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# Digital innovation: Review and novel perspective

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ABSTRACT

While research has produced valuable insights about digital innovation, we lack a comprehensive understanding about its core nature, and research across disciplinary boundaries lacks integration. To address these issues, we review 227 articles on digital innovation across eight disciplines. Based on our findings, we (1) inductively develop a new definition and propose a new framing of current conceptualizations of digital innovation, (2) organize central concepts of the literature on digital phenomena and show how they intersect with our conceptualization, and (3) develop a framework to organize digital innovation research according to five key themes. We conclude by identifying two particularly promising areas of future research.

## Introduction

The phenomenon of digital innovation has captured the attention of scholars and practitioners alike (e.g., Holmström et al., 2021) across multiple disciplines such as economics, strategy, and marketing (e.g., Autio et al., 2018; Beltagui et al., 2020; Konya-Baumbach et al., 2019). The ubiquity of digital technology has not only changed the way we strategize and organize to create innovation (Bharadwaj et al., 2013; 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 (Nambisan et al., 2020).

Particularly, there is a remarkable interconnectedness between social actors and digital technologies (Sandberg et al., 2020; Wang, 2021) involved in digital innovations. The associated emergence of complex sociotechnical systems (Mousavi Baygi et al., 2021; Tilson et al., 2010) requires research to consider "technical artifacts as well as the individuals/collectives that develop and use the artifacts in social […] contexts" (Sarker et al., 2019, p. 696). We, as a field, thus need to focus simultaneously on human *and* technical artifacts when investigating digital innovation (Majchrzak and Griffith, 2020; Yoo et al., 2012). This speaks directly to the sociotechnical core of the Information Systems (IS) discipline, with some even predicting a "golden age of digital innovation [that] provides an unprecedented opportunity for the IS field" (Fichman et al., 2014, p. 349).

However, while there is 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), conceptual ambiguities remain. On the one hand, the prefix *digital* is linked with a plethora of existing concepts (Avital et al., 2019) with numerous leading scholars arguing that the pervasiveness of digital technology fundamentally challenges existing assumptions about innovation (Benner and Tushman, 2015; Nambisan et al., 2017), strategy (Berente, 2020; Bharadwaj et al., 2013), and even the act

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of organizing itself (Majchrzak and Griffith, 2020; Yoo et al., 2012). On the other hand, however, there are persisting warnings that we do not understand what constitutes *digital* since "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). Such warnings have been voiced many times (e.g., Baskerville, 2012; Ekbia, 2009; Grover and Lyytinen, 2015; Orlikowski and Iacono, 2001; Zammuto et al., 2007), leading to ongoing discussions about the implications of the term *digital* per se (Avital et al., 2019; Baskerville et al., 2020). Thus, without a clear conceptualization "we, as a field, risk making 'digital' a buzzword that becomes attached to multiple phenomena" (Wessel et al., 2021, p. 119). With regard to innovation specifically, the lack of a clear conceptualization may jeopardize efforts to fully understand the sociotechnical nature of digital innovation (Majchrzak and Griffith, 2020; Nambisan et al., 2017; Yoo et al., 2010). To this end, this paper thus posits and addresses the need to establish a conceptual distinction between digital innovation and traditional innovation by conceptualizing the sociotechnical nature of digital innovation. Thus, our first research question is:

*RQ1: What constitutes digital innovation and simultaneously distinguishes it from traditional innovation?*

Furthermore, because of the cross-disciplinary interest in digital innovation, insights are currently fragmented across multiple fields without "a common vocabulary or generic framework of digital innovation" (Lyytinen et al., 2020, p. 279), making it difficult to identify overarching themes, findings, and remaining blind spots. For example, the marketing field focuses more on individual implications of digital innovation and how to inform and convince customers (e.g., Belk, 2013; Konya-Baumbach et al., 2019; Lamberton and Stephen, 2016), the IS field has a stronger focus on the role of digital technology itself (e.g., Ciriello et al., 2019; Eaton et al., 2015; Jarvenpaa and Standaert, 2018), and the economics field focuses more on the inter-organizational context of digital innovation in order to deduct policy recommendations (Boons and Stam, 2019; Brunswicker and Schecter, 2019; Pershina et al., 2019). To address the transdisciplinary nature of digital innovation (Lyytinen et al., 2020; Nambisan et al., 2020), it is necessary to organize and integrate research across different fields to enable closer collaboration across boundaries. Our second research question is therefore:

*RQ2: What are common themes across extant research and avenues for future research on digital innovation across disciplines?*

In order to answer the research questions and to organize and synthesize insights from extant research across various disciplines, we conduct a literature review. This review aims to provide an overview of the current state of knowledge on digital innovation by identifying common themes, potential blind spots, and avenues for future research across eight subject areas.

The next section outlines our review methodology. Thereafter, we present and discuss our findings. As first part of the findings, we develop a coherent conceptualization and 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.*

In the findings section, we summarize extant research on digital innovation organized by five themes. After a short discussion, we conclude by highlighting two promising avenues for future research on digital innovation.

## Method

Our literature review follows the guidelines for broad theorizing reviews set out by Leidner (2018). Broad theorizing reviews typically organize extant research by reviewing the literature across various disciplines and synthesizing the findings according to an emergent framework that then serves as the basis for further theorization. To produce this emergent framework, we took a grounded-theory approach as defined by Wolfswinkel et al. (2013) since it facilitates breaking established thinking patterns without ignoring extant knowledge (Siggelkow, 2007). This is important because digital innovation appears to challenge existing knowledge about, among others, strategy (Berente, 2020; Bharadwaj et al., 2013), organizing (Majchrzak and Griffith, 2020; Wang, 2021), and industrial boundaries (Lyytinen et al., 2016; Seo, 2017). While grounded theory is typically used in the context of qualitative data analysis, it also offers a highly systematic and rigorous approach to reviewing literature (Wolfswinkel et al., 2013), as demonstrated by recent literature reviews on digital transformation (Vial, 2019), IS integration (Henningsson et al., 2018), and business-IT alignment (Oehlhorn et al., 2020).

To ensure a rigorous grounded-theory based literature review, Wolfswinkel et al. (2013) propose a five-stage process consisting of (1) Define, (2) Search, (3) Select, (4) Analyze, (5) Present. In the following, we briefly introduce the first four stages and then present our findings (fifth stage) in the next section[1]:

**Define:** We first defined the scope, i.e., the criteria for inclusion and exclusion of our literature search. To scope various fields, we conducted several searches in different meta databases and used the Journal Quality List (JQL) *meta*-ranking (Harzing, 2019) to identify relevant subject areas and respective journals. In total, we selected 54 journals from eight different subject areas (cf. Table 1).

[1] Appendix A contains a detailed description of the grounded theory approach and each of the stages.

**Table 1**
Overview of subject areas, journals, and identified articles.

| Subject areas (# of journals) | Selected journals for initial search | Initial search | Excluded duplicates | Excluded through screening | Forward & backward search | Final sample |
|---|---|---|---|---|---|---|
| Economics (11) | *American Economic Review, Econometrica, Economic Journal, International Economic Review, Journal of Economic Literature, Journal of Economic Theory, Journal of Political Economy, Quarterly Journal of Economics, Review of Economic Studies, Research Policy, RAND Journal of Economics* | 36 | 8 | 16 | 2 | 14 |
| Entrepreneurship (3) | *Journal of Business Venturing, Small Business Economics, Entrepreneurship: Theory & Practice* | 6 | 0 | 3 | 3 | 6 |
| General & Strategy (11) | *Academy of Management Journal, Administrative Science Quarterly, Harvard Business Review, Journal of Management Studies, Strategic Management Journal, Journal of Management, Academy of Management Review, Organizational Research Methods, MIT Sloan Management Review, Strategic Entrepreneurship Journal, Academy of Management Annals* | 98 | 6 | 77 | 9 | 24 |
| Innovation (3) | *R&D Management, Technological Forecasting and Social Change, Journal of Product Innovation Management* | 120 | 1 | 89 | 2 | 32 |
| Marketing (8) | *Journal of Marketing, Journal of Marketing Research, Journal of the Academy of Marketing Science, Journal of Consumer Research, Marketing Science, International Journal of Research in Marketing, Journal of Retailing, Journal of Service Research* | 19 | 0 | 12 | 5 | 12 |
| Management Information Systems (9) | *Journal of Information Technology, MIS Quarterly, Information & Management, Journal of Management Information Systems, European Journal of Information Systems, Journal of Strategic Information Systems, Information Systems Research, Information Systems Journal, Journal of the Association of Information Systems* | 117 | 4 | 54 | 39 | 98 |
| Operation Research & Management Science (4) | *Management Science, Operations Research, Journal of Operations Management, European Journal of Operational Research* | 7 | 0 | 7 | 2 | 2 |
| Organizational Studies & HR (5) | *Organization Studies, Organizational Behavior and Human Decision Processes, Journal of Organizational Behavior, Organization Science, Leadership Quarterly* | 20 | 0 | 9 | 3 | 14 |
| Articles identified during forward & backward search without (or a different) subject area | | | | | 25 | 25 |
| **Total** | | **423** | **19** | **267** | **90** | **227** |

**Search**: In a second step, we searched the 54 journals using the defined search terms "digital" and "innovation" in the title, the abstract, or the keywords without limiting the timeframe. This permitted the inclusion of articles about innovation in a digital context that did not use the term "digital innovation". This is in line with the more encompassing definition of digital innovation proposed by Nambisan et al. (2017). In this second step, we identified 423 articles.

**Select:** In a third step, we refined our initial data set of 423 articles by filtering out duplicates, book reviews, and calls for papers (19 articles). We then screened the title, abstract, and additional excerpts if needed, in accordance with our inclusion and exclusion criteria, thus excluding an additional 267 articles. A forward and backward search as recommended by Webster and Watson (2002) resulted in the identification of 90 additional articles that met our criteria. Overall, we identified 227 articles suited to our analysis.

**Analyze**: In a fourth step, we carried out open, axial, and selective coding as defined by Wolfswinkel et al. (2013). To do so, we relied on an iterative, five-step coding procedure similar to Henningsson et al. (2018). First, we selected 20 articles, which all four authors independently read and drew relevant excerpts from. Afterwards, we conducted a joint coding workshop in which we re-read all identified excerpts and performed open coding by discussing the concept behind each excerpt and "attaching initial labels to all available data" (Wiesche et al., 2017, p. 688). After reaching a shared understanding about the phenomenon of digital innovation, the first author then coded the remaining articles in close consultation with the co-authors, performing comparative analysis by "continuously comparing, relating and linking the identified categorizations with each other and the studied papers and excerpts" (Wolfswinkel et al., 2013, p. 7). Once a clear set of categories and sub-categories had been created, we conducted a second joint coding workshop to perform selective coding aimed at uncovering the interrelations between the categories and relating them to each other. We performed open, axial, and selective coding in an ongoing fashion, iterating between the individual stages until theoretical saturation was reached and the additional reading of excerpts no longer revealed any new findings. The data structure in Appendix B shows how we went from excerpts to open, axial, and selective codes.

## A fresh perspective on digital innovation

In this section, we first present existing definitions of digital innovation before proposing a re-framing of current conceptualizations and inductively developing a new definition of digital innovation. We then show how central concepts in the literature on digital phenomena are related to our conceptualization.

### *Existing definitions in literature*

In reviewing our sample, we derive three key-insights: First, very few (only 29 of 227 articles) define digital innovation explicitly. Out of these 29 definitions, most focus on a specific aspect of the phenomenon and 15 build upon the notion of component recombination („new combinations of digital and physical components") as outlined by Yoo et al. (2010, p. 725). Second, most definitions conflate the concept of digital innovation with its effects. Third, while most definitions include several 'digital' terms (i.e., "digital components", "digital technologies"), these terms are either not defined at all, or just circumscribed, frequently through examples[2].

Overall, the identified definitions include several commonalities but also differences. To systematize these commonalities and differences, we carried out a semantic decomposition (Akmajian et al., 2017) as used by Vial (2019) to identify the constituting primitives of each definition. In total, we inductively identified six primitives: (1) Input (i.e., what goes into creating digital innovation such as physical and digital components), (2) Involvement (i.e., internal and external actors involved), (3) Properties (i.e., factors that characterize digital innovation such as novelty and unboundedness), (4) Scope (e.g., products or services), (5) Implications (i.e., effects of digital innovation such as ensuing change of sociotechnical contexts), and (6) Creation (i.e., how digital innovation is actually created). Fig. 1 depicts exemplarily how two of the most popular definitions of digital innovation differ in terms of the constituting primitives. For example, the definition by Yoo et al. (2010) does not address primitive 5 (implications), which is addressed by the definition of Nambisan et al. (2017). For a detailed description of the semantic decomposition and a full list of the semantically decomposed definitions, please refer to Appendix C.2.

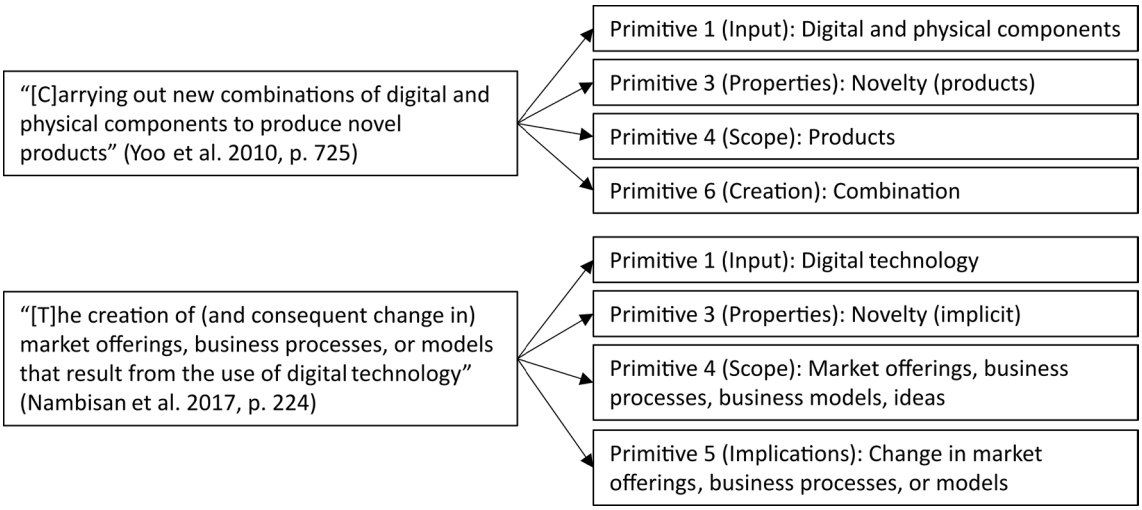



**Fig. 1.** Exemplary semantic decomposition of two popular definitions of digital innovation.

According to Suddaby (2010, p. 347), any good definition must (1) clearly define each concept and construct and include their respective properties, (2) avoid circularity or tautology, and (3) be parsimonious, i.e., "it should try to capture as concisely as possible the essential characteristics of a phenomenon or concept". Building on these criteria and on our semantic decomposition of these definitions, we now develop a definition of digital innovation that incorporates concepts common to the definitions examined while overcoming existing weaknesses.

### *Conceptualizing and defining digital innovation*

Since digital technology is at the core of digital innovation research (e.g., Nambisan et al., 2017; Yoo et al., 2010), we conceptualize digital innovation by theorizing how the concept of *digital objects* (Faulkner and Runde, 2013, 2019) is linked to *digital technology*, and how digital technology is linked to *digital innovation*. The result is a nested three-layer conceptualization (see Fig. 2) where digital technology is embedded in digital innovation, and digital object is embedded in digital technology. The 'digital object' captures the

[2] Appendix C.1 provides an overview of extant definitions of digital innovation.

technical perspective on digital innovation, while 'digital technology' embraces the sociotechnical perspective. 'Digital innovation' itself is defined in terms of its value-adding novelty.

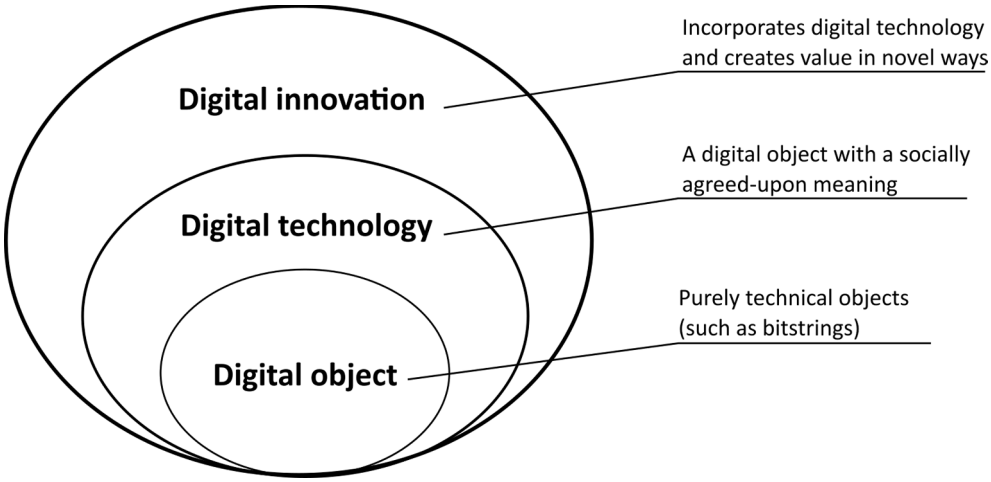



**Fig. 2.** Three-layer conceptualization of digital innovation.

*Digital object*

On the *meta*-level, objects, whether digital or non-digital, are characterized by their structured and enduring nature (Faulkner and Runde, 2013). In this context, the term "structured" signifies that multiple parts are put together in an organized fashion to compose an object. The term "enduring" refers to temporal continuity and full presence during the complete span of existence. Objects can be material or nonmaterial. Material objects, such as a table, possess spatial attributes (e.g., mass, volume, location), whereas nonmaterial objects, such as a software, do not (Faulkner and Runde, 2019).

In the context of digital innovation, a particularly interesting form of nonmaterial objects are bitstrings that follow a set of syntactical rules, e.g., of a specific file format. Bitstrings have no spatial attributes, but are structured (composed of distinct, organized parts) and enduring (once created every part of a bitstring exists simultaneously). Therefore, "[b]itstrings, […] 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 thus serve as the foundation of *digital objects*, which are defined as "[…] objects whose component parts include one or more bitstrings" (Faulkner and Runde, 2019, p. 7). Hence, digital objects can be purely nonmaterial objects but may also be hybrids (bitstrings combined with different nonmaterial and material parts).

