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Digital innovation: A review and synthesis

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Abstract

Organizations are under increasing pressure to apply digital technologies to renew and transform their business models. A great deal of research has examined specific phenomena, such as adoption antecedents and design methods. However, it is unclear what we know in totality, including what research streams exist, how they fit together, and fruitful opportunities for new knowledge development. We combine scientometric and systematic literature review methodologies to examine 7 dimensions of an adapted theoretical framework: initiation; development; implementation; exploitation; the role of the external competitive environment; role of internal organizational environment; and product, service, and process outcomes. From a macro perspective, we find vastly uneven coverage of research streams, diversity and diffusiveness of research, and knowledge and learning as an underlying conceptual pillar. Combined with our summary of each of the 7 research streams, these findings suggest several areas of future research, which we develop by identifying oppositions and tensions.

KEYWORDS

agency, digital, innovation, scientometrics

1 | INTRODUCTION

Organizations are under increasing pressure to apply digital technologies to renew and transform their business models. At the same time, recent surveys indicate that many are not ready to respond to digital trends (Kane, Palmer, Phillips, Kiron, & Buckley, 2015). Hence, there appears to be a misalignment between demands in the marketplace and organizational capabilities to respond.

Information systems (IS) scholars have studied innovation and developed insights that inform management practice and contribute to existing knowledge. Well-studied research streams within digital innovation include adoption antecedents (Fichman, 2004; King et al., 1994; Teo, Wei, & Benbasat, 2003), design and development (Markus, Majchrzak, & Gasser, 2002; Siponen, Baskerville, & Heikka, 2006), and organizational change (Leonard-Barton, 1988; Orlikowski, 1996; Singh, Mathiassen, Stachura, & Astapova, 2011; Swanson, 1994). Other topics have also been examined, including digital innovation initiation (Agarwal & Sambamurthy, 2002; Segars & Grover, 1999), exploitation of existing ISs (Armstrong & Sambamurthy, 1999; Bygstad, 2010), the role of knowledge (Alavi & Leidner, 2001; Carlo, Lyytinen, & Rose, 2012), assimilation gaps (Fichman & Kemerer, 1999), the role of technological framing (Mishra & Agarwal, 2010), and product architecture for organizing digital innovation (Yoo, Henfridsson, & Lyytinen, 2010).

The richness, breadth, and depth of the digital innovation literature are revealed by even a cursory examination of some of the key studies over the decades. However, it is unclear what we know in totality, including what research streams exist, how they fit together, and fruitful opportunities for new knowledge development. Thus, at the same time that organizations are demanding new knowledge about digital transformation, the IS literature provides no unified perspective. In essence, we need a "… tree to which individual findings can be grafted to generate the synthesis and integration …." (Fulk & Steinfield, 1990, p. 13) and propose a theoretical basis for future researchers. As IS researchers, we must also make this knowledge to be accessible to practicing managers in organizations.

This study addresses this gap in knowledge by asking the following research question: "*What is known about digital innovation, how are the various research streams interrelated, what knowledge gaps exist, and what are fruitful areas of future research that contribute to managerial practice and theoretical knowledge?"*

To address this broad research question, we combine scientometric and systematic literature review methodologies to examine 7 dimensions of an adapted theoretical framework: initiation; development; implementation; exploitation; the role of the external competitive environment; role of internal organizational environment; and product, service, and process outcomes.

From a macro perspective, we find vastly uneven coverage of research streams, with development (design and adoption), implementation, and the role of the internal organizational environment accounting for roughly 91% of identified articles, and the balance analyzing initiation, exploitation, the competitive environment, and innovation outcomes (9%). We also found that the digital innovation literature is diverse and diffuse: studies are as related to other domains as those within their own identified cluster. A third key result is that knowledge and learning represents a transcending conceptual theme—an unexpected result that emerged directly from the scientometric analysis. Combined with our summary of each of the 7 research streams, these findings suggest several areas of future research, which we develop by identifying oppositions and tensions.

The contributions of the study are thus three-fold. First, the study represents the first to our knowledge that systematically reviews and synthesizes the diverse digital innovation literature within an established theoretical framework. Second, the study demonstrates how scientometric and systematic literature reviews (Webster & Watson, 2002) can be combined for greater insights within complex fields of research, also a first to our knowledge. Third, we develop a set of insights regarding what we know and what we do not know using tensions and oppositions to motivate future research.

