogeneous layers" (device, network, service, and content layer) (Yoo et al. 2010, p. 728). This enables various actors to independently identify new use cases and combinations for digital objects across these four layers (Henfridsson et al. 2018; Yoo et al. 2010), making digital product designs highly fluid and characterized by "vaguely determined initial outcomes" (Nambisan et al. 2020, p. 2). This high fluidity allows actors to independently reinterpret a digital object's use cases and meanings (Henfridsson et al. 2018) and ultimately assign a new meaning to what purpose the digital object could be used for.

This line of thought intersects with research on technical identity, which argues that objects can possess "a technical identity within a social group – something that flows from the combination of their physical form and the use to which they are put within that group" (Faulkner and Runde 2009, p. 444). In that regard, the object's *function* is the use that members of a social group impose on the object, and thus the function is collectively assigned and not intrinsic to the object (Faulkner and Runde 2013). The *form* of an object relates to physical properties and can be generalized to an object's *structure,* which encompasses material and nonmaterial objects. The structure is a property of the technical artifact and must be "generally able to perform the function" (Faulkner and Runde 2013, p. 807). Figure 2 illustrates how the technical structure of a digital object affords a range of use cases that social actors can then interpret to assign the digital object a technical

[20] To illustrate: A car classifies as an object since it is made up of various organized parts (thus being structured), which persist simultaneously throughout the entire existence of the car (thus being enduring). More specifically, a car would classify as material object since it possesses spatial attributes (location, shape, mass etc.). In contrast: A corporate event, for example, has no spatial properties and could therefore be classified as a non-material object. However, while it could be argued that a corporate event is structured (consists of organized parts such as a reception and various functions), it is not enduring because its "[...]different parts occur at different times" Faulkner and Runde (2019). Therefore, a corporate event does not fulfill the requirements of objecthood.

identity within their group that defines the specific function of the digital object.

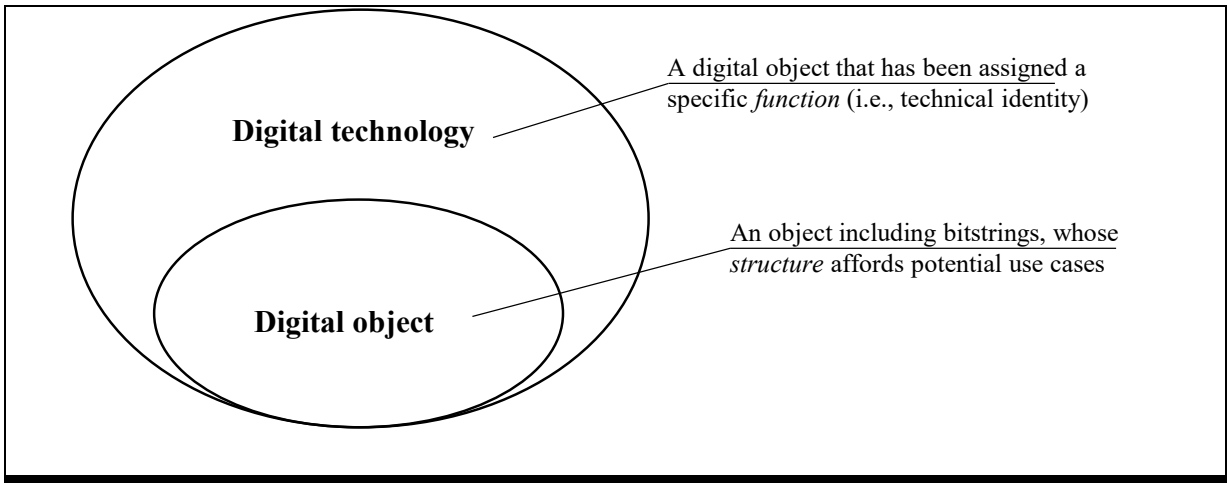

Figure 18. Structure and function of digital technology adapted from Hund et al. (2021c)

During a digital transformation, users assign new meanings and interpretations to digital objects (Faulkner and Runde 2009, 2013), which changes "the identity of digital objects, their use, and 'fit' generally within the social world" (Faulkner and Runde 2019, p. 5). Once "a digital object […] has been assigned a socially agreed-upon meaning" (Hund et al. 2021c, p. 5), it is referred to as digital technology. In other words, digital objects are used for different purposes across different contexts and are, therefore, assigned different technical identities by the respective individual or social group. This perspective puts digital technology at the heart of an organization's value proposition, which is "deeply related to an organization's identity in that it involves a definition of what an organization is and how it creates value for its customers" (Wessel et al. 2021, p. 118).[21]

In summary, the *structure* of a digital object can be described from a purely technical point of view, as highlighted by the discussion on material and nonmaterial objects. Yet, the *function* (i.e., what is the digital object used for) is externally assigned to the digital object by social actors, determining its technical identity and overall place in the world. The label *digital object* accentuates the *structure* (i.e., the technical perspective), whereas the label *digital technology* focuses on the *function* (i.e., socially imposed use cases that determine the overall technical identity).