*Digital technology*

In the context of digital technology, product designers do often not know from the outset how their products – or single components of them – will be used; instead, "a product is inductively *enacted* by orchestrating an ensemble of components" (Yoo et al., 2010, p. 728). Therefore, product boundaries are fluid and new meanings can be assigned. This argumentation intersects with the discussion about the identity of digital objects (Faulkner and Runde, 2009). As discussed above, digital objects can be described from a purely technical point of view, although they may vary in terms of size and complexity ranging from single bitstrings up to full-blown digital networks. However, human actors may interpret a digital object in certain ways and identify properties and opportunities offered by the digital object, such that the digital object acquires a technical identity of its own (Faulkner and Runde, 2009, 2013). In that regard, a digital object can acquire numerous identities from different social groups that use it in differing contexts (Faulkner and Runde, 2019). Put differently, individuals and social groups may use a digital object differently, assign it different meanings, and thereby shape its boundary. In that respect, Faulkner and Runde (2019, p. 5) refer to "the social aspect of digital technology" which concerns "the identity of digital objects, their use, and 'fit' generally within the social world". Taken together, these arguments suggest that digital technology has technical components, such as material and nonmaterial objects, but also a social component where users assign meanings and thus shape the boundary of products. Accordingly, we define *digital technology as a digital object that has been assigned a socially agreed-upon meaning.* This is in line with Yoo et al. (2010), who argue in the context of products as outcome of digital innovation that products are inductively enacted, making product boundaries fluid and allowing new meanings to be assigned. Put differently, *a digital object becomes a digital technology when it is assigned a meaning, namely a purpose for applying it, whereby the purpose is determined by social actors such as users.*

*Digital innovation*

As discussed above, many discussions and definitions of digital innovation focus on digital technology and note digital innovation's transformative power. For example, Nambisan et al. (2017, p. 223) suggest that digital innovation "is the use of digital technology during the process of innovating", and state that the resulting digital innovation has radically changed the way services and products are created and structured, enabling new ways of creating value and appropriation. The authors call digital innovation a sociotechnical phenomenon and conceptualize it "as the creation of (and consequent change in) market offerings, business processes, or models that result from the use of digital technology. Stated differently, in digital innovation, digital technologies and associated digitizing processes form an innate part of the new idea and/or its development, diffusion, or assimilation" (p. 224). This reasoning reflects that innovation outcomes and processes are less bounded and digital innovation provides a new level of fluidity where, e.g., the innovation process as well as outcomes such as a new products or services are constantly re-scoped. Furthermore, innovation agency is much more distributed and encompasses dynamic sets of actors who are not necessarily under the control of a single organization (Lyytinen et al., 2016), but rather include heterogeneous actors who may be affiliated with different organizations integrated only temporarily (Yoo et al., 2012). Moreover, digital innovation goes beyond organizations and industries and also encompasses users and consumers since using digital innovation "is about actively selecting resources of an offering and configuring them with other resources, or even rethinking their usages and purpose" (Henfridsson et al., 2018, p. 91), which, in turn, generates further digital innovation. Thus, "individuals, groups, or organizations can now co-create services and applications limited only by their own abilities to envision desirable properties" which engenders new and changing behaviors (Tilson et al., 2010, p. 752). Furthermore, digital innovation is characterized by generativity (Yoo et al., 2012), which is "a technology's overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences" (Zittrain, 2006, p. 1980). By embedding digital technology in products and services, digital innovation gives birth to the layered modular architecture "incorporating four loosely coupled layers of devices, networks, services, and contents created by digital technology" (Yoo et al., 2010, p. 724). What the authors refer to as loosely coupled layers enables product-agnostic component development, without knowledge of the ultimate end-product (Yoo et al., 2010), and decoupling form from function (Zittrain, 2006). Hence, the layered modular architecture enables generativity through what Yoo et al. call "procrastinated binding" (2012). Additionally, digital technology produces vast amounts of data, which can be combined in new ways to create additional types and forms of innovation, thus, enabling generativity through derivative innovation (Yoo et al., 2012). Overall, digital innovation has become a network phenomenon enabled by the democratized access to digital technology, where individual actors gain more autonomy in working by and for themselves in loose commonality with others without being constrained by traditional hierarchies, and in nonmarket operations (Benkler, 2006). This, in turn, leads to fundamental shifts of the economics of industrial production *per se* towards social production where "the overarching point is that social production is reshaping the market conditions under which businesses operate" (Benkler, 2006, p. 126).

Concluding, we define 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.*[3]

Our definition clarifies each of the primitives identified through the semantic decomposition (see Appendix C.2) and overcomes the identified weaknesses of extant definitions by:

- Clarifying the sociotechnical *Input* through building upon our conceptual definition of "digital technology" and defining it as a necessary part of digital innovation ("incorporation of digital technology");
- Delineating the *Involvement* by showing that digital innovation can be created internally or adopted externally ("creation or adoption");
- Defining necessary *Properties* that go beyond inventions and characterize it as innovation, ("value-adding novelty") as well as highlighting its perpetually incomplete, emerging nature ("inherently unbounded");
- Broadening the oftentimes rather narrow *Scope* of digital innovation by encompassing various possible outcomes ("e.g., product, service, process, or business model").
- Leaving open the exact manner of *Creation* to include various creative processes, as long as the other criteria are met.
- Avoiding circularity by omitting the *Implications* of digital innovation from its definition.

In the following, we show how central concepts in extant literature concerned with digital phenomena intersect with our definition of digital innovation.

*Linking digital innovation and central concepts in extant literature*

Fig. 3 puts the three concepts of our novel conceptualization (digital object, technology, and innovation) in a broader context by relating them to central concepts in the literature on other digital phenomena such as *digitization* and *digitalization* (Tilson et al., 2010), *ontological reversal* (Baskerville et al., 2020), and three characteristics of digital innovation that Yoo et al. (2010) identify as key: homogenization of data, reprogrammability, and self-referentiality. For an overview of definitions of each concept as well as representative articles, please see Appendix C.3.

[3] Our definition explicitly requires digital technology to be an integral part of the digital innovation. Accordingly, while using a 3D-printer to produce a table (which itself has no digital capabilities) might be a digital (process) innovation, the printed products, such as the table itself, are not.

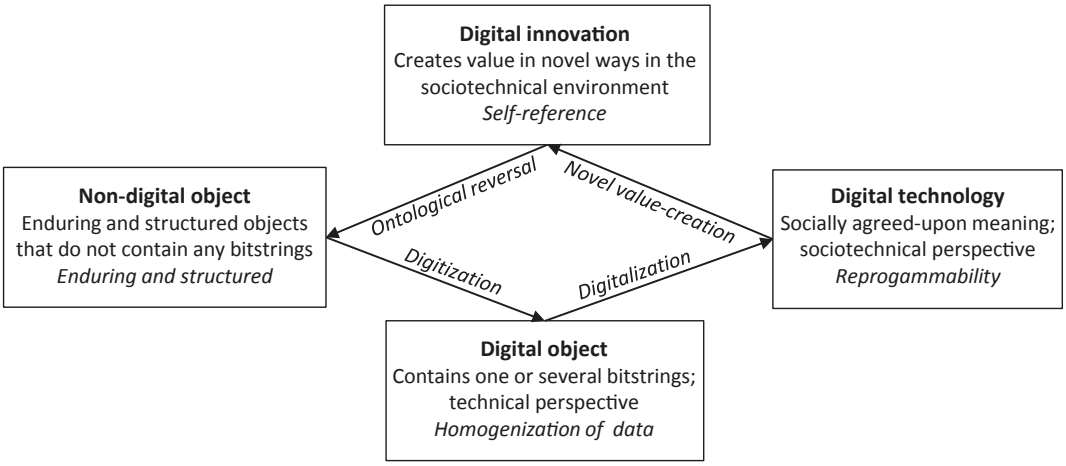



**Fig. 3.** Central concepts and their interrelations.

First, distinguishing between material and nonmaterial objects promotes a more granular understanding of how the unique properties of different types of objects apply to digital objects. While material objects possess properties of portability or durability (Faulkner and Runde, 2019), nonmaterial objects (i.e., digital objects composed of bitstrings) exhibit a key characteristic of digital innovation, the **homogenization of all data**, which is "enabled by discrete representation of data in bits of 0 and 1" (Yoo et al., 2012, p. 1399). Thus, bitstrings homogenize every form of data through **digitization**, "the process of converting analog signals into a digital form, and ultimately into binary digits (bits)" (Tilson et al., 2010, p. 749). In turn, this makes any form of digital content accessible to any kind of digital device, thereby, separating content and medium (Yoo et al., 2012). Hence, the homogenization of all data is coupled with the technological layer, which is the digital object.

Second, defining digital technology as a digital object that is given a socially agreed-upon meaning enables us to link the second key characteristic of digital innovation, **reprogrammability**. In order for digital devices to be reprogrammable, users have to agree upon a shared meaning of the data in order to manipulate it (Yoo et al., 2010). Once users have agreed upon a meaning, there are no limits to the reprogrammability of digital technology, allowing a digital device to perform an almost unlimited number of functions (Yoo et al., 2010). This is in line with the notion of **digitalization** as "a sociotechnical process of applying digitizing techniques to broader social and institutional contexts" (Tilson et al., 2010, p. 749). Thus, we view reprogrammability as a characteristic of digital technology rather than of the digital object.

Third, our definition of digital innovation allows addressing the third key characteristic of digital innovation – **self-reference**. In terms of digital innovations, self-reference is expressed by the use of digital technology to create positive network externalities "[…] that further accelerate the creation and availability of digital devices, networks, services, and contents" which "in turn, fosters further digital innovation through a virtuous cycle of lowered entry barriers, decreased learning costs, and accelerated diffusion rates" (Yoo et al., 2010, p. 726). Such positive network externalities have tremendous influence on the economic and social environment, since they enable new forms of cooperation and exchange and, more generally, democratize innovation (Henfridsson et al., 2018; Yoo et al., 2010). Hence, the "self-referential nature of digital technology" (Yoo et al., 2010, p. 726) comes into being through digital innovation fostering positive network externalities, which creates value and enables even more digital innovation. We link the characteristic of self-reference to the layer of digital innovation. To start such a virtuous cycle, digital innovation must enable **novel value-creation**, which in turn leads to continuous changes in the sociotechnical environment (i.e., market offerings, business processes, individual behavior) (cf. Nambisan et al., 2017; Vega and Chiasson, 2019). With the increasing influence of digital innovation, we can even witness how our physical reality is shaped and modeled after digital innovation. This is in line with the notion of **ontological reversal**, where "the digital version is created first, and the physical version second (if needed)" (Baskerville et al., 2020, p. 509).

## Current themes in digital innovation research: A framework

Fig. 4 represents a visual guide for the detailed presentation of the findings from our literature review. While we have already introduced the multi-layered conceptualization of digital innovation itself (Fig. 2), we now present our findings along the five themes related with it and positioned around it.

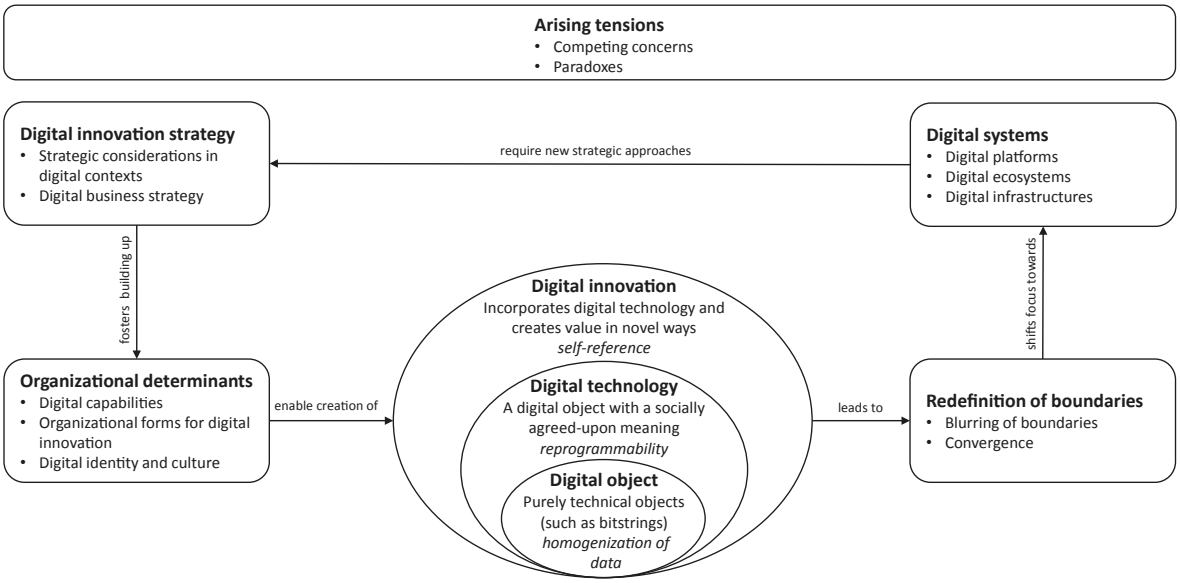



**Fig. 4.** Framework of current themes in digital innovation research.

*Redefinition of boundaries*

Digital innovation increasingly leads to (1) the blurring of long-established boundaries and even (2) to the convergence of previously separate areas (e.g., Nambisan et al., 2017; Seo, 2017; Tilson et al., 2010).

Within our literature sample, studies mention **blurring boundaries** with regard to products, roles, organizations, and industries. The blurring of *product boundaries* may result from the homogenization of data, which makes products open to the integration of data from various sources and facilitates the identification of new use cases (Yoo et al., 2010). Further, many digital products can be used as a standalone product, but can also act as a platform for other products (Lusch et al., 2010; Ng and Wakenshaw, 2017; Yoo et al., 2010), blurring their product boundaries even further (e.g., by adding an app, the smartphone may become a pocket calculator, a diary, or a GPS device).

The blurring of *role boundaries* addresses traditionally separate cognitive and social boundaries between roles that become increasingly intertwined. For example, through the widespread use of digital technology, the boundaries between work and private life and the respective roles we have in each are becoming increasingly blurred (Belk, 2013). Furthermore, the boundaries between producers and users of innovation are increasingly blurred since users can independently select and recombine digital offerings, thereby reinterpreting their purpose, and thus creating digital innovation themselves (Henfridsson et al., 2018).

Blurring *organizational boundaries* are due to the increasing reliance of innovation from distributed sources (Lakhani and Panetta, 2007; Nambisan et al., 2017; Tiwana et al., 2010). These distributed sources of digital innovation are associated largely with digital technologies that enable various actors to cooperate within innovation networks across organizational boundaries (Lyytinen et al., 2016), often beyond the control of the original innovator (Bogers and West, 2012).

Finally, blurring *industrial boundaries* challenge the clear separation of organizations along industrial areas as the focus turns to connected products that transcend established industrial boundaries (Porter and Heppelmann, 2014), forcing organizations to defend their market against organizations from other industries (Hopp et al., 2018; Seo, 2017).

Boundaries are also redefined through **convergence**, which goes beyond blurring boundaries by merging and blending previously separate entities into one. For example, embedding digital technology in physical products ("smart products"), leads to the *convergence of physical and digital materialities* (Yoo et al., 2012). Smart products can access, process, and store any type of digital information, thereby, causing *device convergence* (Tilson et al., 2010) and *user experience convergence* (Yoo et al., 2012) with implications for how consumers select and consume different offerings (e.g., Han et al., 2009; Ordanini and Nunes, 2016).

Furthermore, the application of similar digital innovations across industrial boundaries leads to *industrial convergence* (Tilson et al., 2010; Yoo et al., 2012), which facilitates the exchange between different areas of expertise (i.e., analog and digital domains) (Pershina et al., 2019) but also creates new forms of competitive pressure. For example, the acquisition of Skype has put Microsoft in competition with established telecommunication companies (Yoo et al., 2010). While business expansion is not a new phenomenon, converging industrial boundaries are more profound, as it leads to organizations from different industries competing with each other, while at the same time relying on different resources and acting according to different industrial regulations (Seo, 2017).

**Table 2**
Redefinition of boundaries *(n = 34 , some papers address both categories)*.

| | |
|---|---|
| **Blurring boundaries** | Borders between previously clearly demarcated entities or fields are becoming increasingly permeable |
| *IS journals (n = 7)* | (Henfridsson et al., 2018; Lyytinen et al., 2016; Nambisan et al., 2017; Seo, 2017; Svahn et al., 2017a; Tiwana et al., 2010; Yoo et al., 2010) |
| *Other journals (n = 19)* | (Barrett et al., 2012; Belk, 2013; Bell et al., 2014; Bogers and West, 2012; Browder et al., 2019; Ferlie et al., 2005; Hopp et al., 2018; Kane, 2018; Lakhani and Panetta, 2007; Lusch et al., 2010; Mangematin et al., 2014; Nambisan, 2016; Ng and Wakenshaw, 2017; Ordanini and Nunes, 2016; Payne et al., 2008; Porter and Heppelmann, 2014; Rogowski et al., 2020; Verstegen et al., 2019; Yoo et al., 2012) |
| **Convergence** | Merger and blending of previously separate entities or fields into one |
| *IS journals (n = 6)* | (Fichman et al., 2014; Hanelt et al., 2021; Lyytinen et al., 2016; Seo, 2017; Tilson et al., 2010; Yoo et al., 2010) |
| *Other journals (n = 7)* | (Austin et al., 2012; Boland et al., 2007; Frank et al., 2019; Han et al., 2009; Ordanini and Nunes, 2016; Pershina et al., 2019; Yoo et al., 2012) |

*Digital systems*

The redefinition of boundaries leads to contexts in which digital technology takes a central role, potentially shaping the environment itself and every actor within it (El Sawy et al., 2010). These developments require a shift of research focus away from a focal firm or innovator towards considering the interdependence of various actors simultaneously (Henfridsson and Bygstad, 2013; Vega and Chiasson, 2019).

This shift is reflected by research on infrastructures, platforms, and ecosystems (e.g., Gawer, 2009; Tilson et al., 2010; Tiwana et al., 2010), which fall into the umbrella category of "digital systems". While these three terms are often used interchangeably, we draw on the conceptualizations by Tilson et al. (2010) and Tiwana et al. (2010) to differentiate between them and suggest how they are linked. In essence, digital infrastructures are the "[…] 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) and thus the technical foundation upon which digital platforms operate. Platforms then allow various actors to develop modules such as add-on software. An ecosystem is composed of a platform and its modules (Tilson et al., 2010; Tiwana et al., 2010). For example, since the establishment of the Internet (a type of digital infrastructure), companies such as Google and Apple created the Apple App Store and the Google Play Store (digital platforms), through which external actors can market apps (modules). Each platform and its respective modules follow specific rules and goals (a digital ecosystem). For more details on digital infrastructures, platforms, and ecosystems, please refer to Appendix D.1.