The paper is organized as follows. We begin by formalizing key concepts related to digital innovation and synthesizing them within an adapted theoretical framework. Next, we describe our review methodology, which combines a scientometric analysis and conventional systematic review. We then discuss macro findings (what we know about) as well as specific findings (what we know) within each of the 7 research streams identified in our theoretical framework. Following this, we explore oppositions and tensions to illustrate the descriptive power of our theoretical framework and motivate future research. The paper ends with a brief summary of limitations and concluding thoughts.

2 | THEORETICAL FRAMEWORK

Three dominant conceptualizations of IS and innovation have been used in the extant literature. All three share a process orientation that conceptualizes innovation as steps taken over time.

The first conceptualization, "information technology (IT) innovation," has been used to refer to the organizational adoption and diffusion of new IT-enabled processes, products, and services (Fichman, 2004; Jeyaraj, Rottman, & Lacity, 2006). In this conceptualization, innovation refers to the adoption of an already-existing IT artifact that is new to an organization and that is presumably driven by various technological, organizational, and environmental characteristics. Concepts related to IT innovation include IT diffusion and assimilation.

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 (Lee & Berente, 2012; Yoo et al., 2010). 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. Digital innovation is related to design but takes a more holistic perspective beyond design science to focus on a wider range of concepts.

The third conceptualization, "IS innovation," is used to denote the application of IT artifacts within organizations that requires significant change and leads to new products, services, or processes (Fichman, Dos Santos, & Zheng, 2014; Swanson, 1994). This conceptualization involves technological and organizational dimensions of change associated with the development of new services enabled by information technologies.

In comparing and contrasting the 3 conceptualizations, several patterns emerge. First is the notion that outcomes include IT-enabled products, services, and processes. This is in contrast to the use of IT artifacts such as open innovation to support development of non-IT products (sometimes referred to as "IT and innovation" and out of the scope of the current study). Second is the idea that design and development is a key aspect of innovation, which includes adoption, development of new artifacts, and diffusion of these artifacts throughout the organization (sometimes referred to as implementation). Third is the incorporation of the existing organization and its structure, culture, processes and so forth that shape and are shaped by the generation of such IT-enabled outcomes. Taken together, these concepts of development; implementation; the internal organizational environment; and product, process, and service outcomes are enduring and form the basis for our theoretical framework of digital innovation (Figure 1). For completeness, we add 3 components: initiation, denoting the very early stages; exploitation, denoting reuse and recombination of artifacts and data; and the external competitive environment, which also shapes and is shaped by digital innovation (Cooper & Zmud, 1990).

To summarize, digital innovation includes activities of initiating (triggers, opportunity identification, decision-making), developing (designing, developing, adopting), implementing (installing, maintaining, training, incentives), and exploiting (maximizing returns, leveraging existing systems/data for new purposes; Cooper & Zmud, 1990). These 4 activities need not be present in all digital innovation efforts, need not occur in any sequential order, and may be difficult to disentangle in practice (Figure 1, Table 1).

Digital innovation does not occur in a vacuum within organizations. Digital innovation may be framed as a strategic initiative organized and effected within the IT services function. However, the existing organization is a critical backdrop of digital innovation comprising business strategies, cultures, and ways of doing things that can have a significant impact on digital innovation. This organizational backdrop can shape and be shaped by digital innovation initiatives. For example, the implementation of a conference management system critical to the core processes of 2 business units resulted in objectives not being realized because the internal organizational environment (culture, ways of working, routines, framings of work itself) was incompatible with the functions and processes imposed by the new software (Pentland & Feldman, 2008). Moreover, digital innovation may change the organization itself by enabling new business models (Fichman et al., 2014).