3.3 CONSIDERING SOCIAL *AND* TECHNICAL IDENTITIES IN DIGITAL TRANSFORMATION

Our considerations regarding (1) changes in the deep structure and (2) the sociotechnical nature of digital transformation enable a deeper reading of the phenomenon per se. Figure 3 extends the status quo presented in Figure 1 by taking into account that changes in the deep structure regarding core values and beliefs, which

[21] Just as a human might hold different social identities according to specific contexts (e.g., parent, friend, lawyer), a digital object too can be assigned different technical identities across various use contexts (Faulkner and Runde 2019). Such technical identities can persist "largely independently of their particular occupants. This means, for example, that manufacturers might discontinue old models of objects such as computer screens, inkjet printers, and iPhone apps, and introduce new models, without affecting – indeed often relying on – the social positions concerned to persist in largely unchanged form" (Faulkner and Runde 2013, p. 808).

encompass social *and* technical aspects, must be considered simultaneously (dashed/dotted lines indicate what is new compared to Figure 1).

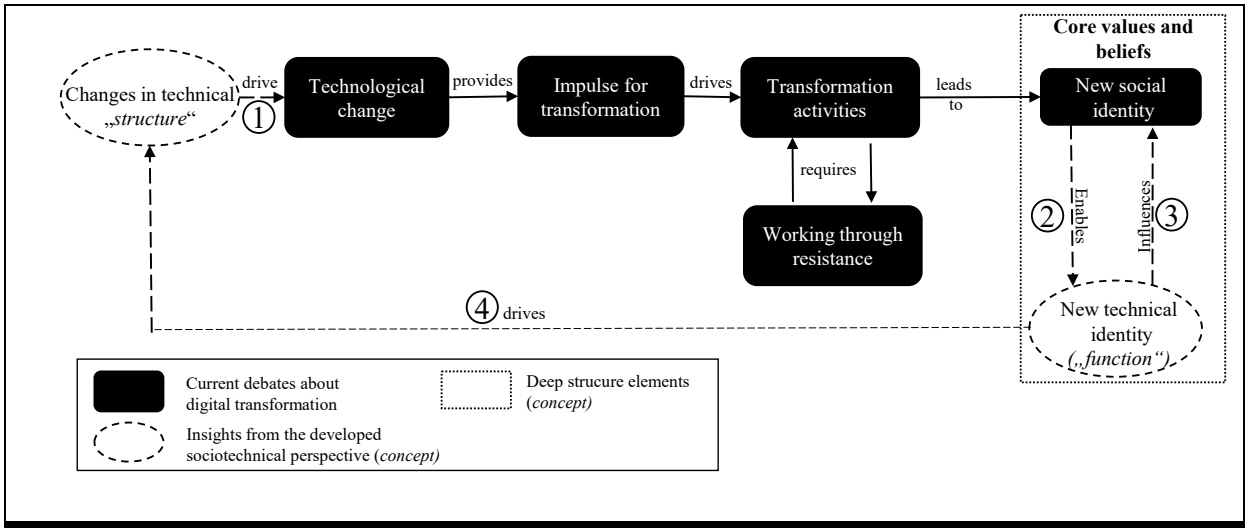

Figure 19. Digital transformation as a sociotechnical phenomenon

In particular, we want to highlight four implications (as indicated by the numbers in the figure) that arise from the sociotechnical perspective, which extend the current understanding of digital transformation and allow a deeper reading of digital transformation per se.

(1) Technological change, which encompasses the environmental and organizational context, is initially driven by changes in the technical *structure* of digital objects. If the structure of a digital object is changed, the inherent technical capabilities and features change accordingly. For example, the immense computing power increase of integrated circuit chips predicted by Moore's Law (Fichman et al. 2014) represents a drastic change in the underlying technical structure, opening up a wide range of potential new use cases for the digital object such as the creation of mobile instead of stationary computing devices. Thereby, changes in the technical structure drive fundamental technological changes in the overall environmental and organizational context.

(2) Using digital technology to transform an organization's value proposition changes the core values and beliefs, which leads to a new social (i.e., organizational) identity and, thereby, enables reinterpreting the *function* of a digital object. However, since existing guidelines expressed in the social identity of individuals and/or groups determine how the structure (i.e., technical capabilities) of a digital object is perceived, reinterpreting the function (i.e., use cases) requires a change in the social identity first (Tripsas 2009). The new social identity provides a new frame of reference to reinterpret the function of an emerging digital object by matching its capabilities with a specific use case and thereby assigning it a new meaning, which is expressed in the new technical identity (Faulkner and Runde 2019). Therefore, organizational identity can be understood as a filter that influences the interpretation of the structure and function of digital technology (Tripsas

2009).