**Table 3**
Digital systems *(n = 69, some papers address both categories)*.

| | |
|---|---|
| **Digital infrastructures** | "[…] 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) |
| *IS journals (n = 14)* | (Barrett et al., 2015; Bonina et al., 2021; Bygstad, 2017; Bygstad and Øvrelid, 2020; Eaton et al., 2015; Fichman et al., 2014; Hanseth and Lyytinen, 2010; Henfridsson and Bygstad, 2013; Huang et al., 2017; Huang et al., 2018; Kazan et al., 2018; Koutsikouri et al., 2018; Tilson et al., 2010; Yoo et al., 2010) |
| *Other journals (n = 5)* | (Nambisan, 2016; Nambisan et al., 2018; Nambisan et al., 2019; Yoo et al., 2012; Zorina and Dutton, 2021) |
| **Digital platforms** | The "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) |
| *IS journals (n = 22)* | (Arakji and Lang, 2007; Barrett et al., 2015; Bonina et al., 2021; Drechsler et al., 2020; El Sawy et al., 2016; Fichman et al., 2014; Foerderer et al., 2018; Foerderer et al., 2019; Ghazawneh and Henfridsson, 2013; Henfridsson et al., 2014; Hinings et al., 2018; Huang et al., 2018; Karhu et al., 2018; Kazan et al., 2018; Lang et al., 2015; Parker et al., 2017; Reuver et al., 2018; Rolland et al., 2018; Sedera et al., 2016; Tan et al., 2016; Tiwana et al., 2010; Yoo et al., 2010) |
| *Othe. journals (n = 24)* | (Autio et al., 2018; Boudreau, 2010; Boudreau, 2012; Brunswicker and Schecter, 2019; Frank et al., 2019; Gawer, 2009; Gawer and Cusumano, 2014; Helfat and Raubitschek, 2018; Hilbolling et al., 2021; Klein et al., 2020; Kulathinal et al., 2020; Lamberton and Stephen, 2016; Magni and Maruping, 2019; Malhotra, 2020; Miric et al., 2019; Nambisan, 2016; Nambisan et al., 2018; Nambisan et al., 2019; Nylén and Holmström, 2015; Parker and van Alstyne, 2018; Saadatmand et al., 2019; Scuotto et al., 2017; Teece, 2018; Yoo et al., 2012) |
| **Digital ecosystems** | The "collection of the platform and the modules specific to it" (Tiwana et al., 2010, p. 676) |
| *IS journals (n = 13)* | (Barrett et al., 2015; Bonina et al., 2021; El Sawy et al., 2010; El Sawy et al., 2016; Fichman et al., 2014; Huang et al., 2018; Karhu et al., 2018; Kazan et al., 2018; Selander et al., 2013; Suseno et al., 2018; Tiwana et al., 2010; Vega and Chiasson, 2019; Wang, 2021) |
| *Other journals (n = 13)* | (Adner and Kapoor, 2010; Autio et al., 2018; Autio and Thomas, 2020; Beltagui et al., 2020; Dong, 2019; Helfat and Raubitschek, 2018; Jarvenpaa et al., 2020; Kolloch and Dellermann, 2018; Nambisan et al., 2018; Sandström, 2016; Scuotto et al., 2017; Song, 2019; Sussan and Acs, 2017) |

*Digital innovation strategy*

The shifts towards more interrelated and dynamic digital infrastructures, platforms, and ecosystems represent important **strategic considerations in a digital context** (Bharadwaj et al., 2013; El Sawy et al., 2010), which require fundamentally different strategic approaches due to digital innovation (Berente, 2020).

Thus, managers rely on new approaches to manage different platform configurations (Henfridsson and Bygstad, 2013) and engage with actors within the broader context of an organization (Huang et al., 2018; Rindfleisch et al., 2017), which requires a shift from hierarchical (top-down versus bottom-up) thinking to strategically engaging both internal and external forces (Arvidsson and Mønsted,

2018; Henfridsson and Bygstad, 2013; Vega and Chiasson, 2019). Additionally, to appropriate value on platforms, organizations rely on either informal or formal strategies with different effects depending on their size (Miric et al., 2019).

Since digital technology is deeply embedded in nearly all organizational processes and products (Rigby, 2014; Yoo et al., 2010), strategy must encompass ways to harness newly arising opportunities, while simultaneously mitigating potential risks (Sebastian et al., 2017).

Doing so might require a departure of established strategy frameworks towards new understandings (Yoo et al., 2010) such as **digital business strategy** (DBS). DBS is defined as an "organizational strategy formulated and executed by leveraging digital resources to create differential value" (Bharadwaj et al., 2013, p. 472). While extant research does not frequently use the DBS label, there are several aspects which are important for strategy in an increasingly digitalized environment. First, strategy must focus on digital technology by considering the three-way dynamics between organizations, the environment, and digital technology (El Sawy et al., 2010). Second, strategy must take the malleable nature of digital innovation into account by framing products and services as perpetually developing (Nylén and Holmström, 2015). This allows to harness the implications of digital innovation such as blurring boundaries, generativity, and convergence (Yoo et al., 2010). Third, DBS questions whether the distinction between business and IT strategy is still adequate and propagates a *fusion* between the two (Bharadwaj et al., 2013). This makes sense since digital technologies and organizational processes are increasingly difficult to disentangle (Pagani, 2013). Fourth, considering that digital innovation can threaten established business models, executives have to be acquainted with new digital technologies in order to internalize the necessity to change and effectively communicate it to employees (Lucas and Goh, 2009).

**Table 4**
Digital innovation strategy *(n = 44, some papers address both categories)*.

| | |
|---|---|
| **Strategic considerations in a digital context** | Relevant factors for successful strategizing in a digital context |
| *IS journals (n = 11)* | (Ciriello et al., 2019; Dong and Yang, 2019; Hanelt et al., 2021; Henfridsson et al., 2014; Henfridsson and Bygstad, 2013; Huang et al., 2018; Tilson et al., 2010; van Looy, 2021; Wang, 2021; Wiredu et al., 2021; Yoo et al., 2010) |
| *Other journals (n = 21)* | (Antonopoulou and Begkos, 2020; Autio and Thomas, 2020; Baird and Raghu, 2015; Bell et al., 2014; Berente, 2020; Chalmers et al., 2020; Dobusch et al., 2019; Foucart et al., 2018; Henfridsson, 2020; Ho and Lee, 2015; Konya-Baumbach et al., 2019; Lam et al., 2017; Liu et al., 2021; Luca et al., 2021; Miric et al., 2019; Rindfleisch et al., 2017; Scott et al., 2017; Shaheer and Li, 2020; Teece, 2018; Thompson et al., 2020; Yoo et al., 2012) |
| **Digital business strategy** | An "organizational strategy formulated and executed by leveraging digital resources to create differential value" (Bharadwaj et al., 2013, p. 472) |
| *IS journals (n = 12)* | (Arvidsson and Mønsted, 2018; El Sawy et al., 2010; El Sawy et al., 2016; Fichman et al., 2014; Henfridsson et al., 2018; Keen and Williams, 2013; Lucas and Goh, 2009; Pagani, 2013; Sebastian et al., 2017; Vega and Chiasson, 2019; Woodard et al., 2013; Yoo et al., 2010) |
| *Other journals (n = 5)* | (Bharadwaj et al., 2013; Kane et al., 2017; Nylén and Holmström, 2015; Rigby, 2014; Yoo et al., 2012) |

*Organizational determinants*

Maintaining a strategic competitive edge in an increasingly digital environment 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). The literature particularly emphasizes the need to develop digital capabilities (Holmström et al., 2021; Kane et al., 2016; Tumbas et al., 2017) as well as establishing new ways of organizing (Lyytinen et al., 2016), which often requires fundamental changes in organizational culture and identity (Lucas and Goh, 2009; Tripsas, 2009).

Digital innovation requires building up **digital capabilities** that are aligned with the new logics of digital innovation (Lanzolla et al., 2021; Svahn et al., 2017b; Tumbas et al., 2017). In this context, research emphasizes agility, ambidexterity, and dynamic capabilities. As digital innovation often leads to unanticipated upheaval within established industries (e.g., Nambisan et al., 2017; Seo, 2017), agility, which involves the capability to identify and respond swiftly to unexpected changes and opportunities, is frequently highlighted as an important organizational capability in the context of deep uncertainty (Chan et al., 2019; Teece et al., 2016). While the core idea behind agility is not exclusively focused on digital innovation (e.g., Austin et al., 2012), the increasing pace of change (Abrell et al., 2016; Henfridsson, 2020) makes agility particularly important for responding to quickly changing market conditions (Bharadwaj et al., 2013; Dong, 2019). While organizational agility is associated with higher costs (Teece et al., 2016), there is a need to switch from classic stage-gate approaches to more iterative design and delivery practices (Sebastian et al., 2017; Troilo et al., 2017).

The digital revolution also influences established notions of ambidexterity (Benner and Tushman, 2015), as novel digital technologies play a central role in exploration and exploitation activities (Del Giudice et al., 2021). For example, modern data analytics enable market ambidexterity, which uses insights about existing customers to identify the needs of future customers (Luca et al., 2021). More generally, digital ambidexterity, the capability to balance the exploration of new digital initiatives without jeopardizing established business processes, becomes increasingly important (Magnusson et al., 2020; Magnusson et al., 2021).

Dynamic capabilities are about the capacity to "innovate, adapt to change, and create change that is favorable to customers and unfavorable to competitors" (Teece et al., 2016, p. 18) and overcoming core rigidities (Lucas and Goh, 2009). In the context of digital marketplaces, particularly 'first-order' capabilities that allow to change existing 'ordinary' capabilities help respond to digital disruptions (Karimi and Walter, 2015). Furthermore, the dynamic capability to rapidly scale up or down digital infrastructures (e.g., cloud computing) (Bharadwaj et al., 2013) as well as integrative and sensing capabilities are important for creating and capturing value on digital platforms (Helfat and Raubitschek, 2018).

Beyond capabilities, research also addresses new **organizational forms for digital innovation** (Lyytinen et al., 2016; Majchrzak and Griffith, 2020; Wang, 2021). Scholars argue that digital innovation requires "a new organizational form that departs dramatically from traditional industrial production" (Berente, 2020, p. 92), due to the general shift towards more distributed innovation agency (e.g., Lakhani and Panetta, 2007) across innovation networks and ecosystems (e.g., Gawer and Cusumano, 2014; Lyytinen et al., 2016; Wang, 2021).

Organizations are embracing this openness to exchange knowledge with external actors (Trantopoulos et al., 2017) at near-zero cost (Altman et al., 2015; Majchrzak et al., 2018). For example, to engage external actors, organizations are involving customers and users (e.g., Eaton et al., 2015; Parmentier and Mangematin, 2014) or entire crowds and networks (Boons and Stam, 2019; Eiteneyer et al., 2019; Lyytinen et al., 2016) in their innovation processes. Furthermore, digital technology enables organizing and coordinating across innovation networks to access external knowledge (Lyytinen et al., 2016). In such networks, actors can have their own economic benefit in mind and do not need to identify with a shared 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).

Furthermore, **digital identity and culture** are important organizational determinants. Organizational identity, which is about the shared norms and beliefs within an organization, may have to change to embrace new opportunities due to digital technology (Huang et al., 2017; Jarvenpaa and Standaert, 2018; Sandberg et al., 2020; Tripsas, 2009). Yet organizations are likely to oversee or misinterpret opportunities from new technologies due to the filter of their established identity (Tripsas, 2009). While there are approaches to redefine and align identities (Klein et al., 2020), introducing digital options that require changes in identity is often met with resistance (Svahn et al., 2017a; Svahn et al., 2017b) and may lead to organizational identity conflict (Hylving and Schultze, 2020).

Organizational culture, which is about shared values within an organization, plays a major role in facilitating digital innovation (Lokuge et al., 2019) and influences how knowledge diffuses (Ferlie et al., 2005), particularly when otherwise disparate disciplines come into contact and collaborate (Boland et al., 2007). While culture can promote open exchange of knowledge (e.g., 'hacker culture' in open source communities) (von Hippel, 2006), it can also cause rigidities that prevent effective reactions to upcoming digital innovation even when leadership is committed to making changes (Lucas and Goh, 2009). Therefore, key actors must find ways to inspire change (Singh and Hess, 2017) towards a digital culture, which is characterized by lower risk adversity, a stronger focus on experiments, and talent development to support digital initiatives (Kane et al., 2016, 2017; Kane, 2017; Magnusson et al., 2020).

**Table 5**
Organizational determinants *(n = 124, some papers address several categories)*.

| | |
|---|---|
| **Digital capabilities** | Organizational capabilities that are relevant to successfully innovating in a digital context (e.g., agility, ambidexterity, dynamic capabilities) |
| *IS journals (n = 26)* | (Abrell et al., 2016; Bygstad, 2017; Bygstad and Øvrelid, 2020; Chan et al., 2019; El Sawy et al., 2010; Henfridsson and Lind, 2014; Hylving and Schultze, 2020; Karimi and Walter, 2015; Kazan et al., 2018; Lucas and Goh, 2009; Mendling et al., 2020; Mousavi Baygi et al., 2021; Park et al., 2020; Schneckenberg et al., 2021; Sebastian et al., 2017; Sedera et al., 2016; Sharma et al., 2014; Sørensen and Landau, 2015; Srivastava and Shainesh, 2015; Steininger, 2019; Tumbas et al., 2017, 2018; van Looy, 2021; Vial 2019; Yoo et al., 2010; Yoo, 2013) |
| *Other journals (n = 41)* | (Austin et al., 2012; Austin, 2016; Bell et al., 2014; Benner and Tushman, 2015; Berente, 2020; Bharadwaj et al., 2013; Brock et al., 2020; Browder et al., 2019; Brunswicker and Schecter, 2019; Day, 2011; Del Giudice et al., 2021; Dong, 2019; Helfat and Raubitschek, 2018; Henfridsson, 2020; Henfridsson and Yoo, 2014; Holmström et al., 2021; Iansiti and Lakhani, 2014; Kane et al., 2016, 2017; Kane, 2017; Kane et al., 2019; Luca et al., 2021; Lusch et al., 2010; Lusch and Nambisan, 2015; Magnusson et al., 2020; Magnusson et al., 2021; Majchrzak and Griffith, 2020; Marion and Fixson, 2021; Naik et al., 2021; Nambisan et al., 2018; Nylén and Holmström, 2015; Panourgias et al., 2014; Ravichandran, 2018; Rayna and Striukova, 2016; Sapsed and Tschang, 2014; Schrage, 2015; Smith and Beretta, 2021; Teece et al., 2016; Teece, 2018; Troilo et al., 2017; Verganti et al., 2020) |
| **Organizational forms for digital innovation** | Organizational forms characterized by a high degree of openness, which facilitate flexible collaboration and coordination across digital platforms, ecosystems, or innovation networks |
| *IS journals (n = 12)* | (Abrell et al., 2016; Eaton et al., 2015; Hensen and Dong, 2020; Hinings et al., 2018; Huang et al., 2017; Huang et al., 2018; Lang et al., 2015; Lehrer et al., 2018; Lyytinen et al., 2016; Nambisan et al., 2017; Trantopoulos et al., 2017; Wang, 2021) |
| *Other journals (n = 28)* | (Altman et al., 2015; Bell et al., 2014; Berente, 2020; Boland et al., 2007; Boons and Stam, 2019; Boudreau and Lakhani, 2013; Dougherty and Dunne, 2012; Eiteneyer et al., 2019; Gawer, 2009; Gawer and Cusumano, 2014; Helfat and Raubitschek, 2018; Henfridsson, 2020; Lakhani and Panetta, 2007; Lanzolla et al., 2021; Lee and Berente, 2012; Majchrzak et al., 2018; Majchrzak and Griffith, 2020; Nambisan et al., 2019; Parmentier and Mangematin, 2014; Pershina et al., 2019; Rindfleisch et al., 2017; Scuotto et al., 2017; Seidel and Berente, 2020; Szalavetz, 2019; Velu, 2020; Verstegen et al., 2019; Wessel et al., 2016; Yoo et al., 2012) |
| **Digital identity and culture** | Shared norms, beliefs, and values within an organization that enable successfully innovating in a digital context |
| *IS journals (n = 19)* | (Baskerville et al., 2020; Bonina et al., 2021; Huang et al., 2017; Hylving and Schultze, 2020; Jarvenpaa and Standaert, 2018; Jonsson et al., 2008; Kazan et al., 2018; Lang et al., 2015; Lindgren et al., 2008; Lokuge et al., 2019; Lucas and Goh, 2009; Sandberg et al., 2020; Singh and Hess, 2017; Svahn et al., 2017a; Tumbas et al., 2017, 2018; Vial, 2019; Wiredu et al., 2021; Yoo et al., 2010) |
| *Other journals (n = 27)* | (Barrett et al., 2012; Belk, 2013; Bell et al., 2014; Benkler, 2006; Benner and Tushman, 2015; Bogers and West, 2012; Boland et al., 2007; Browder et al., 2019; Ferlie et al., 2005; Gawer and Cusumano, 2014; Henfridsson and Yoo, 2014; Kane et al., 2016, 2017; Kane, 2018; King and Grudin, 2020; Klein et al., 2020; Lakhani and Panetta, 2007; Lanzolla et al., 2021; Magnusson et al., 2020; Parmentier and Mangematin, 2014; Pershina et al., 2019; Reck and Fliaster, 2019; Saadatmand et al., 2019; Svahn et al., 2017b; Tripsas, 2009; Troilo et al., 2017; von Hippel, 2006) |

*Arising tensions*

The final theme captures the tensions and **competing concerns** in which the changes necessary to pursue digital innovation are opposed to existing logics and routines (Svahn et al., 2017b). For example, products with integrated digital capabilities require different organizing logics, since they are continuously evolving (Henfridsson et al., 2014; Hylving and Schultze, 2020), which creates a competing concern between a product vs. process focus (Svahn et al., 2017a). Furthermore, the need to build up new capabilities to harness opportunities afforded by digital technology without jeopardizing existing practices and routines represents another competing concern (Svahn et al., 2017a).

Beyond competing concerns, digital technology causes also **paradoxes**, which are about the enduring opposition of interrelated elements (Ciriello et al., 2019). Digital platforms and infrastructures in particular tend to create paradoxical circumstances (e.g., Klein et al., 2020; Reuver et al., 2018; Saadatmand et al., 2019; Tiwana et al., 2010). For example, the paradox of change captures the persistent contradiction between stability (to allow enrolling new actors and developments) versus flexibility (to allow unbounded growth) (Tilson et al., 2010). The paradox of change also affects individual developers on open platforms who have to balance between a strategy of stability, which is in line with the past, and of flexibility to align with future developments (Brunswicker and Schecter, 2019). Similarly, the paradox of control captures the contradiction between enabling individual autonomy through decentralized control to foster generativity, while maintaining centralized control over the platform or infrastructure (Eaton et al., 2015; Nambisan et al., 2019; Tilson et al., 2010).