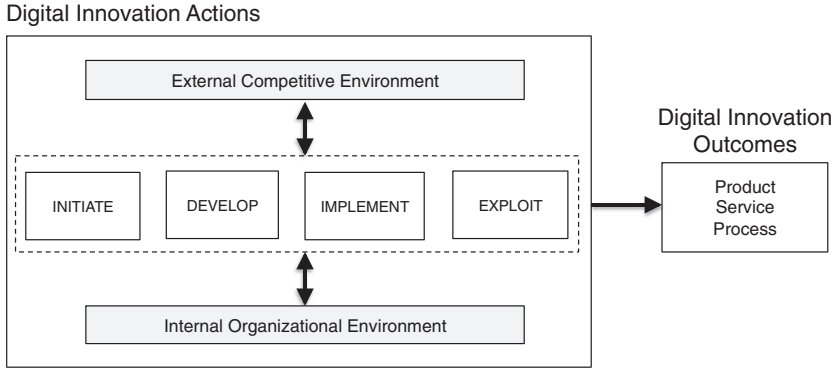

FIGURE 1 Theoretical framework of digital innovation

TABLE 1 Theoretical framework constructs

Construct	Description
Initiate	Identify, assimilate, and apply valuable knowledge from inside and outside firm pertaining to problems and opportunities amenable to digital innovation.
Develop	Design and develop a new information system, customize an existing solution, adopt a pre-existing solution.
Implement	Install and maintain IS from both a technical and an organizational perspective, including new governance systems, training, and processes.
Exploit	Leverage existing IS for maximal value. Reuse existing systems, data, etc for new purposes.
Internal organizational environment	The organizational backdrop, including business strategies, cultures, knowledge management, and ways of doing.
External competitive environment	The competitive marketplace within which firm is embedded, including fads, fashions, and consumer segments.
Outcomes	Either projected or actual new business processes, products, and services because of digital innovation.

Factors in the competitive environment also shape the 4 digital innovation processes. For example, institutional theory (King et al., 1994) and social contagion (Angst, Agarwal, Sambamurthy, & Kelley, 2010) suggest mechanisms by which firms initiate digital innovation that are rooted in the competitive environment. Likewise, digital innovation can itself change the competitive environment in which firms operate. For example, adoption of telematics within an Italian insurance provider signaled a strategic shift throughout the industry towards data-driven services such as premium rates based on driving habits (Vaia, Carmel, DeLone, Trautsch, & Menichetti, 2012).

Finally, IS innovation activities ultimately are intended to achieve certain outcomes, such as new products, services, and processes. Taken together, these factors—the 4 IS innovation activities, internal organizational environment, external competitive environment, and IS innovation outcomes—are collectively illustrated in our theoretical framework (Figure 1). We now summarize our literature review methodology prior to reviewing the extant literature.

3 | LITERATURE REVIEW METHODOLOGY

Given the rich diversity of digital innovation literature, we first used scientometrics (Figure 2) to identify key concepts subsequently applied within a traditional systematic review (Webster & Watson, 2002). Specifically, we used cocitation network analysis, which is based on the assumption that citations are footprints that bear witness to the nature and direction of knowledge transfer (King, 1987). The approach leverages information about how the community of scholarly researchers has cited and cocited articles, which indicates digital innovation research clusters, ie, *what we know about*.

We first generate an article set by searching *Web of Science* for the word "innovation" (title, abstract, key words) in a predefined set of journals (*AIS* Basket of 8) for the timeframe 1981 to 2010, which returned more than 375 articles.[1] Consistent with the scientometric literature (Raghuram, Tuertscher, & Garud, 2010), we then reduce the article set by focusing on the highest cited 100 articles and manually removing articles without an organizational focus or those without a digital innovation focus, leaving 57 articles. Second, we compute a 57 × 57 cocitation matrix by counting the number of all *Web of Science* articles that cite each pair in the core set. The larger the number in each cell, the more similar the articles are (Gmur, 2003). Finally, we use principal components analysis to reduce the dimensions and enable plotting on a 2-dimensional graph. We use an unsupervised machine-learning algorithm, partitioning around

[1]Ending the search in 2010 aligns with our research objective, as scientometrics focuses only on very highly cited articles, which takes time to occur. *Web of Science* recently upgraded its interface to include the "topic" field, which corresponds to title, abstract, and keywords. We chose to use the word "innovation," as this would provide the broadest possible coverage of relevant literature.