(3) The social and technical identity also exhibit a reciprocal relationship. For example, if the technical identity changes (i.e., what digital technology is used for), it might also entail the emergence of new customer segments and markets (Faulkner and Runde 2013) or the identification of new use cases and potential combinations with other digital technologies (Henfridsson et al. 2018). Therefore, such changes in the technical identity may require rethinking the organizational strategy and overall value proposition expressed in the social identity (Wessel et al. 2021). Thus, to understand the sociotechnical nature of digital transformation, changes in social and technical identities must be considered. Either to align existing values expressed in social identity or to enable a new interpretation of the function of digital technology expressed in its technical identity.

(4) The new technical identity, which is about the defined *function* of digital technology, also drives technological change by opening up new use cases. For example, the function of digital technology could be defined as a component of another product (i.e., a tablet that is part of a connected car) or as a standalone product (i.e., the tablet itself) (see Wang 2021a). Users often identify new potential use cases while using a specific technology (Henfridsson et al. 2018). Identifying a new use case and the associated reinterpretation of the technical identity can trigger new, generative developments in the technical structure.

In the following section, we build on our findings regarding technical and social identity changes to illustrate why the emergence of paradoxes is not an undesirable byproduct of digital transformation but rather a necessary component of successful transformation.

4 Digital Transformation as Paradoxical Process of Identity Transformation

We now turn to our second research question, which focuses on the emergence of sociotechnical paradoxes, addressing our *framework* and the existing *myth* that paradoxes are an undesirable byproduct. In the context of digital transformation, core values and beliefs as expressed in social or technical identities, are being challenged by digital technology, often leading to paradoxes (e.g., Brunswicker and Schecter 2019; Ciriello et al. 2019; Smith and Beretta 2021; Svahn et al. 2017a; Tilson et al. 2010). Extant research predominantly views such paradoxes as an undesirable byproduct, standing in the way of successful digital transformation (see Smith and Beretta 2021; Svahn et al. 2017). However, in what follows, we challenge this myth by showing that different types of paradoxes are *necessarily* arising when the activity domains of the deep structure are changing.

For example, digital transformation requires fundamental changes in the existing identity that defines what an organization stands for, including its core values (Wessel et al. 2021). Such fundamental changes

involve dramatic shifts of organizational expectations leading to paradoxical tensions between interwoven but opposing elements (Lüscher and Lewis 2008; Svahn et al. 2017a). When engaging in digital transformation, current understandings must be questioned to discover new ways of thinking to create "a more workable certainty that enables change" (Lüscher and Lewis 2008, p. 234). Although paradoxes can be observed in many areas, the very nature of digital transformation appears to be paradoxical, and the necessary changes in the organizational deep structure are only possible by working through the arising paradoxes within each activity domain. Paradoxes arising from opposing poles in different domains, such as existing vs. requisite capabilities during digital transformation, are frequently reported (e.g., Smith and Beretta 2021; Svahn et al. 2017a). Considering that how paradoxes are managed determines organizational performance and survival (Schad et al. 2016), the paradox lens enables an essential perspective on addressing the management of the contradictory forces arising in the context of digital transformation. In the following paragraphs, we develop our argument that digital transformation is a paradoxical process of identity transformation[22].

Our starting point involves the following premises:

(1) Digital transformation requires fundamental changes in the organizational deep structure, starting with the activity domain 'core values and beliefs' as expressed in social and technical identities.

(2) Changes in the 'core values and beliefs' are "associated with cascading effects in strategy, power, structure and controls" (Tushman and Romanelli 1985, p. 175) and, therefore, affect all activity domains of the deep structure.

(3) Fundamental changes in the organizational deep structure's activity domains due to digital technology inevitably create paradoxes that are a necessary part of the transformation itself and, if addressed adequately, can lead to a successful digital transformation.

Figure 4 presents our final *framework* that illustrates how the sociotechnical *conceptualization* of social and technical identity in the digital transformation enables a deeper reading of the necessary changes in deep structure, which are only possible through the emergence of specific types of paradoxes. After the overview presented in Figure 4, we discuss the different types of paradoxes in detail and apply our insights to the case of Volvo Cars published by Svahn et al. (2017a).

[22] For a brief discussion on paradoxes already discussed in extant literature pertaining to digital transformation, please refer to Appendix C.