Similarly, office workers experience paradoxical tensions, e.g., between freedom and captivity due to the simultaneous malleability and rigidity of certain digital technologies such as PowerPoint (Ciriello et al., 2019). Coping with such paradoxes requires specific cognitive frames (Benner and Tushman, 2015) in order to accept, separate, or synthesize diametrically opposed factors (Ciriello et al., 2019).

**Table 6**
Arising tensions *(n = 56, some papers address both categories)*.

| | |
|---|---|
| **Competing concerns** | Changes necessary to pursue digital innovation are opposed to existing logics |
| *IS journals (n = 20)* | (Andersson et al., 2008; Andersson and Lindgren, 2005; Bonina et al., 2021; Bygstad and Øvrelid, 2020; Ghazawneh and Henfridsson, 2013; Hanelt et al., 2021; Henfridsson et al., 2014; Henfridsson and Lind, 2014; Henfridsson and Lindgren, 2005, 2010; Hylving and Schultze, 2020; Jonsson et al., 2008; Jonsson et al., 2009; Lindgren et al., 2008; Lucas and Goh, 2009; Sandberg et al., 2020; Svahn et al., 2017a; Tumbas et al., 2018; Westergren and Holmström, 2012; Woodard et al., 2013) |
| *Other journals (n = 12)* | (Bailey et al., 2012; Barrett et al., 2012; Boudreau, 2012; Browder et al., 2019; Dougherty and Dunne, 2012; Henfridsson and Yoo, 2014; Klein et al., 2020; Lanzolla et al., 2021; Lee and Berente, 2012; Lenfle and Midler, 2009; Svahn et al., 2017b; Thorén et al., 2018) |
| **Paradoxes** | Enduring opposition of interrelated elements |
| *IS journals (n = 11)* | (Barrett et al., 2015; Baskerville et al., 2020; Ciriello et al., 2019; Eaton et al., 2015; Kallinikos et al., 2013; Nambisan et al., 2017; Reuver et al., 2018; Seo, 2017; Tilson et al., 2010; Tiwana et al., 2010; Wang, 2021) |
| *Other journals (n = 15)* | (Benner and Tushman, 2015; Brunswicker and Schecter, 2019; Dobusch et al., 2019; Geissinger et al., 2018; Geissinger et al., 2019; Klein et al., 2020; Nambisan et al., 2019; Saadatmand et al., 2019; Sapsed and Tschang, 2014; Smith and Beretta, 2021; Thorén et al., 2018; Tripsas, 2009; Troilo et al., 2017; Watanabe et al., 2018; Yoo et al., 2012) |

## Discussion

The fundamental impact of digital technology on almost all aspects of our lives was recognized decades ago and has inspired seminal contributions (e.g., Kalakota and Whinston, 1996; Negroponte, 1995). Today, the near ubiquity of digital technology has sparked cross-disciplinary debates about whether there is something new, as indicated by the widespread appending of the prefix "digital" to established concepts such as innovation (Avital et al., 2019; Lyytinen et al., 2020; Wessel et al., 2021). By systematically reviewing 227 articles on digital innovation from eight different fields of research, we make three major contributions.

First, we inductively develop a new definition and propose a re-framing of current conceptualizations of digital innovation. The developed definition overcomes major conceptual ambiguities in existing definitions (see Appendix C.1 and C.2) in four ways: (1) by excluding the effects of digital innovation from its definition, (2) by explicitly theorizing the "digital" and theoretically reformulating and linking the concepts of digital object, digital technology, and digital innovation, (3) by recognizing the technical and social nature of digital innovation, and (4) by emphasizing that digital technology is an integral part of digital innovation itself, which clearly distinguishes it from traditional innovation. Based on aspects (2) and (3), we engage in *perspectival theorizing* (Cornelissen et al., 2021) by reframing current conceptualizations of digital innovation along a multi-layered model to enable a deeper understanding of the phenomenon of digital innovation. The three layers of our model highlight the interlinking between the technical (digital object) and social (digital technology) perspectives, which together define the sociotechnical nature of digital innovation.

Second, we organize central concepts in the literature on digital phenomena and show how they intersect with our conceptualization of digital innovation (see Fig. 3), for example, by distinguishing between digitization as a technical process and digitalization as the "sociotechnical process of applying digitizing techniques" (Tilson et al., 2010, p. 749). Thus, while digital innovation, per definition, always encompasses technical and social aspects jointly, our conceptualization of digital innovation also considers a continuum of possible instantiations of digital innovation ranging from focusing foremost on the technical aspects to focusing foremost on the social aspects of digital innovation. This continuum reflects extant research with its various instantiations. It also allows future

research to position its investigation of digital innovation explicitly along this continuum by emphasizing the technical or the social side of digital innovation without losing sight of the other. This is consistent with current recommendations for studying sociotechnical phenomena and places digital innovation in the center of the IS "discipline's sociotechnical character" (Sarker et al., 2019, p. 695).

Third, our inductive framework organizes and synthesizes existing knowledge from 227 articles from eight different fields of research along five key themes. In this way, we address the currently fragmented state of research on digital innovation (Lyytinen et al., 2020) and take a big step towards the development of a common set of concepts and vocabulary to integrate future research across disciplines. Future research can use our framework to focus on specific themes (e.g., how can organizations formulate a digital innovation strategy?) and their interrelations (e.g., how do organizational forms evolve as agility becomes the new root metaphor of digital innovation strategy?).

In addition, the holistic overview may provide an opportunity to examine the conceptual boundaries between closely related phenomena such as digital transformation and digital entrepreneurship, or to identify blind spots in the current literature. In the following, we highlight two particularly promising avenues for future research.

## Avenues for future research on digital innovation

Based on our systematic review of extant research on digital innovation, we outline a future research agenda highlighting (1) paradoxes and (2) knowledge recombination in the context of digital innovation.

### *Avenue 1: paradoxes in digital innovation*

Different types of paradoxes, their nature and causes, as well as coping strategies have been discussed for more than 20 years but – in spite of this history – "remain a nascent field of study" (Ciriello et al., 2019, p. 2) that deserves and is gradually receiving increasing research attention. This importance is reflected in recent discussions about paradoxes across disciplines[4] (e.g., Berti and Simpson, 2021a, 2021b; Brunswicker and Schecter, 2019; Gregory et al., 2015; Hahn and Knight, 2021a, 2021b). However, the unsystematic discussion and scattered focus on paradoxes in the literature, on the one hand, emphasizes their importance and, on the other, shows potentials for promising future research (Schad et al., 2016).

Regarding the areas well addressed, most research engages in the identification of types of paradoxes and approaches at the organizational level and views paradoxes as inherent in, e.g., a digital artefact. For example, Tilson et al. (2010) investigate types of paradoxes such as the paradox of change and the paradox of control in the context of digital infrastructures. Ciriello et al. (2019) identify different types of paradoxes such as the tension between freedom and captivity, and argue that these paradoxes are inherent in digital artefacts. The organizational level of paradox research and the nature of paradox as being inherent to some "object" is also prominent in other IS literature. Jarvenpaa and Lang (2005) identify several types of technology paradoxes, that are seen as being inherent to technology use, such as empowerment/enslavement or the interaction between situational factors and technology paradoxes.

While research focusing on the organizational level and viewing paradoxes as being inherent in, e.g., a digital artefact, produces a number of relevant and valuable insights, other areas are far less in focus, but might be promising. Particularly 'individual approaches', i.e., "how individuals experience and react to paradox" (Schad et al., 2016, p. 29) appear to be a promising avenue for future research for the following reasons.

First, individuals perceive paradoxes differently (Hahn and Knight, 2021a) indicating that certain paradoxes appear more or less intensely for different individuals. In addition, there is an ongoing discussion about whether paradoxes are inherent or socially constructed, or both, and how they can be addressed (Hahn and Knight, 2021b). Consequently, if, for example, individuals comprehend certain paradoxes as being inherent to an "object", coping strategies might address the "object" such as "digital infrastructures need to be organized in ways that are simultaneously stable and flexible" (Tilson et al., 2010, p. 753). In contrast, if individuals comprehend the paradox as being socially constructed, coping strategies might focus on individuals' capacity to tackle paradoxical situations (Ciriello et al., 2019; Gregory et al., 2015). Considering the prominence of comprehending paradoxes as being inherent to some "object" in extant research, an individual approach could open up new ways to see and address paradoxes.

Second, paradoxes span different levels of analysis such as the organizational and the individual level (Schad et al., 2016). As discussed above, an organization encompasses a number of organizational actors that might differ in their comprehension of and approaches to paradoxes (Hahn and Knight, 2021a) such as individuals confronted with the paradox of control exhibit different preferences regarding modes of control and dynamically adapt to paradoxes, accordingly (Tilson et al., 2010). These different individual approaches make it necessary to find aggregate solutions at an organizational level (Schad et al., 2016). For example, on the one hand, users of certain artefact might comprehend paradoxical tensions as being inherent to the object used and require the development of some features to address the paradox. On the other hand, developers comprehend the same situation as a socially constructed paradox and favor programs to train users and increase their capacity. These different approaches might mutually influence each other as well as affect the development of an approach at the organizational level (Smith and Beretta, 2021). Accordingly, negotiating multilateral agreements and finding mutual solutions are important management tasks, and a topic rarely addressed by extant research.

[4] Appendix D.2 provides an overview of identified articles that address paradoxes and contradicting forces in the context of digital innovation.

Third, Li (2021a) advocates a neither-nor approach to paradoxes (neither inherent nor socially constructed), that emphasizes the interrelations between two opposites instead of focusing on paradoxes as unit of analysis. Thereby, "any paradox or paradoxical tension is caused by the asymmetry between one's capacity and expectation (ACE)" (Li, 2021a, p. 412). As a result, paradoxes are not only created but also overcome by addressing this asymmetry. The two aspects – capacity and expectations – have been mentioned, but not deeply investigated in extant research. For example, Jarvenpaa and Lang (2005) argue that users run into conflict if technology does not work according to their expectations, which then leads to applying avoidance or confrontation coping strategies. Gregory et al. (2015) point to the importance of research into *leaders' capabilities* as important means to resolve paradoxical tensions. Yet, the literature is relatively silent on the combination of both aspects – expectations and capacity – although we know that different people experience more or less tension when confronted with similar situations (Hahn and Knight, 2021a). The ACE perspective (Li, 2021a, 2021b) provides a framework to engage in future research on capabilities and expectations of individuals, the relationship between capability and expectation, and how this relationship is related to experiencing and coping with paradoxes. In that regard, future research could also investigate individuals' agency since extant research tackles individuals as "free and able to choose how to engage with paradoxical tensions" and neglects that power and domination effects might constrain the action space in the face of interdependent contradictions (Berti and Simpson, 2021b, p. 252).

The following table offers potential research questions related to the individual approaches discussed.

**Table 7**
Avenue 1: Individual approaches to paradoxes in digital innovation.

| Identified gap(s) | Exemplary research questions |
|---|---|
| **Coping** with paradoxes | • How does individuals' comprehension of paradoxes influence their coping strategies?<br>• How does coping with paradoxes influence their comprehension?<br>• How does peers' and leaders' comprehension of paradoxes influence an individual's coping strategies? |
| **Management** of paradoxes | • How does the interplay among different individuals' comprehensions of paradoxes as being (1) inherent to digital innovation, or (2) socially constructed, or (3) both influence coping and management strategies at an organizational level?<br>• How do multilateral agreements among individuals about coping with paradoxes evolve in organizations?<br>• How does the interplay among different individuals' comprehensions of paradoxes and coping strategies influence the development of mutual solutions for an effective coping strategy at an organizational level over time? |
| **Asymmetry** between capacity and expectations (ACE) | • How does the interplay between individuals' expectations and capacity shape how they cope with paradoxical tensions?<br>• How does the asymmetry between individuals' capacity and expectations influence their comprehension of paradoxes?<br>• Which individual skills and abilities are appropriate to cope with paradoxes?<br>• How do capacity and expectations evolve during coping with paradoxes?<br>• How does an individual's agency influence its coping strategies? |

*Avenue 2: Knowledge recombination for digital innovation*

The topics of knowledge and knowledge recombination have a long tradition in different research domains and across various levels of analysis. At the macro-economic level of analysis, growth theories tackle knowledge from various angles. The endogenous growth theory, for example, models evolutionary progress by recombining technology and knowledge (in our terms), and discusses key features of knowledge such as unbounded growth and incomplete appropriability (Romer, 1990). These models explain (technological) innovation and economic growth.

At the micro-economic level, the knowledge-based theory argues that knowledge is the most important asset of organizations and that the primary role of organizations is to integrate knowledge to create and sustain competitive advantage (Grant, 1996a, 1996b). In a similar vein, the knowledge management literature (e.g., Alavi and Leidner, 2001) discusses the application of different types of knowledge in organizations while another literature strand explores successful exchange and recombination of knowledge across craft-specific boundaries (e.g., Dougherty and Dunne, 2012; Pershina et al., 2019).

While the concept of recombining digital and physical components is central to digital innovation research (e.g., Henfridsson et al., 2018; Yoo et al., 2010), the recombination of organizations' most important asset, knowledge (Grant, 1996b), has so far been neglected in digital innovation research (Hund, 2020), even though it has been repeatedly emphasized across disciplines as essential for innovation (e.g., Balachandran and Hernandez, 2018; Kogut and Zander, 1992; Rosenkopf and Almeida, 2003).

A focus on knowledge recombination offers several valuable avenues for future research on digital innovation: First, there are insights that "digitalization creates a new form of knowledge", by enabling complementary insights between different fields of practice (Dougherty and Dunne, 2012, p. 1467). Nevertheless, different types of knowledge have only been considered superficially in extant research. Distinguishing between different types of knowledge as proposed in the knowledge management literature (e.g., declarative, procedural, causal, conditional, relational (Alavi and Leidner, 2001)), it might be possible to uncover what roles certain types of knowledge play during specific phases of the innovation process. In light of ubiquitous digital technology and since there is an almost unlimited supply of knowledge (Majchrzak et al., 2018), we need a deeper understanding of how developing specific types of knowledge can support strategies for and practical advice on how to identify, prioritize, access, and recombine knowledge.

Second, beyond the particularities of knowledge, the role of digital technology itself offers another promising avenue for future research. Digital technologies such as artificial intelligence (AI) foster new ways to create knowledge through data analysis and is already influencing the way we access, evaluate, and interpret knowledge (Lanzolla et al., 2021). AI can "ingest human-level knowledge (e.g., via machine reading and computer vision) and use this information to automate and accelerate tasks that were previously only performed by humans" (Taddy, 2019, p. 62). Digital technology can therefore augment human capabilities, potentially overcoming current limitations in innovation processes (Verganti et al., 2020), for example, by connecting "disparate pieces of knowledge" (Chalmers et al., 2020, p. 8) in ways humans cannot. Thus, a stronger sociotechnical focus on the role of digital technology, as an actor that can learn by itself, in the process of knowledge search and recombination provides interesting future perspectives on knowledge recombination.

Third, digitally enabled forms of collaboration (e.g., crowdsourcing, online communities, ecosystems) facilitate the exchange of knowledge between different actors across time and space. The combination and convergence of such knowledge "is serendipitous in a manner that is continually gained and lost" (Faraj et al., 2011, p. 1230). To benefit from serendipity, organizations must identify tools and behaviors that promote unplanned recombination (Austin et al., 2012; Yoo et al., 2012). Particularly, since digital innovation does not require holistic knowledge about the underlying product architecture (Yoo et al., 2010), individual actors are empowered to participate in complex innovation processes (Henfridsson et al., 2018; Lanzolla et al., 2021). This leads to the democratization of innovation where "even individual hobbyists have access to sophisticated design tools" (von Hippel, 2006, p. 122) as, for example, in the case of 3D printing ecosystems, where the exaptation of existing features for new contexts might spark innovation (Beltagui et al., 2020). Since individual actors in such ecosystems pursue their own goals and are typically not united under a common purpose (Boland et al., 2007; Lyytinen et al., 2016), serendipity provides an interesting lens to investigate under what circumstances individual actors might recombine and create new expert knowledge, which serendipitously solves existing, yet unrecognized, problems (cf. von Hippel and von Krogh, 2016).

Table 8 provides an overview of the identified gaps and puts forward exemplary research questions.

**Table 8**
Avenue 2: Knowledge recombination for digital innovation.

| Identified gap(s) | Exemplary research questions |
|---|---|
| **Knowledge typologies** to distinguish between different types of knowledge | • How does digital technology enable the creation of a new form of knowledge?<br>• Which role does knowledge recombination play in the creation of digital innovation? How does it differ from component recombination?<br>• Which type of knowledge is needed in which particular stage of innovation creation? How can innovators prioritize? |
| **Role of digital technology** in knowledge recombination | • How can human and technological capabilities be used jointly to facilitate knowledge recombination?<br>• How can digital technologies such as AI support or even replace human capabilities during various phases of the knowledge recombination process?<br>• What are the implications of relying on digital technologies to carry out unsupervised recombinations (e.g., black boxing)? |
| **Serendipity** as a way to investigate unintended recombinations of knowledge in digitally enabled collaborations | • How can the unprecedented amount of accessible knowledge be leveraged to foster serendipitous innovation?<br>• How can organizations design tools that foster serendipitous behavior? If there are such tools, (how) do they differ across contexts?<br>• How can valuable recombinations be identified and appropriated? How does serendipity influence organizational strategy making? |

## Limitations

As with all research, this literature review has certain limitations. First, conducting a broad theorizing review (Leidner, 2018) requires a focus on breadth rather than on depth. While this allows a wide range of extant knowledge to be organized and makes literature streams more accessible, that comes at the expense of delving into the details of each topic. Second, while we followed established best practices for conducting a literature review (Leidner, 2018; Wolfswinkel et al., 2013), there remains the risk of human error. To mitigate this risk as far as possible, we constantly cross-checked the results between all four authors and conducted two joint coding workshops, in which the results were discussed in detail. Lastly, most research on digital innovation has taken qualitative approaches. While our conceptualization might contribute to achieving the necessary conceptual clarity to develop quantifiable measures, the development of such is out of scope of our work.