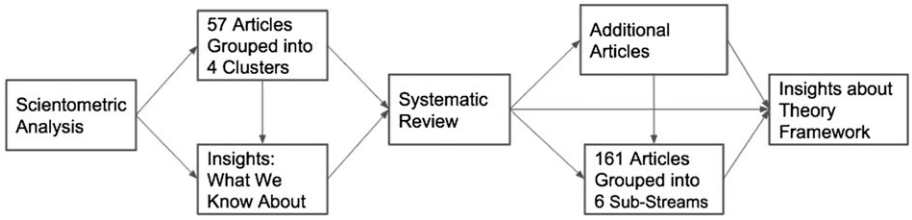

FIGURE 2 Literature review methodology

medoids (PAM), to cluster articles (Kaufman & Rousseeuw, 1990) using the *R* package "cluster" (Maechler, 2013). We then check results against standard validation metrics, including average silhouette width to assess the extent to which each article belongs within its cluster and variance explained to assess between-group to total variance.

We use the identified clusters and articles from the scientometric analysis to systematically review the digital innovation literature. Briefly, we first identify prior review articles (Fichman, 1992; Fichman, 2004; Jeyaraj et al., 2006) as well as 10 highly cited digital innovation studies spanning research clusters identified using scientometrics (Armstrong & Sambamurthy, 1999; Chwelos, Benbasat, & Dexter, 2001; King et al., 1994; Ko, Kirsch, & King, 2005; Liang, Sharaf, Hu, & Xue, 2007; Lyytinen & Yoo, 2002; Orlikowski, 1996; Straub, 1994; Swanson, 1994; Teo et al., 2003). From these articles, each of which has been cited more than 100 times, we search forward and backward to identify other studies that were highly cited but which may not appear in the AIS Basket of 8 (Webster & Watson, 2002). Specifically, we use the *Web of Science* "times cited" (forward) and "cited references" (backward) features, sorted by times cited, and examine the top articles, regardless of journal. We continue the process until saturation, which in our case means that new articles do not add new insights to the clusters identified in the first phase and do not add new findings within each dimension of our theoretical framework.

4 | RESULTS: MACRO FINDINGS

4.1 | Knowledge gaps

Our literature review reveals uneven knowledge across the 7 research streams in our theoretical framework (see Supporting Information for complete listing of categorized articles). Highly active research streams include develop (adoption and design), implement, and the role of the internal organizational environment. In contrast, very few articles have addressed issues within the initiate, exploit, external competitive environment, and outcomes streams (Figure 3). Early and late stages of innovation, as well as the role of the external competitive environment and exploration of innovation outcomes, have not been a focus. Although a small number of articles span multiple digital innovation research streams (in these cases, author judgement was used to place within one), overall the pattern of very uneven coverage illustrated in Figure 3 is preserved.

One implication is that a critical area such as initiation remains understudied and poorly understood. For example, is initiation driven by directed opportunity identification, fortuitous happenstance, external forcing (such as industry consortia or new regulatory regimes), internal political considerations, or perhaps by other forces? What underlying causal mechanisms might be at play and how can existing theories (or new theories) inform these mechanisms?

4.2 | Diversity and diffusiveness

The literature review confirms 1 characteristic of the literature that is readily discernible even from a cursory examination of articles: the literature is diverse. However, our scientometric analysis reveals an important but heretofore unidentified (to our knowledge) feature of the digital innovation literature. It is highly *diffuse*, meaning that articles within a given digital innovation topic are related to adjacent research streams and other scholarly fields

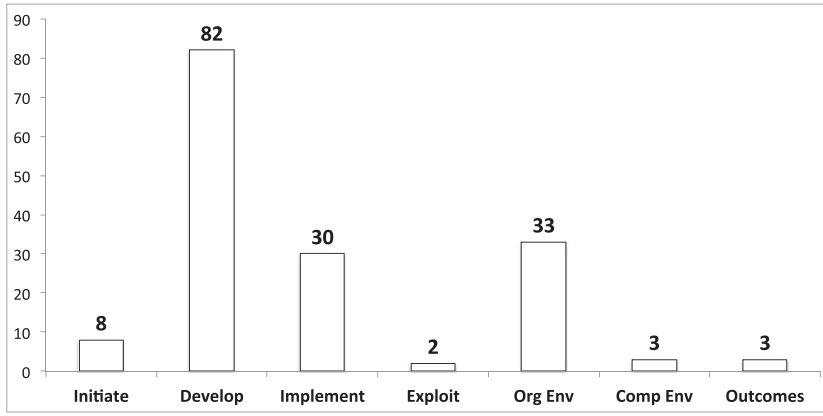

FIGURE 3 Count of articles by research stream

as much as (or perhaps more than) each other. Clearly defined but permeable boundaries seem to rule the day, as we now describe.