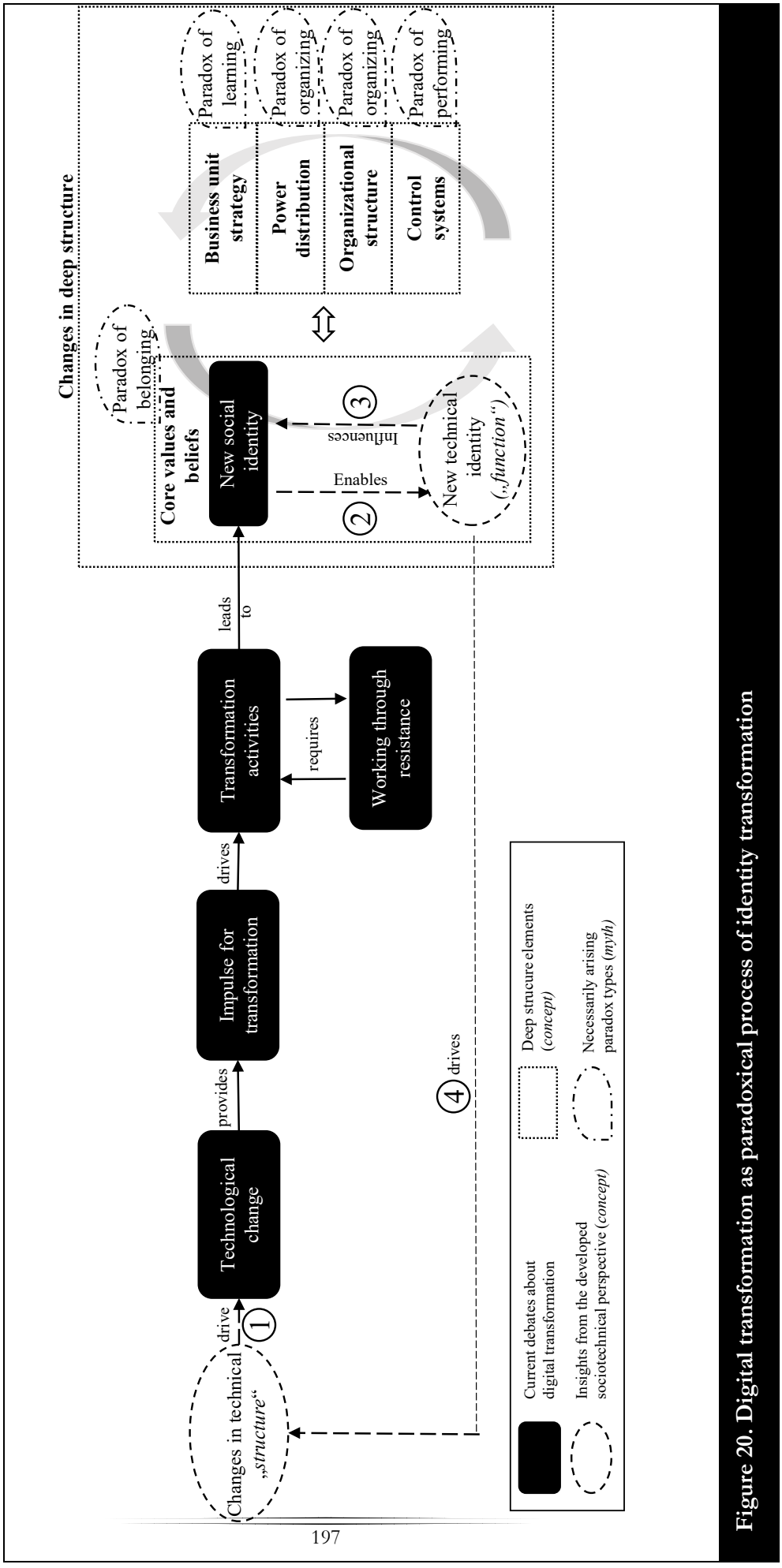

Figure 20. Digital transformation as paradoxical process of identity transformation

4.1 Paradoxes Related to Deep Structure Changes during Digital Transformation

Smith and Lewis (2011, p. 383) identify four categories of paradoxes which are the paradoxes of organizing (processes), performing (goals), learning (knowledge), and belonging (identity/interpersonal relationships) (for definitions and explanations, please refer to Table 3 below). In the following, we use the four categories of paradoxes to better understand the interaction between technical and social identity and use the Volvo Cars case by Svahn et al. (2017a) as an illustrative case.

4.2 The Case of Volvo Cars

In a case study of Volvo Cars, Svahn et al. (2017a) report on the connected-car initiative with its vision to enhance customer experience and generate new revenue streams by embracing digital technology to connect with consumer electronics developments, requiring the continuous development of cars after their production. Essentially, "a connected car had to be designed for continuous evolution across its lifetime" instead of "pushing well-defined, incrementally improved product attributes to market through model year facelifts" (Svahn et al. 2017a, p. 241). This vision involves engaging with external developers, an increased pace of change, and, consequently, a departure from traditional automotive cycle plans and division of labor, essentially reflecting that "products and services are inherently unbounded […] and incomplete" (Svahn et al. 2017a, p. 248).

Interpreting the case through the lens of technical and social identity, the "connected car" represents the digital object, designed in a new way that allows continuous evolution and requires changes of the organization from a product focus to a process focus. The move from "car" to "connected car" represents a change of technical identity expressed by these labels. As discussed above, if the structure of digital objects changes, new uses become possible, and users may assign new meanings (Faulkner and Runde 2009, 2013), which changes "the identity of digital objects, their use, and 'fit' generally within the social world" (Faulkner and Runde 2019, p. 5). In the case, new uses are identified, leading to a new meaning as a "connected car", which, in turn, requires changes of the social identity of organizational members and the organization itself. Changes in the established identity are necessary to interpret the digital object's structure (i.e., technical capabilities) outside of already existing frames, which potentially filter out the new affordances (Nambisan et al. 2017; Tripsas 2009).