## Conclusion

Digital innovation is a rapidly growing field of research reflecting the profound and pervasive processes of digitalization and technological development. This review organizes insights of 227 articles across eight different fields and proposes a novel perspective on digital innovation focusing on its sociotechnical nature. Our aim with this review is conceptual clarity to stimulate new research on the complex interactions of the technical and social in sociotechnical phenomena such as digital innovation.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Appendix A. Methodology

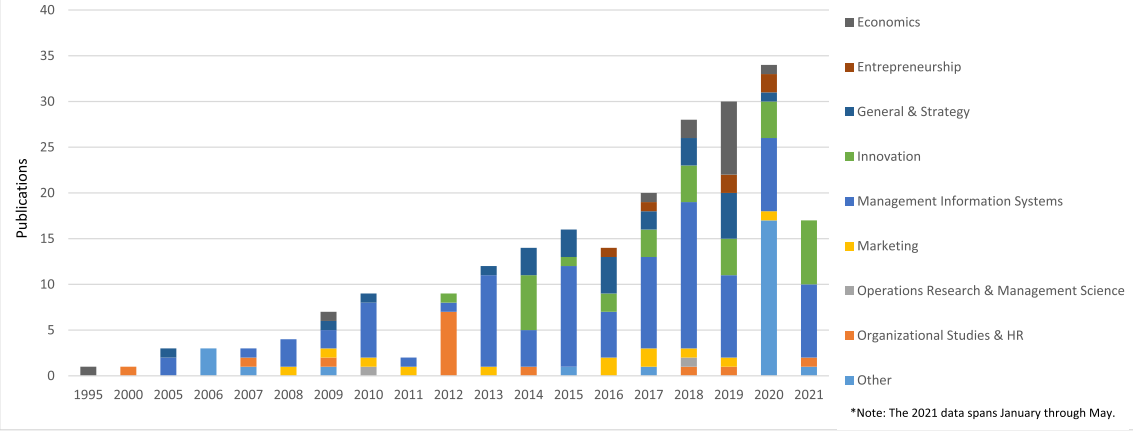
### *A.1. Type of review: Broad theorizing review*

In cases when "existing theory does not effectively capture the literature stream", Leidner suggests taking a more grounded approach in order to develop a new framework but also highlights that it is "the authors' responsibility to justify the choice made" (Leidner, 2018, p. 556). Justification specifically depends on (1) the relative novelty of the phenomenon under review and (2) justified doubts whether existing theory can fully depict the phenomenon.

*Relative novelty of the phenomenon*

Several seminal works have already outlined the transformative effect of digital technology on all areas of life decades ago (e.g., Kalakota and Whinston, 1996; Negroponte, 1995). Thus, the 'digital' prefix per se is not new at all. However, during recent years, "we have seen a growing trend in which the term digital is affixed to other management concepts, implying that there is something different with 'digital'" (Avital et al., 2019, p. 2). Leading IS scholars underscore 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, emphasis added). We agree with this due to three factors:

(1) Publications on digital innovation in leading journals across several disciplines have more than doubled between 2016 (14 articles) and 2020 (34 articles), as depicted below.
(2) There is a vivid ongoing discourse in the academic world about what is novel about 'digital' as evidenced by conference panel discussions (e.g., Avital et al., 2019), newly established special interest groups (SIG)[5], and current conference tracks[6] that specifically focus on digital phenomena, as well as recently published articles in leading journals that underscore changing logics due to digital technology (e.g., Baskerville et al., 2020; Wessel et al., 2021).
(3) Research on digital innovation is taking place across various disciplines simultaneously, leading to a fragmented state of the field and an inconsistent use of definitions and concepts (cf., Appendix C.2). The fragmentation is exacerbated by the fact that there exists no comprehensive overarching review or framework that provides an overview about current concepts, definitions, and themes in digital innovation research.




*Justified doubts whether existing theory can capture the phenomenon*

Our doubts about whether existing theories can fully capture the phenomenon of digital innovation stems from three observations:

[5] SIG on Digital Innovation, Transformation, and Entrepreneurship: https://communities.aisnet.org/sigdite/new-item5/new-item2 [accessed: 24.05.2021].
[6] ICIS conference track on Digital Innovation, Entrepreneurship, and Business Models: https://icis2021.aisconferences.org/track-descriptions/#toggle-id-15 [accessed: 24.05.2021].

(1) Initially, to gain a better understanding of the current state of research, we familiarized ourselves with extant literature[7], "[…] to determine the extent to which a body of empirical studies in a specific research area supports or reveals any interpretable patterns or trends with respect to pre-existing propositions, theories, methodologies or findings" (Paré et al., 2015, p. 4). To do so, we relied on an established multi-level framework to distinguish between innovation as a process vs. as an outcome, and three levels of determinants (individual, organizational, environmental) (Crossan and Apaydin, 2010, p. 1182). Using the existing framework helped structuring the review process but also highlighted several discrepancies between traditional innovation and digital innovation research such as difficulties to distinguish between process and outcome (Nambisan et al., 2017), between user and producer (Henfridsson et al., 2018), and generally the notion of clearly defined innovation actors (Boland et al., 2007; Lyytinen et al., 2016). This initial overview allowed us to develop a better understanding of the research problem as is suggested in the GT literature as a first step (see the section below on 'Researcher as a Blank Slate').
(2) Definitions of digital innovation oftentimes suffer from conceptual clarity and are inconsistently used (see Appendix C.2 and C.3).
(3) Leading scholars regularly question whether extant theory sufficiently addresses the role of digital technology (e.g., Barrett et al., 2015; Baskerville et al., 2020; Benner and Tushman, 2015; Briel et al., 2018; Ekbia, 2009; Faulkner and Runde, 2019; Henfridsson et al., 2018; Nambisan et al., 2017; Nambisan et al., 2020).

Due to the relative novelty of the phenomenon and the justified doubts about whether extant theories adequately capture the essence of digital innovation, we decided to conduct a *broad theorizing review* with two main goals (1) addressing what the 'digital' prefix connotes in the context of innovation research, and (2) organizing current knowledge across various fields by identifying core themes and their connection. Leidner (2018) describes that broad theorizing reviews initially organize extant research by reviewing the literature across various disciplines, typically synthesizing the findings in form of an emergent framework, which serves then as the basis for further theorizing.

### *A.2. Grounded theory as approach to reviewing the literature*

To produce the emergent framework, we relied on the five-stage process of Wolfswinkel et al. (2013) as specified in their article *Using grounded theory as a method for rigorously reviewing literature.* While grounded theory is typically used in the context of empirical data analysis, the approach has been embraced rapidly by the IS community for rigorously reviewing literature as demonstrated by current reviews on digital transformation (Vial, 2019), IS integration (Henningsson et al., 2018), and IT-business alignment (Oehlhorn et al., 2020). The five-stage process outlined by Wolfswinkel et al. (2013) is presented in Table A.2-1:

**1. Define**

In a first step, we defined the scope of the review and the criteria for inclusion and exclusion (1.1).

*Quality threshold:* We established quality thresholds based on the 65th edition of the Journal Quality List (JQL) (Harzing, 2019), which is a *meta*-ranking summarizing insights of 12 internationally acclaimed journal rankings such as the Financial Times 50, the ABDC 2016 and the VHB-JOURQUAL3 to determine the quality of journals across various fields.

*Inclusion criteria*: During the initial search, journals must be listed in the JQL and have a high rating in most of the rankings. Since research fields differ with regard to their maturity and size (e.g., there is no Entrepreneurship journal achieving the top score in every ranking, but several General & Strategy journals do so), we compared journal rankings with the average ranking of each field, in order to not exclude any field upfront. We only considered articles in line with the very broad conceptualization of digital innovation by Nambisan et al. (2017, p. 224): "[…] the creation of (and consequent change in) market offerings, business processes, or models that result from the use of digital technology".

*Exclusion criteria*: We excluded articles focusing primarily on other types of innovation or not focusing on digital technology. Since there are high-quality reviews about innovation in general (e.g., Crossan and Apaydin, 2010) and loosely related terms such as IT-innovation are conceptualized differently (Fichman, 2004; Kohli and Melville, 2018), a missing focus on digital technology prevents insights into the ontological complexities of digital innovation (Faulkner and Runde, 2019; Kallinikos et al., 2013; Riemer and Johnston, 2017).

In a second step, we defined the field of research (1.2). Here, similarly to Baarspul and Wilderom (2011) we conducted several keyword-based searches (combinations of "digital" "innovation" and "invention") in different meta databases (e.g., Web of Science, EBSCO Business Source Ultimate, Google Scholar) to scope different fields. After compiling a list of interesting journals, we cross-checked where each journal is categorized within the 16 subject areas of the JQL (Harzing, 2019). This left us with seven subject areas of interest: General&Strategy, Management Information Systems (MIS), Innovation, Organizational Studies and HR, Operation Research and Management Science, Economics, and Entrepreneurship. Additionally, we included the field of Marketing during the review process. Within these eight subject areas, we determined the leading journals in every field and added them to our initial list of interesting journals. As stated above, in order to prevent the exclusion of smaller or nascent fields, we compare journal rankings to the average ranking of each field. In total, we selected 54 journals (cf. Table 1). For example, in the field of MIS, our final list of journals includes amongst others the Senior Scholar Basket of 8, which represents the core of the MIS field according to recent bibliometric analyses (Lowry et al., 2004; Lowry et al., 2013). Together with the forward and backward search in step 3, 'Select', we are confident

[7] This initial, rather small review can be provided upon request.

**Table A.2-1**
**Review methodology based on** Wolfswinkel et al. (2013).

| Step | Task | Subtasks |
|---|---|---|
| 1. Define | 1.1 Define the criteria for inclusion/ exclusion | • Quality threshold: Journal Quality List (Harzing, 2019)<br>• Inclusion criteria: Clear and central focus on digital innovation as defined by Nambisan et al. (2017)<br>• Exclusion criteria: Focus on other types of innovation (e.g., IT innovation) |
| | 1.2 Identify relevant fields of research | • Fields of research: Management Information Systems, Strategy, Innovation, Entrepreneurship, Management and Operation, Organization and HR, Marketing, Economics (cf. Table 1) |
| | 1.3 Determine the appropriate sources | • EBSCO Business Source Ultimate<br>• AISel Online Library<br>• Journal Websites (e.g., JSIS) |
| | 1.4 Decide on the specific search terms | • "Digital" AND "Innovation" (in either title, abstract, or keywords) |
| 2. Search | 2.1 Conduct Search | • Result: 318 papers |
| 3. Select | 3.1 Refine the sample | • 1. Filter: Removed duplicates, book reviews, calls for papers<br>• 2. Filter: Excluded articles based on title, abstract (+additional parts if necessary)<br>• Forward and backward search<br>• Finalize data set |
| 4. Analyze | 4.1 Open coding | • Extracting excerpts<br>• Open coding:<br>o Organizing excerpts into a set of concepts<br>o Aggregate concepts into categories |
| | 4.2 Axial coding | • Axial coding:<br>o Identify interrelations between categories<br>o Establish subcategories |
| | 4.3 Selective coding | • Selective coding:<br>o Integrate and refine categories<br>o Establish 'main' categories |
| 5. Present | 5.1 Represent and structure the content | • Provide rationale for the review (Introduction)<br>• Definitions of the key terms (final definition of digital innovation depends on results from the analysis)<br>• Methodological section<br>• Findings<br>• Discussion |

that our primary search is comprehensive enough to identify all important relevant articles.

Third, we determined appropriate sources (1.3) to search for our selected journals. Most journals are directly accessible via EBSCO Business Source Ultimate and AISel Online Library. For the rare exceptions that were not accessible, we searched directly via the journal website or Google Scholar.

Fourth, we chose search terms (1.4). For the initial search, we searched for "digital" AND "innovation" in the title, abstract or keywords. This included papers that talk about "innovation" in a "digital" context but do not use the term "digital innovation". This is in line with the more encompassing definition of Nambisan et al. (2017).

**2. Search**

We then conducted a separate search for each field of research (2.1) and identified 423 articles. Table 1 in the main article depicts an overview over the fields of research, the chosen journals, and number of articles identified.

**3. Select**

To refine the results (3.1), we filtered the initial data and performed a forward/backward search. *First filtering:* Excludes duplicates, book reviews, and calls for papers. *Second filtering:* Excludes articles outside the scope of the review by screening title, abstract and additional excerpts if necessary. This step was carried out by the first and second author and discussed with the third and fourth author in an ongoing, iterative, manner. We then conducted a forward and backward search as recommended by Webster and Watson (2002), thus identifying and including 90 additional articles that met our inclusion criteria. Overall, we came up with 227 articles relevant to our analysis.

**4. Analyze**

In our analysis, we followed the recommendations of Wolfswinkel et al. (2013). We adopted an iterative, five-step coding procedure similar to Henningsson et al. (2018). First, we imported the selected 227 articles into Citavi6 and randomly selected 20 articles, which all four authors read independently to identify relevant excerpts. Afterwards, we conducted a coding workshop with all four authors in which we re-read all identified excerpts and performed open coding by discussing the concept behind each excerpt and "attaching initial labels to all available data" (Wiesche et al., 2017, p. 688). This resulted in 292 open codes, which formed the basis for an initial round of axial coding in which we identified similarities between concepts and related them to each other in categories and corresponding subcategories. After reaching a shared understanding, the first author then coded the remaining articles in close consultation with authors two and three, performing comparative analysis by "continuously comparing, relating and linking the identified categorizations with each other and the studied papers and excerpts" (Wolfswinkel et al., 2013, p. 7). Importantly, insights from the workshop were not used as preconceived theoretical lens and were frequently challenged and changed based on new insights from the data. Discussing any unclear excerpts along the way and frequently iterating between open and axial coding helped refine the emerging concepts and categories. Once a clear set of categories and sub-categories had been created, a second coding workshop with all four authors was conducted to perform selective coding, aimed at uncovering the interrelations between the categories, finding 'main' categories and relate them to each other. A 'main category' "is either the subject of the review or concerns directly one or more of the specific research questions" (Wolfswinkel et al., 2013, p. 7). Open, axial and selective coding was performed in an ongoing fashion, iterating between the individual stages until theoretical saturation was reached and the additional reading of excerpts no longer revealed any new findings. The data structure in Appendix B below shows how we went from excerpts to open, axial, and selective codes.

**5. Present**

In this final step, a rationale for the review is presented and the results of the literature review are written up and presented.

### *A.3. Relevant clarifications about grounded theory for reviewing literature*

*Stance on philosophy of science*

The success of grounded theory (GT) in the social sciences has led to the development of various variants with different underlying ontological and epistemological assumptions and coding procedures (Goldkuhl and Cronholm, 2019; Wiesche et al., 2017). Researchers sometimes distinguish between Glaserian GT, which is perceived as rather objectivistic and thus closer to a positivistic worldview, whereas Straussian GT is perceived as rather constructivist and thus closer to an interpretive worldview (Goldkuhl and Cronholm, 2019). Yet, "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). Thereby, GT may be able to "bridge traditional positivistic methods with interpretative methods" (Charmaz, 2010, p. 30) and it is the responsibility of the researcher to clarify their underlying epistemological assumptions (Urquhart and Fernández, 2013). In the context of this literature review, we adopted an interpretivist stance since the approach to reviewing literature as proposed by Wolfswinkel et al. (2013) is organized around two key concepts: *comparative analysis* (constantly comparing the underlying data with emerging concepts, categories, and their interrelations) and *theoretical sampling* (insights from already read articles inform the analysis of the remaining articles). Both concepts are inconsistent with purely positivist assumptions since they challenge the clear separation of data collection and data analysis, leading to an iterative understanding of the topic, rather than an *a priori* defined understanding in form of hypotheses (Suddaby, 2006).

*Type of data*

GT is typically associated with the analysis of data in the form of observational notes or interview transcripts. The specific type of data is, however, not necessarily pivotal since "[g]rounded theory works are *empirical studies*, whether their data sources are

autobiographies, published accounts, public records, novels, intensive interviews, case-studies, participant observer field notes or personal journals" (Charmaz, 2010, p. 31). When using literature as the data source to be analyzed, a careful selection of high-quality, peer-reviewed articles within the final corpus of articles constitutes the best available knowledge within a specific area of expertise (Wolfswinkel et al., 2013). A grounded literature review can therefore be seen as "part of a discourse development: To interpret, reconstruct and assess arguments and discourse in order to contribute to a restructured and expanded discourse" (Goldkuhl and Cronholm, 2019, p. 3).

*Distinction to meta-analysis*

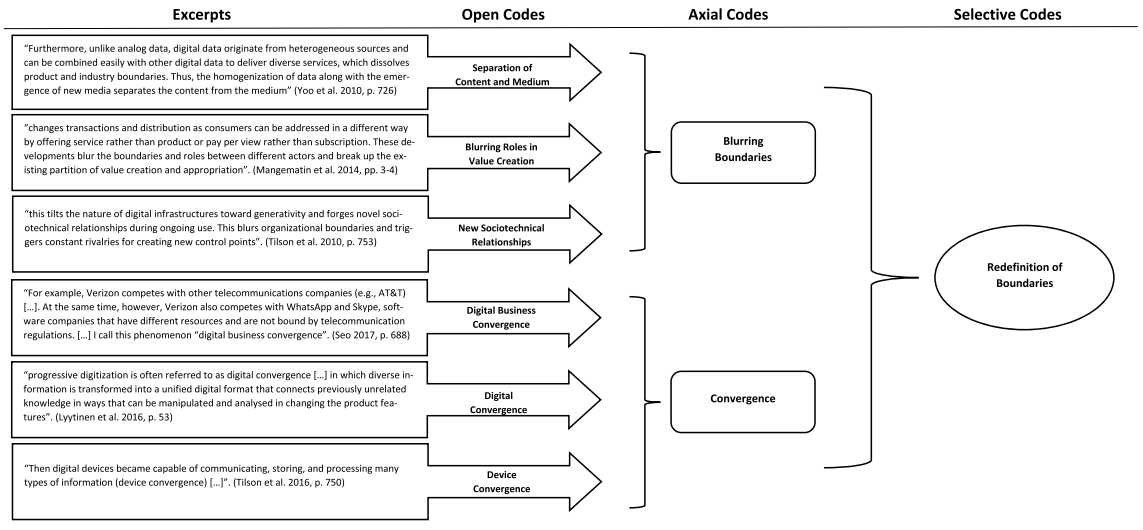
Meta-analyses are a tool to systematically analyze and integrate the findings from other empirical studies (Hunter and Schmidt, 2015). While *meta*-analysis is typically associated with statistical measures to cumulate quantitative findings (e.g., Gerow et al., 2014), there are also qualitative *meta*-analyses which cumulate the qualitative findings of, for example, case studies (e.g., Berente et al., 2019; Habersang et al., 2019). Both types of *meta*-analysis have in common that they typically restrict the type or setting of research articles (e.g., only case studies) to ensure comparability of the findings. By contrast, when reviewing literature using a GT approach, the focus shifts more to the theoretical concepts and their interrelations (Wolfswinkel et al., 2013), which is particularly useful when conducting a concept-centric review, as recommended by Webster and Watson (2002). Furthermore, while GT is a rigorous approach to organizing and integrating extant literature (Wolfswinkel et al., 2013), the ultimate aim is developing new conceptualizations and theory-building (Urquhart et al., 2010). Thus, while both, *meta*-analysis and GT, are valuable tools to analyze large sets of literature, they differ in terms of their respective focus and aim. For our review, which focuses on the identification of relevant concepts across various disciplines and the development of novel conceptualization/theory, the GT approach represents the better approach.