On the one hand, the scientometric analysis reveals 4 article clusters that appear to have greater structure than a randomly generated network. This is illustrated visually in Figure 4, which contains 2 bivariate plots of the first 2 principal components resulting from the principal components analysis together with ellipses indicating the PAM clusters—one plot for the article network (on the left) and one for a randomly generated network (on the right).

On the other hand, the computed average silhouette width of 0.04 is much lower than the rule of thumb (0.25) for a data set with reasonable structure (articles within a cluster are highly related to one another, and each cluster is well separated from others; Kaufman & Rousseeuw, 1990; Rousseeuw, 1987).[2] Moreover, the average variance explained of 10.1% computed in our analysis is much lower than that found in other scientometric studies within IS research (Taylor, Dillon, & Van Wingen, 2010). Both of these empirical facts—very low average silhouette width and low variance explained–suggest that the literature is diffuse.

A diverse and diffuse literature aligns with the nature of digital innovation as a body of diverse research. However, while diversity and diffusiveness informs the complex phenomenon of innovation from multiple perspectives and adds richness to our understanding, these obscure research boundaries and cohesive yet interrelated research questions do not, in the absence of synthesis, support clear bridges to future research.

4.3 | Knowledge and learning

Our approach to examining the digital innovation research according to our theoretical framework yielded numerous findings and insights. At the same time, a key finding resulting from the scientometric analysis would not have emerged via use of a conventional systematic review alone. Knowledge and learning was one of the clusters identified within the PAM analysis. While intuitively this makes sense, identifying the cluster on par with, for example, adoption and diffusion, emphasizes the extent to which knowledge and learning are intimately tied to the notion of digital innovation.

Learning is often necessary (although not sufficient) for digital innovation. For example, in the case of externally adopted IS, knowledge drives opportunity sensing, which in turn drives experimentation and subsequent innovation (Carlo et al., 2012). In contrast, the lack of knowledge can be a barrier to assimilation (Fichman & Kemerer, 1999). Knowledge can thus underlie digital business innovation capabilities, either as enabler or hindrance. Moreover,

[2]Note that while 4 was deemed to be the optimal number of clusters based on scientometric conventions, changing the number of clusters to 3 or 5 retains the same pattern of low silhouette width.

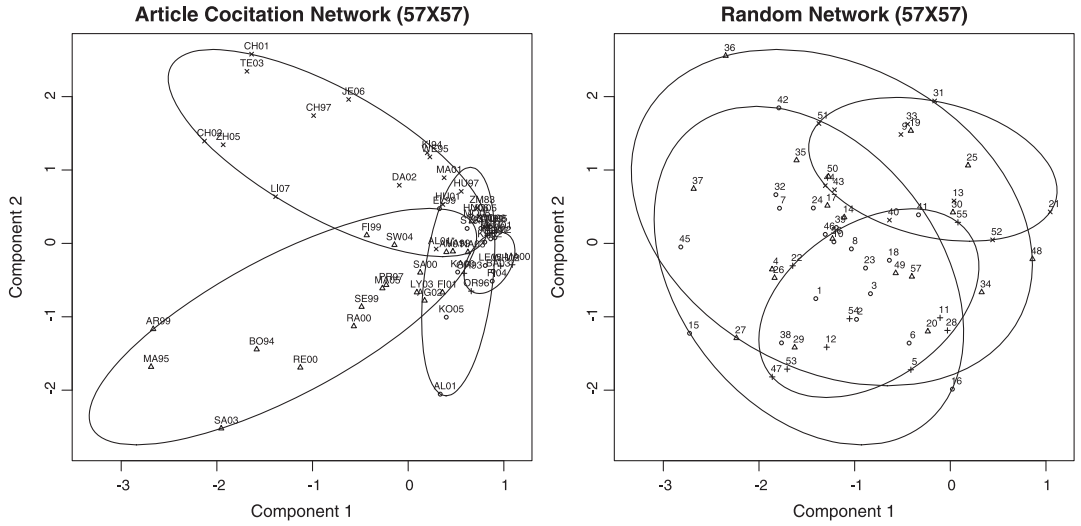

FIGURE 4 Plot of first 2 components of principal components analysis and clusters: article and random networks