Regarding the case (Svahn et al. 2017a), members of the Connectivity Hub focused on generating new functionality through the interplay between various internal and external stakeholders, which, in addition to the fast pace of changes in the connectivity domain, makes thinking in multi-year plans obsolete. Members of the Hub assumed new organizational roles and were recruited to fill these roles, which fit the new technical identity of the "connected car". However, this was in stark contrast to other stakeholders. While recognizing the long-term vision, middle managers focused on their established practices of traditional automotive cycle

plans, which require scheduling product releases. Purchasers were obliged to acquire physical products according to a roadmap, and designers were used to thinking about physical products rather than platforms with open API. These stakeholders' social identity did not fit with the technical identity of the "connected car", which created tensions.

The four paradox types can be applied to the Volvo Cars case to illustrate how considering social and technical identities enables a deeper reading of digital transformation per se. Table 3 defines each paradox type, outlines their manifestation in the Volvo Cars case, and highlights the role of technical and social identities.

Table 9. Social and technical identity formation and paradoxes

Paradox type and definition	**Manifestation in the Volvo Car case**	**Role of identity exemplified in the Volvo Car Case**
Paradox of organizing surfaces "as complex systems create competing designs and processes to achieve a desired outcome" (Smith and Lewis 2011, 383-384)	Tension between enabling more external collaboration without jeopardizing internal cost and coordination efficiency	• Change in **technical identity** highlights the need for new norms, roles, and structures. The establishment of the Connectivity Hub reflects this as a learning repository and to support a new technical identity. • The established **social identity** within the organization is challenged by creating new norms, roles, and structures. Connectivity Hub members are expected to challenge existing norms and practices and facilitate learning from other social groups. The identity of their social group changes, which is reflected in new roles, e.g., purchasing function.
Paradox of performing stems "from the plurality of stakeholders and result in competing strategies and goals" (Smith and Lewis 2011, p. 384)	Tension between stakeholder groups that understand their product either as "car" versus "connected car" and associated differences in measuring success	• Different **technical identities** exist within the company as some stakeholders still interpreted their product as a "car" whereas others are working on the "connected car". • **Social identity** is changing at different trajectories within the company as, e.g., middle managers are struggling to unite short-term commitments with the new long-term vision.
Paradox of learning surfaces "as dynamic systems change, renew, and innovate" (Smith and Lewis 2011, p. 383)	Tension between building up requisite capabilities aligned with the "connected car", without jeopardizing existing capabilities aligned with the logics of the	• The shift in **technical identity** highlights the need for new digital capabilities supported by the Connectivity Hub, which was established to facilitate networked arrangements. • **Social identity** changes due to the new capability requirements, which oftentimes compete

	"car"	with existing capabilities. The Connectivity Hub serves as repository for learning and to enable other organizational functions
In the **paradox of belonging** "[c]omplexity and plurality drive belonging paradoxes, or tensions of identity" (Smith and Lewis 2011, p. 383)	Tensions between already existing norms, roles, and structures and the need to critically rethink them	• Changing the **technical identity** from "car" to "networked car" means moving away from the traditional planning cycles in the automotive industry with its predefined versions and moving away from the established arrangements for the division of labor. • Established **social identity** within the company is challenged, resulting in new norms, roles, and structures. For example, purchasers should focus more on relationships than purchasing physical goods with specific quality and price.

4.2.1 Paradox of Organizing

The paradox of organizing emerges through new organizational designs and processes. It involves, for example, the opposing elements empowerment and direction, loose and tight coupling, and routine and change (Smith and Lewis 2011).

As discussed above, the change in the structure of the digital object (here: initially the "car") entailed a change in the technical identity as expressed in the new label "connected car," which in turn induced changes in the social identity of the individual and the organization. These changes are coupled with paradoxes of organizing that, among other things, require engaging "in external collaboration with new partners while preserving cost-efficient coordination of internal resources" (Svahn et al. 2017a, p. 247). To support the connected-car initiative, Volvo Cars' executive team established the Connectivity Hub designed to overcome traditional division of labor and integrate different stakeholders such as R&D, Marketing, and Design to foster engagement with the external ecosystem. The Connectivity Hub was set up as a transient initiative to prevent it from becoming a rival unit to the existing units and staffed with people willing to challenge established practices (see Svahn et al. 2017a). The Connectivity Hub brought about a new set of actors (the Hub's members), roles, and goals, which remained embedded in the organization while challenging established arrangements and, at the same time, requiring cognitive and emotional distance from certain aspects of the organization per se. "This mix of distance and embeddedness in turn animated a sense of purpose" (Creed et al. 2010, p. 1353) and thereby changed social identity. This seemed to be the case for members of the Connectivity Hub (the new roles) and, e.g., for middle management (the established roles). In response to the new technical identity of the "connected car", organizational members' social identity changed regarding what they focused on and how they understood their role. Further, organizational members' and the organ-

ization's social identity mutually interacted because the organizing model and organizational members challenge existing routines and practice experienced paradoxes to which they reacted by "enact[ing] the design locally through their everyday work" and, in turn, altered the organizing model in fundamental ways (Smith and Beretta 2021, p. 186).