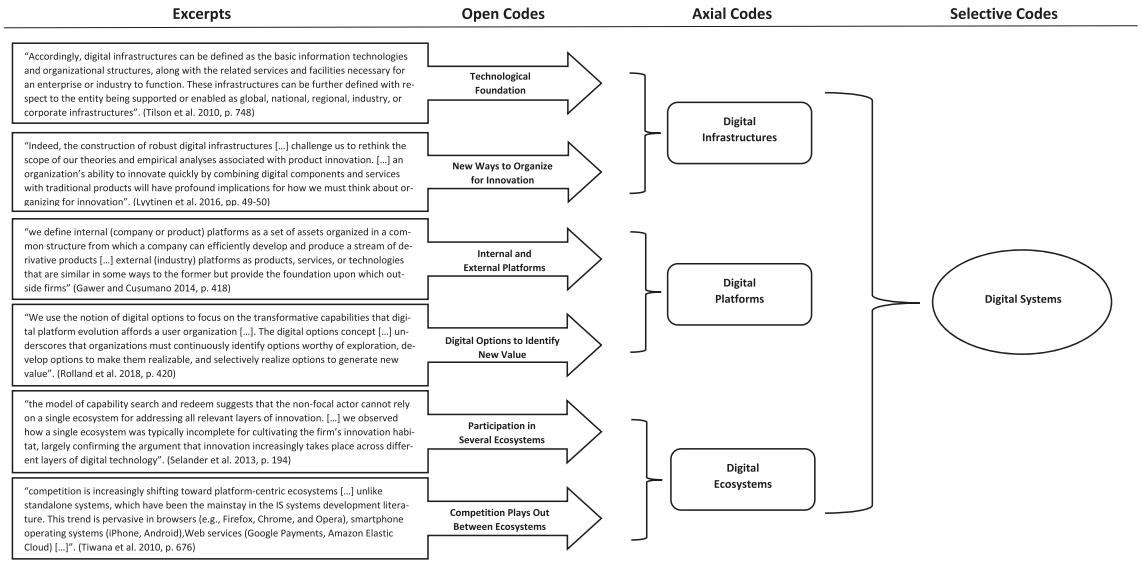
*Researcher as a blank slate*

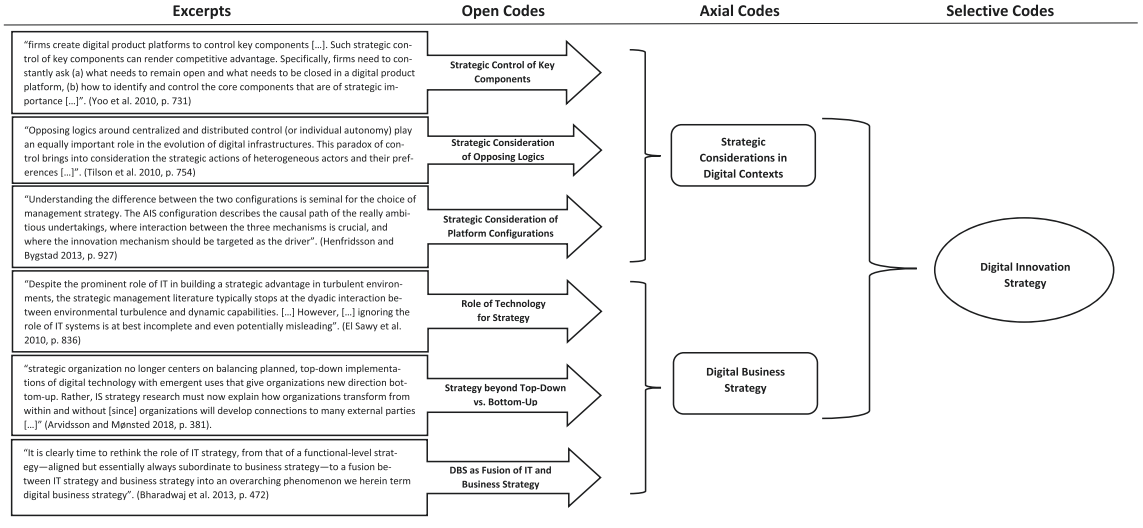
The starting point of a GT analysis is often portrayed as a blank slate in which the researcher consciously avoids learning about any existing concepts or theories until the analysis of the data has produced concepts and theories independently. However, this is a common misconception stemming from one of the central ideas of GT that research must "set aside" existing knowledge, which does not imply that "researchers must ignore the existing literature and become a tabula rasa" (Urquhart and Fernández, 2013, p. 226). This is also clarified in the first chapter of the original text book by Glaser and Strauss (1967, p. 3): "the researcher does not approach reality as a tabula rasa. He must have a perspective that will help him see relevant data and abstract significant categories from his scrutiny of the data". Thus, the researcher must acknowledge what is already known while remaining open to new insights (Wolfswinkel et al., 2013), since "an open mind is good; an empty mind is not" (Siggelkow, 2007, p. 21). Leading experts on GT even recommend conducting a non-committal pre-study literature review to flesh out the nature of the research problem and to develop a general theoretical sensitivity (Urquhart and Fernández, 2013).

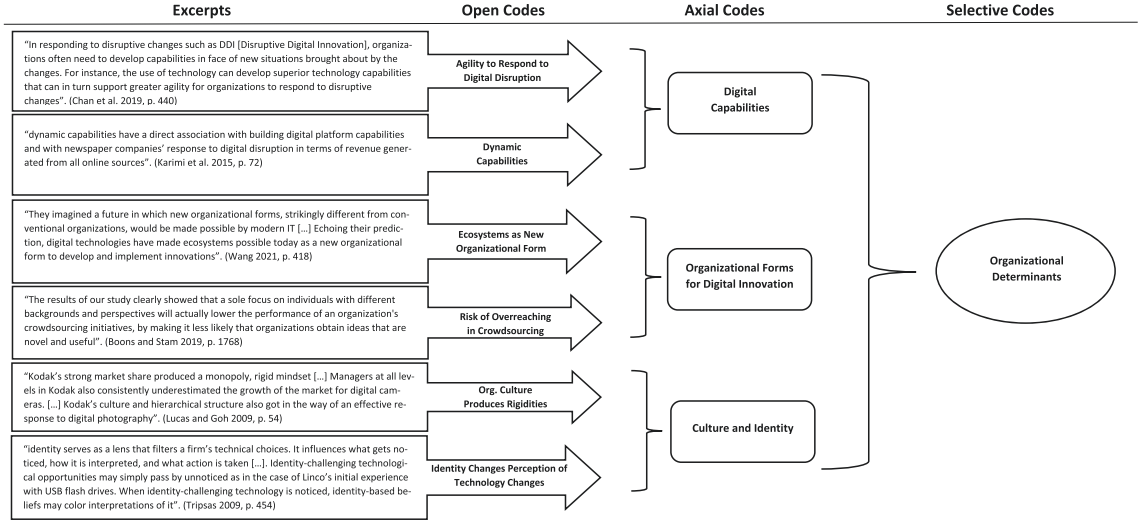
While a solid understanding of the research problem is critical and often requires initial consultation of the existing literature, it is important that existing knowledge does not predetermine findings in the data (Goldkuhl and Cronholm, 2019; Hughes and Jones, 2003; Matavire and Brown, 2013). Therefore, we intentionally set aside prior knowledge during the initial open coding phase in our review and immersed ourselves by staying as close as possible to the data (see Appendix B). Over time, in parallel with our evolving understanding of the topic, our analysis moved from inductive to increasingly abductive by considering theory and data simultaneously (Alvesson and Kärreman, 2007; Gioia et al., 2013).

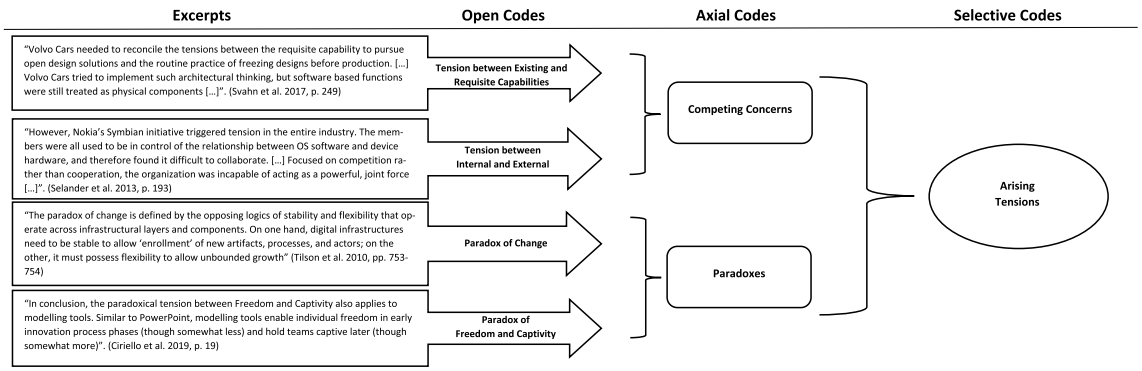
## Appendix B. Data structure

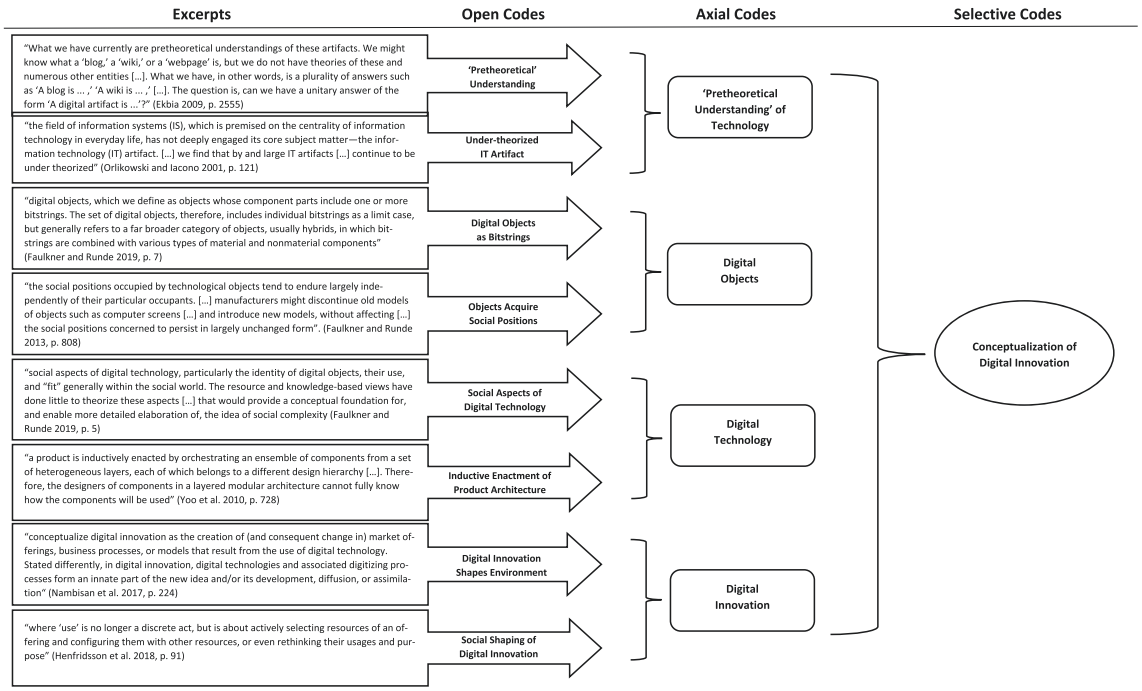



Excerpts
Open Codes
Axial Codes
Selective Codes
"Accordingly, digital infrastructures can be defined as the basic information technologies and organizational structures, along with the related services and facilities necessary for an enterprise or industry to function. These infrastructures can be further defined with respect to the entity being supported or enabled as global, national, regional, industry, or corporate infrastructures". (Tilson et al. 2010, p. 748)
Technological Foundation
"Indeed, the construction of robust digital infrastructures [...] challenge us to rethink the scope of our theories and empirical analyses associated with product innovation. [...] an organization's ability to innovate quickly by combining digital components and services with traditional products will have profound implications for how we must think about organizing for innovation". (Lyytinen et al. 2016, pp. 49-50)
New Ways to Organize for Innovation
Digital Infrastructures
"we define internal (company or product) platforms as a set of assets organized in a common structure from which a company can efficiently develop and produce a stream of derivative products [...] external (industry) platforms as products, services, or technologies that are similar in some ways to the former but provide the foundation upon which outside firms" (Gawer and Cusumano 2014, p. 418)
Internal and External Platforms
"We use the notion of digital options to focus on the transformative capabilities that digital platform evolution affords a user organization [...]. The digital options concept [...] underscores that organizations must continuously identify options worthy of exploration, develop options to make them realizable, and selectively realize options to generate new value". (Rolland et al. 2018, p. 420)
Digital Options to Identify New Value
Digital Platforms
"the model of capability search and redeem suggests that the non-focal actor cannot rely on a single ecosystem for addressing all relevant layers of innovation. [...] we observed how a single ecosystem was typically incomplete for cultivating the firm's innovation habitat, largely confirming the argument that innovation increasingly takes place across different layers of digital technology". (Selander et al. 2013, p. 194)
Participation in Several Ecosystems
"competition is increasingly shifting toward platform-centric ecosystems [...] unlike standalone systems, which have been the mainstay in the IS systems development literature. This trend is pervasive in browsers (e.g., Firefox, Chrome, and Opera), smartphone operating systems (iPhone, Android),Web services (Google Payments, Amazon Elastic Cloud) [...]". (Tiwana et al. 2010, p. 676)
Competition Plays Out Between Ecosystems
Digital Ecosystems
Digital Systems


Excerpts
Open Codes
Axial Codes
Selective Codes
"firms create digital product platforms to control key components [...]. Such strategic control of key components can render competitive advantage. Specifically, firms need to constantly ask (a) what needs to remain open and what needs to be closed in a digital product platform, (b) how to identify and control the core components that are of strategic importance [...]". (Yoo et al. 2010, p. 731)
Strategic Control of Key Components
"Opposing logics around centralized and distributed control (or individual autonomy) play an equally important role in the evolution of digital infrastructures. This paradox of control brings into consideration the strategic actions of heterogeneous actors and their preferences [...]". (Tilson et al. 2010, p. 754)
Strategic Consideration of Opposing Logics
"Understanding the difference between the two configurations is seminal for the choice of management strategy. The AIS configuration describes the causal path of the really ambitious undertakings, where interaction between the three mechanisms is crucial, and where the innovation mechanism should be targeted as the driver". (Henfridsson and Bygstad 2013, p. 927)
Strategic Consideration of Platform Configurations
Strategic Considerations in Digital Contexts
"Despite the prominent role of IT in building a strategic advantage in turbulent environments, the strategic management literature typically stops at the dyadic interaction between environmental turbulence and dynamic capabilities. [...] However, [...] ignoring the role of IT systems is at best incomplete and even potentially misleading". (El Sawy et al. 2010, p. 836)
Role of Technology for Strategy
"strategic organization no longer centers on balancing planned, top-down implementations of digital technology with emergent uses that give organizations new direction bottom-up. Rather, IS strategy research must now explain how organizations transform from within and without [since] organizations will develop connections to many external parties [...]" (Arvidsson and Mønsted 2018, p. 381).
Strategy beyond Top-Down vs. Bottom-Up
"It is clearly time to rethink the role of IT strategy, from that of a functional-level strategy—aligned but essentially always subordinate to business strategy—to a fusion between IT strategy and business strategy into an overarching phenomenon we herein term digital business strategy". (Bharadwaj et al. 2013, p. 472)
DBS as Fusion of IT and Business Strategy
Digital Business Strategy
Digital Innovation Strategy


Excerpts
Open Codes
Axial Codes
Selective Codes
"In responding to disruptive changes such as DDI [Disruptive Digital Innovation], organizations often need to develop capabilities in face of new situations brought about by the changes. For instance, the use of technology can develop superior technology capabilities that can in turn support greater agility for organizations to respond to disruptive changes". (Chan et al. 2019, p. 440)
Agility to Respond to Digital Disruption
"dynamic capabilities have a direct association with building digital platform capabilities and with newspaper companies' response to digital disruption in terms of revenue generated from all online sources". (Karimi et al. 2015, p. 72)
Dynamic Capabilities
Digital Capabilities
"They imagined a future in which new organizational forms, strikingly different from conventional organizations, would be made possible by modern IT [...] Echoing their prediction, digital technologies have made ecosystems possible today as a new organizational form to develop and implement innovations". (Wang 2021, p. 418)
Ecosystems as New Organizational Form
"The results of our study clearly showed that a sole focus on individuals with different backgrounds and perspectives will actually lower the performance of an organization's crowdsourcing initiatives, by making it less likely that organizations obtain ideas that are novel and useful". (Boons and Stam 2019, p. 1768)
Risk of Overreaching in Crowdsourcing
Organizational Forms for Digital Innovation
"Kodak's strong market share produced a monopoly, rigid mindset [...] Managers at all levels in Kodak also consistently underestimated the growth of the market for digital cameras. [...] Kodak's culture and hierarchical structure also got in the way of an effective response to digital photography". (Lucas and Goh 2009, p. 54)
Org. Culture Produces Rigidities
"identity serves as a lens that filters a firm's technical choices. It influences what gets noticed, how it is interpreted, and what action is taken [...]. Identity-challenging technological opportunities may simply pass by unnoticed as in the case of Linco's initial experience with USB flash drives. When identity-challenging technology is noticed, identity-based beliefs may color interpretations of it". (Tripsas 2009, p. 454)
Identity Changes Perception of Technology Changes
Culture and Identity
Organizational Determinants




## Appendix C. Conceptualizing and defining digital innovation

### *C.1. Identification of existing definitions of digital innovation*

During the literature review, several conceptual differences between extant definitions of digital innovation became evident. In total, we identified 29 explicit definitions within our sample. Table C.1-1 provides an overview of each identified definition, its' source, and discusses the type, scope, and inherent issues.