knowledge sharing in communities can support digital innovation (Huysman & Wulf, 2006; Malhotra, Gosain, & El Sawy, 2005; Wang & Ramiller, 2009). For example, knowledge sharing to promote digital innovation may occur from external consultants to clients via knowledge-related, motivational, and communication-related mechanisms (Ko et al., 2005). A holistic view of how knowledge is generated to support digital business innovation capabilities thus includes a broader view of stakeholders going beyond the firm. In summary, knowledge and its management appear to be critically important to digital innovation, whether applying existing knowledge or learning from sources in the competitive environment such as supply chain partners.

5 | RESULTS: DIGITAL INNOVATION RESEARCH STREAMS

5.1 | Initiate

Our analysis found that from a process perspective, 4 research streams are salient: initiate, develop, implement, and exploit (Figure 1). Initiate refers to the organizational capability to identify, assimilate, and apply valuable knowledge from inside and outside the firm regarding opportunities for digital innovation. Studies within this stream ask the question of how firms initiate digital innovation, including questions such as how are new opportunities identified, what is the role of trends and fads, and how are opportunities translated into digital innovation initiatives. Compared with other research streams, our literature review revealed that few studies focus on the initiate activity of digital innovation. At the same time, identified studies provide theoretical and practical insights that form a foundation for future research (Table 2).

One view is that initiation involves capabilities enabling detection of opportunities in the external environment. For example, technological opportunism capabilities may complement existing technological frames (Mishra & Agarwal, 2010), while entrepreneurial alertness may enable firms to detect gaps at the nexus of products and markets, and envision how to address them (Sambamurthy, Bharadwaj, & Grover, 2003).

A different perspective is that firms may fall prey to external influences that drive ill-conceived initiation of digital business innovation (Fichman, 2004; Kaganer, Pawlowski, & Wiley-Patton, 2010; King et al., 1994). Institutional isomorphic change offers several mechanisms by which this may occur, including coercion, uncertainty driving imitation, and normative pressures (DiMaggio & Powell, 1983). In this vein, IS scholars have argued that organizations seek

TABLE 2 Initiate—summary of key findings from literature review

Finding
Initiation can be viewed as capabilities enabling detection of opportunities in the external environment, such as technological opportunism capabilities and entrepreneurial alertness.
Firms may initiate on the basis of institutional isomorphism, including coercion, uncertainty driving imitation, and normative pressures. Following an "organizing vision" may oppose initiation of digital innovation based on local facts and specifics.
Organizations are knowledge-generating entities that draw learning from inside and outside their organization and apply it to foster effective initiation and may inoculate against fads and fashions.
Knowledge may lead to initiation of innovations. Such knowledge gathering itself may be enabled by IT, such as crowd-sourced innovation platforms.

legitimacy by following a diverse interorganizational community that creates an "organizing vision" providing legitimacy to a set of innovative actions (Swanson & Ramiller, 1997). Viewed in this way, organizations may indeed be following a rationale by seeking legitimacy in initiating digital innovation—although one that may oppose initiation based on local facts and specifics (Swanson & Ramiller, 2004) and thus represent a suboptimal decision.

Initiation requires capabilities rooted in knowledge, including its generation and application (Alavi & Leidner, 2001). According to this perspective, organizations are knowledge-generating entities that draw learning from inside and outside their organization and apply it to foster effective initiation. For example, knowledge capabilities related to information technology may drive the championing or initiating of digital business innovation, including advocating for the adoption of a particular digital business innovation (Bassellier, Benbasat, & Reich, 2003). Drawing on knowledge management theories, IS scholars posit that knowledge capabilities can act as an inoculation of sorts against fads and fashions while enabling them to better recognize opportunities (Swanson & Ramiller, 1997). Scholars also examine how organizational knowledge leads to the initiation of innovations (Carlo et al., 2012). Finally, new business models leveraging the wisdom of crowds (Surowiecki, 2004) provide new mechanisms by which firms can draw diverse and potentially valuable knowledge to the firm to support the initiation process (Leimeister, Huber, Bretschneider, & Krcmar, 2009).