4.2.2 Paradox of Performing

The paradox of performing emerges through the plurality of stakeholders and their multiple and competing goals (Smith and Lewis 2011). This paradox is reflected in IS research, e.g., by discussing short- vs. long-term goals (Gregory et al. 2015). For example, middle managers in the "connected cars" case study "felt trapped between long-term visions requiring novel capabilities and short-term commitments related to existing practices" (Svahn et al. 2017a, p. 241). Middle managers asked when specific functions would be integrated into the car, reflecting a product focus, following the established planning processes in the automotive industry. Nevertheless, a classic automotive planning schedule contradicts the long-term vision of giving life to cars even after they are sold, which requires "disconnecting from traditional automotive cycle plans" (Svahn et al. 2017a, p. 241).

In contrast to the goals of middle managers, the overall goal of members of the Connectivity Hub related to generating new functionality through networked arrangements with internal and external stakeholders. Based on traditional automotive industry cycle plans, the purchasing function aimed to structure contracts to ensure delivered goods' quality, price, and functionality throughout the product lifecycle. However, introducing the connected car challenged these goals and required purchasing goals, geared more towards the consumer electronic market with shorter lead times (Svahn et al. 2017a).

The statements above tap into the paradox of performing by entailing diverse stakeholders and their opposing but still interrelated goals. While it can generally be assumed that the tensions between the goals of different stakeholder groups are also present in the established environment of the 'car' (as opposed to the 'connected car'), these tensions may have been latent and are now becoming salient (Smith and Lewis 2011) due to the 'connected car'. As discussed above, the 'connected car' label signifies a shift in technical identity. However, to stick with our example, the shift of technical identity is first taking place among the members of the Connectivity Hub, while other parts of the company, such as the middle management, initially keep the technical identity of the "car". Along with the change of technical and social identity, the paradox of performing unfolds with the competing goals of multiple stakeholders where in the beginning, the goals of Volvo's Hub members stood in stark contrast to the goals of middle management.

4.2.3 Paradox of Learning

The paradox of learning emerges through "(e)fforts to adjust, renew, change, and innovate (which) foster tensions between building upon and destroying the past to create the future" (Smith and Lewis 2011, p. 238). The case of the 'connected car' shows that the company's innovation capabilities had to be adapted, creating

tensions between "employees who seek to bring about change and those whose capabilities have become core rigidities" (Svahn et al. 2017a, p. 239). Volvo's purchasing contracts evolved from acquiring physical goods to acquiring partnerships in the "connected car" context, which understands the 'connected car' as an unbound and incomplete digital object and requires networks of partners to come to life. Thus, Volvo used the new organizational arrangement "Connectivity Hub" to "serve as a repository for cumulative learning about managing radical innovation" (Svahn et al. 2017a, p. 248, after Leifer et al. 2001). In that respect, the Connectivity Hub helped the purchasing department learn about new requirements, focusing on the innovation process rather than its outcome. Similarly, the design department had to learn how to deal with platforms and communities.

The paradox of learning is thus linked to a shift in the technical identity of the 'connected car', which is highlighted in the initial inability of design engineers to make sense of new developments. Addressing such inabilities required workshops where hub members offered new approaches "to learn how to identify, encourage, and leverage external partners based on continuous scanning of emerging markets and technology developments" (Svahn et al. 2017a, p. 242). The detection of the "*need to shift focus toward external environments and adopt new perspectives on a world with which we are increasingly intertwined*" (Svahn et al. 2017a, p. 242, italics in the original text) is influenced by the shift in the digital object's technical identity, which leads to new requirements in learning.

4.2.4 Paradox of Belonging

The paradox of belonging is about competing values and roles that cause identity tensions arising "between the individual and the collective" (Smith and Lewis 2011, p. 383). In the case, this is illustrated when the "executive team expected the transformation to be burdensome because it involved shifts in firm identity […]", which would uncover tensions between existing and new structures (Svahn et al. 2017a, p. 246). In a similar vein, Wessel et al. (2021, p. 106) argue that strategic initiatives have consequences for organizational identity because "identity-related microdynamics […] may arise during different transformation processes, as managers often ask organizational members to engage in new work practices". Such new work practices entail redefining roles that may lead to conflicts (Wessel et al. 2021) and challenge organizational members' attitudes and, thus, their social identity (Ashforth and Mael 1989).