**Table C.1-1**
Definitions of digital innovation.

| Definition | Source | Root of definition, scope & issue(s) |
|---|---|---|
| "[C]arrying out new combinations of digital and physical components to produce novel products" | Yoo et al. (2010) | **Based on:** Schumpeter (1934)<br>Scope: Restricted to products (and services)<br>Unclear term: "digital component" |
| "'Carrying out new combinations of digital and physical components' to produce novel products and services" | Abrell et al. (2016) | **Based on:** Yoo et al. (2010)<br>Scope: Restricted to products and services.<br>Unclear term: "digital component" |
| "[N]ew combinations of digital and physical components to produce new products (and services) by combining digital data from heterogeneous sources easily 'to deliver diverse services, which dissolves product and industry boundaries'" | Barrett et al. (2015) | **Based on**: Yoo et al. (2010)<br>Scope: Restricted to products and services<br>Unclear term: "digital component"<br>Conflation of concept and impact |
| "All [disruptive digital innovation] can trace their origins to some form of digital technology. New digital technologies are constantly developed from scientific research and discoveries. Some of these digital technologies may be combined and developed into digital innovation." | Chan et al. (2019) | **Based on**: Christensen and Rosenbloom (1995)<br>Scope: Only disruptive digital innovation.<br>Unclear term: "digital technology"<br>Conflation of concept and impact |
| "[T]he recombination of digital components in a layered, modular architecture to create new value-in-use to users or potential users of a service" | Huang et al. (2017) | **Based on**: Yoo et al. (2010), Lusch and Nambisan (2015)<br>Scope: Restricted to service<br>Unclear term: "digital component" |
| "A complex set of inter-connected phenomena characterised in terms of digital innovation is bringing 'digitality' to the foreground, and with it the notion of recombination of digital capabilities" | Sørensen and Landau (2015) | **Based on**: Yoo et al. (2010)<br>Unclear terms: "digitality", "digital capabilities"<br>Conflation of concept and impact |
| "Digital innovation is largely about recombining existing resources and knowledge to spur new ideas. It is rarely guided by a long-term vision, because products and services are inherently unbounded and incomplete. Instead, digital innovation is powered by a selfcontained system's generative capacity to produce something new without input from the system's originator" | Svahn et al. (2017a) | **Based on**: Henfridsson and Yoo (2014), Henfridsson and Lindgren (2010), Avital and Te'eni (2009), Tilson et al. (2010), Yoo et al. (2012)<br>Lack of parsimony<br>Unclear term: "generative capacity" |
| "[D]igital innovation, defined as an innovation enabled by digital technologies that lead to 'the transformation of sociotechnical structures that were previously mediated by nondigital artifacts or relationships' " | Barrett et al. (2012) | **Based on**: Yoo et al. (2010)<br>Unclear term: "digital technology"<br>Conflation of concept and impact |
| "Complex products themselves are increasingly made up of digital components, a trend that Yoo et al. (2010) refer to as 'digital innovation,' which emphasizes the digital elements of product innovation (in contrast to this work on information technology innovation that focuses on the *process* of innovation)" | Lee and Berente (2012) | **Based on**: Yoo et al. (2010)<br>Unclear terms: "digital components", "digital elements" |
| "'[D]igital innovation' is used to refer to a product-centric perspective involving new combinations of physical and digital products to form new products. In this conceptualization, innovation refers to the role of underlying architectures of IT artifacts in enabling and constraining the development of new IT artifacts and the implications for structuring and managing innovation within firms" | Kohli and Melville (2018) | **Based on**: Yoo et al. (2010), Lee and Berente (2012)<br>Scope: Restricted to product<br>Unclear terms: "digital product"<br>Conflation of concept and impact |
| "[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) | **Original definition**<br>Scope: Only outcome focus<br>Unclear: link to *digital*<br>Conflation of concept and impact |
| Digital product innovation: 'Significantly new (from the perspective of a particular community or market) products or services that are either embodied in information and communication technologies or enabled by them'" | Lyytinen et al. (2016) | **Original definition**<br>Scope: Restricted to products<br>Missing: link to *digital* |
| "[T]he creation of (and consequent change in) market offerings, business processes, or models that result from the use of digital technology. Stated differently, in digital innovation, digital technologies and associated digitizing processes form an innate part of the new idea and/or its development, diffusion, or assimilation" | Nambisan et al. (2017) | **Original definition**<br>Unclear term: "digital technology"<br>Lack of parsimony<br>Conflation of concept and impact |
| " 'The creation of (and consequent change in) market offerings, business processes, or models that result from the use of digital technologies … [In which] the outcomes themselves do not need to be digital … It includes a broad swath of digital tools and infrastructure … for making innovation possible … And the possibility that the outcomes may be diffused, assimilated, or adapted to specific use contexts such as typically experienced with digital platforms" | Vega and Chiasson (2019) | **Adopted from**: Nambisan et al. (2017)<br>Unclear term: "digital technology"<br>Lack of parsimony<br>Conflation of concept and impact |
| "Digital innovation—the process of leveraging digital artifacts to transform existing physical products or create new ones—offers a powerful lens for developing such frameworks. The concept of digital innovation draws attention to the ways in which firms recombine, reconfigure, or design new digital artifacts in response to competitors' actions or windows of market opportunity" | Woodard et al. (2013) | **Based on:** Yoo et al. (2010)<br>Unclear term: "digital artifacts"<br>Lack of parsimony |

(*continued on next page*)

**Table C.1-1** (*continued*)

| Definition | Source | Root of definition, scope & issue(s) |
|---|---|---|
| "[D]igital innovation is an organizational capability, not merely a new technological platform or an innovation incubator. Developing digital innovation capability 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) | **Original definition**<br>Unclear term: "digital innovation capability"<br>Conflation of concept and requirements |
| "Crossan and Apaydin (2010, p. 1155) state that innovation is a 'production or adoption, assimilation and exploitation of a value-added novelty in economic and social spheres; renewal and enlargement of products, services and markets; development of new methods of production; and establishment of new management systems.'<br>… this study proposes digital innovation as innovation enabled through or triggered by digital technologies" | Lokuge et al. (2019) | **Based on**: Crossan and Apaydin (2010), Henfridsson et al. (2014), Yoo et al. (2010)<br>Unclear term: "digital technologies" |
| "the co-creation of novel offerings through the recombination of digital and/or physical components" | (Hukal and Henfridsson, 2017) | **Based on**: Yoo et al. (2010)<br>Unclear term: "digital component" |
| "Digital innovation (as a verb) is an innovation process involving sociotechnical combinations of digital technologies and complementary material and ideational resources and (as a noun) the direct outcomes of that innovation process, such as the creation, introduction, and use of a new product, process, or business model" | (Markus and Nan, 2020) | **Original definition**<br>Unclear term: "digital technologies", "sociotechnical combinations" |
| "Even in industrial-age industries, companies need to engage in digital innovation, that is, the creation of or change in market offerings that result from the use of digital technologies (Nambisan et al., 2017)" | (Hanelt et al., 2021) | **Based on**: Nambisan et al. (2017)<br>Unclear term: "digital technology"<br>Conflation of concept and impact |
| "For Nambisan et al. (2017:224) digital innovation is the use of digital technology in a wide range of innovations: We understand the term 'digital' as the conversion from mainly analog information into the binary language understood by computers. The malleability (e.g., re-programmability), homogeneity (e.g., standardized software languages) and transferability (e.g., ease of transferring digital representations of any object) is at the heart of technologies meshing digital, and often physical materiality, thereby enabling, constraining, but also interwoven with, human action" | (Hinings et al., 2018) | **Based on:** Nambisan et al. (2017)<br>Conflation of concept and impact<br>Lack of parsimony |
| "[D]igital innovation deals with the 'concerted orchestration of new products, new processes, new services, new platforms or even new business models'" | (Magnusson et al., 2021) | **Based on:** Hinings et al. (2018)<br>Unclear link to *digital* |
| "Digital innovation for the manufacturing firms refers to the change or creation of products and innovation processes that result from the new combinations of digital and physical components enabled by digital technology" | (Liu et al., 2021) | **Based on:** Nambisan et al., 2017, Yoo et al. (2010)<br>Scope: Restricted to products, innovation processes<br>Unclear term: "digital components", "digital technology"<br>Conflation of concept and impact |
| "I subscribe to a broader definition of digital innovation: 'a product, process or business model that is perceived as new, requires significant changes on the part of adopters, and is embodied in or enabled by IT'" (Fichman et al., 2014, p. 333)." | (Wang, 2021) | **Based on:** Fichman et al. (2014)<br>Scope: Only outcome focus<br>Unclear link to *digital*<br>Conflation of concept and impact |
| "On a general level, digital innovation is a distinct form of innovation which relies on the combination of digital and physical components and results in digital objects that propose valuable new uses for goods, services or procedures" | (Antonopoulou and Begkos, 2020) | **Based on:** Yoo et al. (2010), Kolloch and Dellermann (2018)<br>Unclear term: "digital components", "digital objects"<br>Conflation of concept and impact |
| "Definitions of digital innovation range from '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), to 'the carrying out of new combinations of digital and physical components to produce novel products' (Yoo et al., 2010: 276). These definitions accent different aspects of digitalization: while the former focuses on innovation as an outcome, the latter privileges its processual nature (also Kohli and Melville, 2019). In this paper, we emphasize digital innovation's processual quality, particularly the evolution of its architecture and organizing structures." | (Hylving and Schultze, 2020) | **Based on:** Fichman et al. (2014), Yoo et al. (2010)<br>Unclear term: "digital components" |
| "Digital innovation can be generally defined as 'the creation of (and consequent change in) market offerings, business processes, or models that result from the use of digital technology'" (Nambisan, Lyytinen, Majchrzak, & Song, 2017, p. 224)." | (Nambisan et al., 2020) | **Based on:** Nambisan et al. (2017)<br>Unclear term: "digital technology"<br>Conflation of concept and impact |
| "[D]igital innovations, defined as embedded software that enables capabilities into physical objects to produce novel products" | (Shaheer and Li, 2020) | **Based on:** Boudreau (2012), Nambisan et al. (2017), Yoo et al. (2010)<br>Unclear term: "capabilities"<br>Scope: restricted to products |
| "Digital innovation refers to the firms' strategic choices to execute digitally enhanced value-adding activities, transforming business models, and enabling new product and service offerings" | (Schneckenberg et al., 2021) | **Based on:** Kohli and Melville (2018), Hensen and Dong (2020) |

### C.2. Semantic decomposition

After identifying each relevant definition of digital innovation within our final sample, we used semantic decomposition to derive our definition of digital innovation. Semantic decomposition is the "analysis of a single word or morpheme into a set of semantic primitives that define it" (Akmajian et al., 2017, p. 555). Since semantic decomposition helps identifying patterns (or "primitives") in the underlying data, we see it as particularly fitting in the context of a grounded-theory analysis. In a semantic context, a primitive can be defined as something that is "not derived" and "assumed as a basis"[8]. To do so, sentences and groups of words are decomposed into individual words (or even morphemes). Then, the semantic purpose of each word is analyzed within the context of the respective definition. This process has already been used to construct definitions of digital phenomena (e.g., Vial, 2019) and has proven valuable in identifying important aspects of extant definitions, which then form the foundation for a novel definition. In our case, semantic decomposition helped us to identify six primitives that constitute the key features of extant definitions of digital innovation (see Table C.2-1 below).

1. **Primitive 1:** Input. Input describes what goes into the creation of digital innovation. Here, every definition refers to some digital component (digital artifact, digital technology etc.), with one exception that refers to existing resources and knowledge (Svahn et al., 2017a), and only implicitly relates to some digital aspect. Only some definitions specify what is meant by the digital component such as 'digital data' (Barrett et al., 2015) or 'digital infrastructure' (Vega and Chiasson, 2019).
2. **Primitive 2:** Involvement. Involvement refers to the internal and/or external actors involved in the creation of digital innovation. Within our sample, only five definitions specify this aspect. Three of them refer to internal and external actors (Barrett et al., 2015; Lokuge et al., 2019; Svahn et al., 2017b), one takes a strong external focus (Chan et al., 2019), and one an internal focus (Woodard et al., 2013).
3. **Primitive 3:** Properties. Properties refers to factors that distinguish digital innovation. Here, only two articles do not make any statement (Lee and Berente, 2012; Sørensen and Landau, 2015). Every other article highlights particularly the novelty of digital innovation with regard to different scopes such as products (Yoo et al., 2010) and/or value-in-use of services (Huang et al., 2017). Also, the properties of value-added in economic and social spheres are mentioned (Lokuge et al., 2019).
4. **Primitive 4:** Scope. The scope of digital innovation describes what a definition is focusing on. We find that most definitions focus on products and services, which can be explained by the dominance of the definition of Yoo et al. (2010). Others extend the scope by highlighting aspects such as 'sociotechnical structures' (Barrett et al., 2012), 'ideas' (Nambisan et al., 2017; Svahn et al., 2017b), 'industry' (Barrett et al., 2015), or 'social and economic spheres' (Lokuge et al., 2019).
5. **Primitive 5:** Implications. Implications refers to effect of digital innovation. Here, eight articles do not make an explicit statement, while the remaining articles generally highlight the ensuing changes by highlighting the need for significant changes on the side of the adopter and market offerings, business processes, or models (Fichman et al., 2014; Nambisan et al., 2017; Vega and Chiasson, 2019), the transformation of sociotechnical structures (Barrett et al., 2012), blurring boundaries on product and industry level (Barrett et al., 2015), and generativity (Svahn et al., 2017a).
6. **Primitive 6:** Creation. Creation refers to how digital innovation is actually created. Nine articles refer to '(re)combination' (e.g., Abrell et al., 2016; Huang et al., 2017; Yoo et al., 2010) with one of them also referring to 'reconfiguration' and 'design' (Woodard et al., 2013). The remaining articles leave creation open.

[8] https://www.merriam-webster.com/dictionary/primitive?utm_campaign=sd&utm_medium=serp&utm_source=jsonld , accessed: June 23, 2021.

**Table C.2-1**
Semantic decomposition.

| Definition | Source | Primitive 1: Input | Primitive 2: Involvement | Primitive 3: Properties | Primitive 4: Scope | Primitive 5: Implications | Primitive 6: Creation |
|---|---|---|---|---|---|---|---|
| "[C]arrying out new combinations of digital and physical components to produce novel products" | Yoo et al. (2010) | Digital and physical components | N/A | Novelty (products) | Products | N/A | Combination |
| " 'Carrying out new combinations of digital and physical components' to produce novel products and services" | Abrell et al. (2016) | Digital and physical components | N/A | Novelty (products, services) | Products, services | N/A | Combination |
| "[N]ew combinations of digital and physical components to produce new products (and services) by combining digital data from heterogeneous sources easily 'to deliver diverse services, which dissolves product and industry boundaries'" | Barrett et al. (2015) | Digital and physical components, digital data | Internal and external (heterogeneous sources) | Novelty (products, services) | Products, services, industry | Blurring boundaries (product, industry) | Combination |
| "All [disruptive digital innovation] can trace their origins to some form of digital technology. New digital technologies are constantly developed from scientific research and discoveries. Some of these digital technologies may be combined and developed into digital innovation." | Chan et al. (2019) | Digital technology | External (scientific research) | Novelty (implicit) | N/A | N/A | Combination |
| "[T]he recombination of digital components in a layered, modular architecture to create new value-in-use to users or potential users of a service." | Huang et al. (2017) | Digital components | N/A | Novelty (value-in-use of services) | Services | N/A | Combination |
| "A complex set of inter-connected phenomena characterised in terms of digital innovation is bringing 'digitality' to the foreground, and with it the notion of recombination of digital capabilities" | Sørensen and Landau (2015) | Digital capability | N/A | N/A | Digital capabilities | Bringing 'digitality' to the foreground | Combination |
| "Digital innovation is largely about recombining existing resources and knowledge to spur new ideas. It is rarely guided by a long-term vision, because products and services are inherently unbounded and incomplete. Instead, digital innovation is powered by a selfcontained system's generative capacity to produce something new without input from the system's originator" | Svahn et al. (2017a) | Existing resources and knowledge | N/A | Novelty (ideas), unbounded and incomplete, generativity | Ideas, products, services | | Combination |
| "[D]igital innovation, defined as an innovation enabled by digital technologies that lead to 'the transformation of sociotechnical structures that were previously mediated by nondigital artifacts or relationships' " | Barrett et al. (2012) | Digital technology | N/A | Novelty (implicit) | Sociotechnical structures | Transformation of sociotechnical structures | N/A |
| "Complex products themselves are increasingly made up of digital | Lee and Berente (2012) | Digital and physical components | N/A | N/A | Products | N/A | N/A |

(*continued on next page*)

**Table C.2-1** (*continued*)

| Definition | Source | Primitive 1: Input | Primitive 2: Involvement | Primitive 3: Properties | Primitive 4: Scope | Primitive 5: Implications | Primitive 6: Creation |
|---|---|---|---|---|---|---|---|
| components, a trend that Yoo et al. (2010) refer to as 'digital innovation,' which emphasizes the digital elements of product innovation (in contrast to this work on information technology innovation that focuses on the process of innovation)" | | | | | | | |
| "The second conceptualization, 'digital innovation,' is used to refer to a product-centric perspective involving new combinations of physical and digital products to form new products. In this conceptualization, innovation refers to the role of underlying architectures of IT artifacts in enabling and constraining the development of new IT artifacts and the implications for structuring and managing innovation within firms" | Kohli and Melville (2018) | Digital and physical products | N/A | Novelty (IT artifacts) | Products | Implications for structuring and managing innovation within firms | Combination |
| "[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) | IT | N/A | Novelty (perceived; product, process, business model) | Product, process, business model | Requires significant changes by adopters | N/A |
| Digital product innovation: 'Significantly new (from the perspective of a particular community or market) products or services that are either embodied in information and communication technologies or enabled by them'" | Lyytinen et al. (2016) | Information and communication technology | N/A | Novelty (perceived by community or market; product, services) | Product, services | N/A | N/A |
| "[T]he creation of (and consequent change in) market offerings, business processes, or models that result from the use of digital technology. Stated differently, in digital innovation, digital technologies and associated digitizing processes form an innate part of the new idea and/or its development, diffusion, or assimilation" | Nambisan et al. (2017) | Digital technology | N/A | Novelty (implicit) | Market offerings, business processes, business models, ideas | Change in market offerings, business processes, or models | N/A |
| "The creation of (and consequent change in) market offerings, business processes, or models that result from the use of digital technologies … [In which] the outcomes themselves do not need to be digital … It includes a broad swath of digital tools and infrastructure … for making innovation possible … And the possibility that the outcomes may be diffused, assimilated, or adapted to | Vega and Chiasson (2019) | Digital tools and infrastructures | N/A | Novelty | Market offerings, business processes, business models | Change in market offerings, business processes, or models | N/A |

(*continued on next page*)