While these statements concern the social identity of the organization's members and the organization itself, the sociotechnical perspective on digital transformation shows the essential role of technical identity. New combinations of hardware and software components change the structure of the digital object 'car,'[23] affording new action potentials. Social actors such as organizational members interpret these action potentials and identify new uses, ultimately assigning a new technical identity to the digital object, which is explicit

[23] For referring to the 'car' as a digital object we think that it is reasonable to assume that the 'car' already encompassed bitstrings, e.g., in form of embedded software.

with the label 'connected car'. The changed technical identity interacts with the social identity as organizational members found new roles, e.g., designers considered platforms instead of hardware, and buyers focused on relationships with partners instead of traditional quality attributes (see Svahn et al. 2017). In addition, new roles were defined for members of the Connectivity Hub, where Volvo sought individuals who challenge existing norms, or in other words, the established social identity of organizational members and corporate identity.

5 DISCUSSION

We started this paper by noting that extant research on digital transformation has considered changes in core values and beliefs as expressed in social identities but has not considered technical identities. By examining the interplay between social and technical identities and associate changes in other activity domains of the deep structure, we delineate the integral role of paradoxes in enabling change. While paradoxes in digital transformation have been addressed in previous research, they are viewed as an undesirable byproduct rather than an integral part of digital transformation. Addressing this dearth in the extant literature, we develop four products of theorizing (questions, concept, framework, myth) (Hassan et al. 2022), which enable a more profound reading and understanding of digital transformation to foster future theorizing.

5.1 PRODUCTS OF THEORIZING

Questions: The posed research questions (*RQ1: How do social and technical identities change and interact during digital transformation?; RQ2: How can a sociotechnical perspective on paradoxes help navigate digital transformation?)* require considering "technical artifacts as well as the individuals/collectives that develop and use the artifacts in social […] contexts" simultaneously (Sarker et al. 2019, p. 696). Question 1 addresses the reciprocal relationship between social and technical identities. Question 2 addresses the paradoxes that arise from this sociotechnical interrelationship and how they can be addressed in the context of digital transformation. Since sociotechnical questions are at the heart of the IS discipline (Sarker et al. 2019), these questions represent *disciplinary questions* that outline "an object of study as a problem requiring a solution based on the field's rules of discourse and pattern of inquiry" (Hassan et al. 2022, p. 5).

Concept: While the prefix 'digital' indicates something new (Avital et al. 2019), the term remains ambiguous in extant research on digital transformation. We introduce insights from related but disparate research areas (see Faulkner and Runde 2009, 2019; Hund et al. 2021c) that allow for a deeper reading of the term 'digital' itself. This deeper reading enables a clear conceptualization of the sociotechnical nature of digital transformation, allowing us to conceptually distinguish between technical and social aspects and examine their interrelations (see Figure 2). Furthermore, we introduce the concept of 'deep structure' to the literature on digital transformation and highlight that changes in the activity domain of 'core values and beliefs' as expressed in social and technical identities also trigger changes in all other activity domains.

Framework: A framework is "the researcher's map of the territory being studied" (Hassan et al. 2022, p. 5). We extend current debates in IS regarding digital transformation as recently put forward by Wessel et al. (2021) (see framework depicted in Figure 1) by considering the implications that arise from the sociotechnical perspective enabled through our previous conceptualization. Doing so, we first develop the argument that digital transformation leads to a change in social identity and technical identity (see Figure 3) before discussing how the interplay between technical and social identity in the activity domain 'core values and beliefs' triggers changes in all other activity domains of the deep structure (see Figure 4). Importantly, we closely follow the underlying context and assumptions of current debates within the IS field regarding digital transformation and highlight the central role of technical identity and paradoxes by considering the sociotechnical nature of digital transformation. Thereby, we introduce a common denominator between research on digital transformation, which highlights the central role of digital technology and identity (e.g., Vial 2019; Wessel et al. 2021), and research that investigates the nature of 'digital' and its identity per se (e.g., Faulkner and Runde 2019; Hund et al. 2021c). We illustrate the conceptual benefits of considering social *and* technical identity changes as well as paradoxes using the Volvo Car case as an example (see Svahn et al. 2017a).

Myth: A myth is a narrative that underlies the understanding of the origin or the change of some imagined event (Hassan et al. 2022). While myths are colloquially understood as popular but false beliefs, "they can help uncover unquestioned assumptions within existing belief systems and theories" (Hassan et al. 2022, p. 9). Extant research that examines digital phenomena frequently reports emerging paradoxes (e.g., Ciriello et al. 2019; Jarvenpaa and Lang 2005; Tilson et al. 2010), yet mainly with the underlying assumption that such paradoxes represent a rather inconvenient byproduct. We challenge this assumption by arguing that the fundamental changes in the deep structure (Tushman and Romanelli 1985) necessary for successful digital transformation are only possible by engaging with and working through such emerging paradoxes. Thus, digital transformation is a paradoxical process of social and technical identity formation, which challenges the predominant myth that paradoxes are a harmful byproduct and introduces an alternative myth that frames paradoxes as an integral and necessary part of digital transformation.

5.2 IMPLICATIONS OF THE PRODUCTS OF THEORIZING

The four products of theorizing have implications for future research on digital transformation. To address our first research *question*, "How do social and technical identities change and interact during digital transformation?" we developed an in-depth conceptualization of digital transformation by introducing the *concepts* 'deep structure' and 'technical identity'. Based on our insights, we highlight two key implications for future research: (1) Changes in the deep structure domain 'core values and beliefs' encompass social and technical identities, which enables future research to truly consider the sociotechnical nature of digital transformation. Considering social *and* technical factors, which are at the heart of digital transformation, enables positioning research "explicitly along this continuum by emphasizing the technical or the social side […]

without losing sight of the other" (Hund et al. 2021c, p. 13), as has been recommended for digital phenomena (Sarker et al. 2019). (2) Furthermore, since "(c)hanges in core values will be associated with cascading effects in strategy, power, structure and controls" (Tushman and Romanelli 1985, p. 175), digital transformation does not only lead to changes in 'core values and beliefs' as expressed in social and technical identity. Instead, it causes fundamental changes within the deep structure across all five activity domains, as our final *framework* displayed in Figure 4 indicates. Future research on digital transformation can, therefore, focus on the implications of digital transformation for specific activity domains (i.e., how does digital technology change the overall 'Business unit strategy'?) or consider the holistic interplay between several activity domains (i.e., how do changes in 'Business unit strategy' affect the 'Organizational structure' and vice versa?).

Building upon these insights, we address our second research *question*, "How can a sociotechnical perspective on paradoxes help navigate digital transformation?". Here, we also want to highlight two key implications for future research: (1) Digital transformation inevitably leads to paradoxes, e.g., when an organization tries to enable more autonomy at the individual and team level while controlling the overall contributions of individuals and teams at the organizational level. As discussed within the exemplary case of Volvo Cars (Svahn et al. 2017a), different types of paradoxes are prone to arise within different domains of the deep structure (see the final *framework* in Figure 4 for an illustration). Therefore, future research can examine the emergence and resolution of specific types of paradoxes (i.e., organizing, performing, learning, belonging) (Schad et al. 2016) within the grander context of digital transformation. (2) In contrast to the predominant *myth* that frames paradoxes as an undesirable byproduct that should be reduced as much as possible or, if possible, avoided altogether, we develop an alternative narrative that defines paradoxes as an integral and even necessary part of digital transformation. Tackling the inevitably arising paradoxes during digital transformation leads to "reinforcing cycles that can be negative or positive" and are part of a dynamic process of resolving and accepting paradoxes, leading to new paradoxes, and so on (Smith and Lewis 2011, p. 391). Embracing the developed *myth* that frames paradoxes as a necessary part of digital transformation enables working with and through them productively, for example, by adopting "paradoxical thinking in order to cope with and work through contradictions and initiate virtuous cycles of acceptance and synergy" (Ciriello et al. 2019, p. 21). Our final *framework* facilitates the identification of specific paradoxes during digital transformation by locating different types of paradoxes within the different domains of the affected deep structure. In the Volvo Cars case (Svahn et al. 2017a), the shift from a "car" to a "connected car" logic led to competing identities possessing different 'core values and beliefs', ultimately giving rise to the paradox of belonging. This, in turn, led to paradoxes of organizing (e.g., roles and departments aligned with the 'car' versus the 'connected car' logic), performing (e.g., goals aligned with the 'car' versus the 'connected car' logic), and learning (e.g., existing versus required, new skills and knowledge). Engaging with these paradoxes, facilitated by members of the Connectivity Hub, helped reconcile and align social identities, giving birth to a new technical identity of the digital object by assigning meaning and evolving social identities of individuals and organizations. Therefore, minimizing potential paradoxes risks minimizing the overall potential of digital

transformation. Instead, digital transformation requires embracing the potentially inconvenient but necessary paradoxes as "these paradoxical tensions, […] can be a source of productive and creative digital artefact usage" (Ciriello et al. 2019, p. 29).

6 CONCLUSION

In this paper, we develop four products of theorizing (question, concept, framework, myth), to take a first step towards developing next-generation IS theories. Doing so allows us to make four key contributions: (1) we emphasize the sociotechnical nature of digital transformation, which has implications for *social and technical* identities; (2) we show that digital transformation does affect all domains of the organizational deep structure, rather than just the 'core values and beliefs'; (3) we reframe paradoxes as an integral and necessary part of digital transformation rather than an undesirable byproduct; (4) we locate specific types of paradoxes that are more prone to arise in different domains of the organizational deep structure.

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APPENDIX

PUBLICATIONS

PEER REVIEWED JOURNAL ARTICLES

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Figure 4	Reprinted from Publication title: Information and Organization; Vol/edition number: 28; Authors: Ola Henfridsson, Joe Nandhakumar, Harry Scarbrough, Nikiforos Panourgias; Title of article: Recombination in the open-ended value landscape of digital innovation; Page: 89-100; Copyright (year): 2018; with permission from Elsevier