**Table C.2-1** (*continued*)

| Definition | Source | Primitive 1: Input | Primitive 2: Involvement | Primitive 3: Properties | Primitive 4: Scope | Primitive 5: Implications | Primitive 6: Creation |
|---|---|---|---|---|---|---|---|
| specific use contexts such as typically experienced with digital platforms" | | | | | | | |
| "Digital innovation—the process of leveraging digital artifacts to transform existing physical products or create new ones—offers a powerful lens for developing such frameworks. The concept of digital innovation draws attention to the ways in which firms recombine, reconfigure, or design new digital artifacts in response to competitors' actions or windows of market opportunity" | Woodard et al. (2013) | Digital artifacts, physical products | Internal (firms) | Novelty (digital artifacts) | Products | N/A | Combination, Reconfiguration, Design |
| "[D]igital innovation is an organizational capability, not merely a new technological platform or an innovation incubator. Developing digital innovation capability 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) | N/A | Internal and external (business organization, partnerships) | Novelty (implicit) | Organizational capability, business | Rethinking how business is organized | N/A |
| "[I]nnovation is a 'production or adoption, assimilation and exploitation of a value-added novelty in economic and social spheres; renewal and enlargement of products, services and markets; development of new methods of production; and establishment of new management systems.' […] Following recent work on digital innovation (e.g., Henfridsson et al., 2014; Yoo et al., 2012), this study proposes digital innovation as innovation enabled through or triggered by digital technologies" | Lokuge et al. (2019) | Digital technology | Internal and external (production or adoption) | Novelty (products, services, markets), value-added (in economic and social spheres) | Economic and social spheres, products, services, markets, methods of production, new management systems | N/A | N/A |
| "[T]he co-creation of novel offerings through the recombination of digital and/or physical components" | (Hukal and Henfridsson, 2017) | Digital and physical components | Internal and external (co-creation) | Novelty | Offerings | N/A | Recombination |
| "Digital innovation (as a verb) is an innovation process involving sociotechnical combinations of digital technologies and complementary material and ideational resources and (as a noun) the direct outcomes of that innovation process, such as the creation, introduction, and use of a new product, process, or business model" | (Markus and Nan, 2020) | Digital technologies, complementary material, ideational resources | N/A | N/A | New product, process, business model | N/A | Sociotechnical combinations |
| | | Digital technologies | N/A | Novelty (implicit) | Market offerings | | N/A |

(*continued on next page*)

**Table C.2-1** (*continued*)

| Definition | Source | Primitive 1: Input | Primitive 2: Involvement | Primitive 3: Properties | Primitive 4: Scope | Primitive 5: Implications | Primitive 6: Creation |
|---|---|---|---|---|---|---|---|
| "Even in industrial-age industries, companies need to engage in digital innovation, that is, the creation of or change in market offerings that result from the use of digital technologies" | (Hanelt et al., 2021) | | | | | Change in market offerings | |
| "For Nambisan et al. (2017:224) digital innovation is the use of digital technology in a wide range of innovations: We understand the term 'digital' as the conversion from mainly analog information into the binary language understood by computers. The malleability (e.g., re-programmability), homogeneity (e.g., standardized software languages) and transferability (e.g. ease of transferring digital representations of any object) is at the heart of technologies meshing digital, and often physical materiality, thereby enabling, constraining, but also interwoven with, human action" | (Hinings et al., 2018) | Digital technologies, digital and physical materiality | N/A | Malleability, homogeneity, transferability | N/A | Enabling and constraining human action | Meshing |
| "According to Hinings et al. (2018, p. 10), digital innovation deals with the 'concerted orchestration of new products, new processes, new services, new platforms or even new business models'." | (Magnusson et al., 2021) | N/A | N/A | Novelty | New products, processes, services, new platforms, business models | N/A | Orchestration |
| "Digital innovation for the manufacturing firms refers to the change or creation of products and innovation processes that result from the new combinations of digital and physical components enabled by digital technology" | (Liu et al., 2021) | Physical and digital components | N/A | Novelty | Products, innovation processes | Change of products and innovation processes | Combinations |
| "I subscribe to a broader definition of digital innovation: 'a product, process or business model that is perceived as new, requires significant changes on the part of adopters, and is embodied in or enabled by IT'" (Fichman et al., 2014, p. 333)." | (Wang, 2021) | IT | N/A | Novelty (perceived; product, process, business model) | Product, process, business model | Requires significant changes by adopters | N/A |
| "On a general level, digital innovation is a distinct form of innovation which relies on the combination of digital and physical components and results in digital objects that propose valuable new uses for goods, services or procedures" | (Antonopoulou and Begkos, 2020) | Physical and digital components | N/A | Novelty | Digital objects, goods services, procedures | Propose valuable new uses for goods, services or procedures | Combination |
| "Definitions of digital innovation range from 'a product, process, or business model | (Hylving and Schultze, 2020) | IT, physical and digital components | N/A | Novelty | Products, process, business model | N/A | Combination |

(*continued on next page*)

**Table C.2-1** (*continued*)

| Definition | Source | Primitive 1: Input | Primitive 2: Involvement | Primitive 3: Properties | Primitive 4: Scope | Primitive 5: Implications | Primitive 6: Creation |
|---|---|---|---|---|---|---|---|
| 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), to 'the carrying out of new combinations of digital and physical components to produce novel products' (Yoo et al., 2010: 276). These definitions accent different aspects of digitalization: while the former focuses on innovation as an outcome, the latter privileges its processual nature (also Kohli and Melville, 2019). In this paper, we emphasize digital innovation's processual quality, particularly the evolution of its architecture and organizing structures." | | | | | | | |
| "Digital innovation can be generally defined as 'the creation of (and consequent change in) market offerings, business processes, or models that result from the use of digital technology'" (Nambisan, Lyytinen, Majchrzak, & Song, 2017, p. 224). | (Nambisan et al., 2020) | Digital technology | N/A | Novelty (implicit) | Market offerings, business processes, or models | Change in market offerings, business processes, or models | N/A |
| "[D]igital innovations, defined as embedded software that enables capabilities into physical objects to produce novel products" | (Shaheer and Li, 2020) | N/A | N/A | Novelty, capabilities | Embedded software, products | N/A | N/A |
| "Digital innovation refers to the firms' strategic choices to execute digitally enhanced value-adding activities, transforming business models, and enabling new product and service offerings" | (Schneckenberg et al., 2021) | Digitally enhanced activities | Internal (firm) | Novelty, Value-adding | Business models, product and service offerings | Transforming business models, enabling new product and service offerings | N/A |

### C.3. Overview of Central Concepts and their Definitions

See Table C.3-1.

**Table C-3-1**
Central concepts, their definitions, and representative articles.

| Concept | Definition | Representative articles |
|---|---|---|
| Non-digital object | Enduring and structured objects that do not contain any bitstrings | (Faulkner and Runde, 2013, 2019) |
| Digitization | "the process of converting analog signals into a digital form, and ultimately into binary digits (bits)" (Tilson et al., 2010, p. 749) | (Tilson et al., 2010; Yoo et al., 2010) |
| Digital object | "[…] objects whose component parts include one or more bitstrings" (Faulkner and Runde, 2019, p. 7) | (Ekbia, 2009; Faulkner and Runde, 2009, 2013, 2019; Henfridsson et al., 2018) |
| Digitalization | "[…] a sociotechnical process of applying digitizing techniques to broader social and institutional contexts that render digital technologies infrastructural" (Tilson et al., 2010, p. 749) | (Tilson et al., 2010) |
| Digital technology | Digital technology is a digital object that has been assigned a socially agreed-upon meaning | (Faulkner and Runde, 2009, 2013, 2019; Henfridsson et al., 2018; Yoo et al., 2010) |
| Novel value creation | A process that adds value to the sociotechnical environment (e.g., individual behavior, market offerings, business processes) in a novel way | (cf. Nambisan et al., 2017; Vega and Chiasson, 2019) |
| Digital innovation | 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 | (cf. Benkler, 2006; Henfridsson et al., 2018; Nambisan et al., 2017; Yoo et al., 2010; Yoo et al., 2012; Zittrain, 2006) |
| Ontological reversal | "[…] ontological reversal is where the digital version is created first, and the physical version second (if needed)" (Baskerville et al., 2020, p. 509) | (Baskerville et al., 2020) |

## Appendix D. Current themes in digital innovation research

### D.1. Digital systems

**Digital infrastructures**. Unlike specific systems and applications, digital infrastructures are not defined by pre-defined functions (Tilson et al., 2010). Research to date has focused on paradoxes to describe the inherent dynamics of digital infrastructures that arise between the need to enable high levels of flexibility and generativity, while also ensuring stability and maintaining control (e.g., Barrett et al., 2015; Eaton et al., 2015; Nambisan et al., 2019; Tilson et al., 2010). Furthermore, digital infrastructures enable generative mechanisms that lead to self-reinforcing processes of innovation, adoption and scaling (Henfridsson and Bygstad, 2013). These self-reinforcing processes help explain the causal forces shaping the evolution of digital infrastructures.

**Digital platforms** represent the "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). While platforms are not a new phenomenon, the ubiquity of digital technology and its associated flexibility has brought digital platforms to the center of attention, with firms focusing on platforms rather than single products (Yoo et al., 2012). One of the reasons is that, in contrast to single products, platforms create their own ecosystem (Gawer, 2009; Gawer and Cusumano, 2014; Tiwana et al., 2010), bringing together diverse contributors (e.g., Boudreau, 2012). To benefit from the ensuing generativity on a digital platform, platform owners must consider the different type of platform (e.g., Bonina et al., 2021; Gawer and Cusumano, 2014; Rolland et al., 2018) and carefully manage the evolution of a platform (Saadatmand et al., 2019; Yoo et al., 2012). For example, the amount and diversity of producers on a platform is linked to the diversity produced (Boudreau, 2012), thereby, requiring platform owners to make decisions about the openness of the platform. Restricting access to the platform ('closing the platform') enables the platform owner to charge for access to the platform, while opening fosters the ability of producers to build upon the platform (Parker and van Alstyne, 2018).

**Digital ecosystems** are defined as a "collection of the platform and the modules specific to it" (Tiwana et al., 2010, p. 676), which create a number of "specific market, regulatory and environmental contexts" (Suseno et al., 2018, p. 2) and develop their own evolutionary dynamics (Beltagui et al., 2020; Wang, 2021). For individual firms, participation in digital ecosystems is becoming increasingly mandatory to foster innovativeness (Selander et al., 2013), especially since competition is increasingly playing out between ecosystems and not between individual firms (Tiwana et al., 2010). While dynamic capabilities are central to capture value within ecosystems (Helfat and Raubitschek, 2018), digital ecodynamics – defined as the intricate interplay between environmental turbulence, dynamic capabilities, and technology – pose new challenges for IS strategy and require technology to be considered as a central factor alongside the classic consideration of dynamic capabilities and environmental turbulence (El Sawy et al., 2010). Hence, due to the increasing complexity of digital innovation, the digital ecosystem is an important consideration for future research and suggests a departure from innovator- or firm-centrism (Vega and Chiasson, 2019).

### D.2. Arising tensions

Recent research on digital innovation has identified numerous contradicting forces that arise due to the requisite 'digital logics', which are at odds with established logics. Table D.2-1 summarizes current literature on contradicting forces within digital innovation:

**Table D.2-1**
Overview of contradicting forces within our sample.

| Terminology | Description of contradictory force? | Title | Author | Journal | Subject Area |
|---|---|---|---|---|---|
| Competing concern | Innovation capability: existing vs. requisite,<br>Innovation focus: product vs. process,<br>Innovation collaboration: internal vs. external innovation<br>Governance: control vs flexibility | Embracing Digital Innovation in Incumbent Firms: How Volvo Cars Managed Competing Concerns | (Svahn et al., 2017a) | MIS Quarterly | MIS |
| Competing concern | Balancing new and established innovation capability,<br>Balancing process and product focus,<br>Balancing external and internal collaboration,<br>Balancing flexibility and control | Mastering the Digital Innovation Challenge | (Svahn et al., 2017b) | MIT Sloan Management Review | General & Strategy |
| Conflicting goals | Control vs. flexibility | Balancing Platform Control and External Contribution in Third-Party Development: the Boundary Resources Model | (Ghazawneh and Henfridsson, 2013) | Information Systems Journal | MIS |
| Controversies | More of the same vs. we've had enough | Understanding Controversies in Digital Platform Innovation Processes: The Google Glass Case | (Klein et al., 2020) | Technological Forecasting and Social Change | Innovation |
| Controversies | Human vs. non-human actors | Digital Innovation in the Energy Industry: The Impact of Controversies on the Evolution of Innovation Ecosystems | (Kolloch and Dellermann, 2018) | Technological Forecasting and Social Change | Innovation |
| Paradox | Freedom vs. captivity,<br>Clarity vs. ambiguity,<br>Scarcity vs. abundance | The Paradoxical Effects of Digital Artefacts on Innovation Practices | (Ciriello et al., 2019) | European Journal of Information Systems | MIS |
| Paradox | Paradox of openness: value creation vs. value appropriation,<br>Paradox of control vs. autonomy,<br>Paradox of stability vs. change | The Digital Transformation of Innovation and Entrepreneurship: Progress, Challenges and Key Themes | (Nambisan et al., 2019) | Research Policy | Economics |
| Paradox | Paradox of productivity | Measuring GDP in the Digital Economy: Increasing Dependence on Uncaptured GDP | (Watanabe et al., 2018) | Technological Forecasting and Social Change | Innovation |
| Paradox | Paradox of control vs. generativity | Distributed Tuning of Boundary Resources: The Case of Apple's iOS Service System | (Eaton et al., 2015) | MIS Quarterly | MIS |
| Paradox | Paradox of change: stability vs. flexibility,<br>Paradox of control: centralized vs. distributed control | Research Commentary —Digital Infrastructures: The Missing IS Research Agenda | (Tilson et al., 2010) | Information Systems Research | MIS |
| Paradox | Windows paradox: unspecified,<br>Control vs. coordination | Research Commentary —Platform Evolution: Coevolution of Platform Architecture, Governance, and Environmental Dynamics | (Tiwana et al., 2010) | Information Systems Research | MIS |
| Paradox (mentioned) | N/A | Digital Innovation Management: Reinventing Innovation Management Research in a Digital World | (Nambisan et al., 2017) | MIS Quarterly | MIS |
| Paradox, tension | Managerial control vs. open practices | Voicing the Puppet: Accommodating Unresolved Institutional Tensions in Digital Open Practices | (Thorén et al., 2018) | Organization Studies | Org. Studies & HR |
| Tension | Existing and emerging approaches to innovation with digital technologies | Digital Innovation and Institutional Entrepreneurship: Chief Digital Officer Perspectives of their Emerging Role | (Tumbas et al., 2018) | Journal of Information Technology | MIS |
| Tension | Past-Future tension | The Liminality of Trajectory Shifts in Institutional Entrepreneurship | (Henfridsson and Yoo, 2014) | Organization Science | Org. Studies & HR |
| Tension | Long-term strategy vs. short-term strategy | Design Capital and Design Moves | (Woodard et al., 2013) | MIS Quarterly | MIS |
| Tension | Network effects vs. competitive crowding | Let a Thousand Flowers Bloom? An Early Look at Large Numbers of Software App Developers and Patterns of Innovation | (Boudreau, 2012) | Organization Science | Org. Studies & HR |
| Unspecified | Implicit: Tension between product vs. process innovation | Information Systems Strategizing, Organizational Sub-Communities, and the Emergence of a Sustainability Strategy | (Henfridsson and Lind, 2014) | The Journal of Strategic Information Systems | MIS |
| Unspecified | Implicit: Paradox of information affluence vs. adding more information | The Ambivalent Ontology of Digital Artifacts | (Kallinikos et al., 2013) | MIS Quarterly | MIS |

(*continued on next page*)

**Table D.2-1** (*continued*)

| Terminology | Description of contradictory force? | Title | Author | Journal | Subject Area |
|---|---|---|---|---|---|
| Unspecified | Internal vs. external collaboration | Capability Search and Redeem Across Digital Ecosystems | (Selander et al., 2013) | Journal of Information Technology | MIS |
| Unspecified | Internal vs. external collaboration | Exploring Preconditions for Open Innovation: Value Networks in Industrial Firms | (Westergren and Holmström, 2012) | Information and Organization | Finance and Accounting |
| Unspecified | Implicit: Tension between product vs. process innovation | The Lure of the Virtual | (Bailey et al., 2012) | Organization Science | Org. Studies & HR |
| Unspecified | Implicit: Tension between product vs. process innovation | Digital Science and Knowledge Boundaries in Complex Innovation | (Dougherty and Dunne, 2012) | Organization Science | Org. Studies & HR |
| Unspecified | Implicit: Tension between product vs. process innovation | Digital Innovation and the Division of Innovative Labor: Digital Controls in the Automotive Industry | (Lee and Berente, 2012) | Organization Science | Org. Studies & HR |
| Unspecified | Implicit: Internal vs. external collaboration | User Involvement in Developing Mobile and Temporarily Interconnected Systems | (Henfridsson and Lindgren, 2010) | Information Systems Journal | MIS |
| Unspecified | Implicit: Internal vs. external collaboration | Turn to the Material: Remote Diagnostics Systems and New Forms of Boundary-Spanning | (Jonsson et al., 2009) | Information and Organization | Finance and Accounting |
| Unspecified | Existing vs. requisite capabilities | Technology, Identity, and Inertia Through the Lens of "The Digital Photography Company" | (Tripsas, 2009) | Organization Science | Org. Studies & HR |
| Unspecified | Implicit: Product vs. process | The Launch of Innovative Product-Related Services: Lessons from Automotive Telematics | (Lenfle and Midler, 2009) | Research Policy | Economics |
| Unspecified | Implicit: Existing vs. requisite capabilitites | Disruptive Technology: How Kodak Missed the Digital Photography Revolution | (Lucas and Goh, 2009) | The Journal of Strategic Information Systems | MIS |
| Unspecified | Internal vs. external collaboration | Technologies for Value Creation: An Exploration of Remote Diagnostics Systems in the Manufacturing Industry | (Jonsson et al., 2008) | Information Systems Journal | MIS |
| Unspecified | Implicit: Internal vs. external collaboration | Multi-Contextuality in Boundary-Spanning Practices | (Lindgren et al., 2008) | Information Systems Journal | MIS |
| Unspecified | Implicit: Product vs. process | Architectural Knowledge in Inter-Organizational IT Innovation | (Andersson et al., 2008) | The Journal of Strategic Information Systems | MIS |
| Unspecified | Implicit: Control vs. flexibility | Multi-Contextuality in Ubiquitous Computing: Investigating the Car Case Through Action Research | (Henfridsson and Lindgren, 2005) | Information and Organization | Finance and Accounting |
| Unspecified | Implicit: Control vs. flexibility | The Mobile–Stationary Divide in Ubiquitous Computing Environments: Lessons from the Transport Industry | (Andersson and Lindgren, 2005) | Information Systems Management | MIS |

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