In summary, despite the paucity of literature exploring digital innovation initiation, several conceptual perspectives related to initiation phenomena—opportunity identification, capabilities, isomorphic pressure—offer reinforcing and opposing mechanisms that underlie the early stages of digital innovation. At the same time, given the scarcity of prior research, it is unclear under what conditions these mechanisms emerge, nor it is clear whether any mechanism is more or less binding than others.

5.2 | Develop

The develop research stream comprises research that seeks to determine not only what works in terms of designed technology artifacts but also why (March & Smith, 1995). As such, this research stream comprises 2 related but distinct substreams: design science research focusing on the creation of technology artifacts and adoption research focusing on how such artifacts are adopted. The research question is thus how are IS artifacts developed and what are adoption antecedents? The abundant literature within both substreams of this question addresses various phenomena, as we now describe (Table 3).

At the foundation of design research are design science theory (Gregor & Jones, 2007; Walls, Widemeyer, & El Sawy, 1992), design science research paradigms (Hevner, March, Park, & Ram, 2004), and research methods (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007). Several insights emerged from our review of this large literature.

First, the notion of architecture is a universal and critical concept within IS design. This means that design studies examine diverse architectural layers, including device, network, service, and content (Yoo et al., 2010). However, the final outcome often relies on attention to all layers. The criticality of effective design in all layers is emphasized by the finding that success requires both effective system design (device, network, content) and effective design of new

TABLE 3 Develop—summary of key findings from literature review

Finding
Architecture is a universal and critical concept within IS design; different layers have different impacts on design effectiveness.
Omitting meta-requirements as a starting point for designs can lead to design failure.
Idea of a "best practice" design of a vendor-supplied IS may be a myth.
Top management support, external pressure, and organizational size are most predictive of adoption.

"patterns of action" or work routines (service; Pentland & Feldman, 2008), echoing the central idea of socio-technical theory (Mumford, 2003).

Second, the concept of meta-requirements, a "class of goals to which the theory applies" (Walls et al., 1992, p. 42), as a starting point for design is another foundational concept. For example, in the realm of security we have learned that enacted approaches do not meet developed meta-requirements, including the incorporation of organizational-security requirements as well as representations of system objects, system threats, and system security features (Siponen et al., 2006). This may be one reason for the poor state of information security observed in practice.

Third, the idea of a "best practice" design of a vendor-supplied IS may be a myth (or at least ephemeral), given strong evidence that organizations redesign third-party systems based on their own facts and specifics (Swan, Newell, & Robertson, 1999). This suggests that system design is an ongoing and iterative process rather than having a clear beginning and end. Finally, we note that given the range of kernel theories that may be invoked in a given design setting, design research has numerous overlaps with other digital innovation research streams, as we describe in subsequent sections.

In sum, design science is a long-standing research tradition in IS that has recently gained renewed momentum but has traditionally not been considered a research stream within digital innovation research. At the same time, other management disciplines are increasingly recognizing the importance of design science research, which provides IS with a unique and compelling contribution as an important innovation reference discipline (Nambisan, 2003).

Regarding adoption studies, the second substream within development, scholars have proposed and analyzed numerous adoption correlates (IS maturity, organizational culture, perceived benefits, industry type, communicability, maturity, competition) falling within 3 broad groupings: technological, organizational, and environmental factors. For example, environmental factors have been examined from various perspectives, including institutional factors (King et al., 1994), standards (Yoo et al., 2005), fashions (Wang, 2010), and organizing visions (Ramiller & Swanson, 2003). Regarding which specific characteristics appear to matter and which ones do not, top management support, external pressure, and organizational size appear to be most predictive, based on meta-analysis of 47 adoption correlates within 51 articles (Jeyaraj et al., 2006). Overall, this finding means that these 3 variables are the most likely to predict whether an organization adopts a given IT.

Beyond adoption, different factors may advance or hinder assimilation (Fichman & Kemerer, 1997) depending on the phase (initiation, adoption, routinization; Rai, Brown, & Tang, 2009; Zhu, Kraemer, & Xu, 2006). Indeed, top management support appears to be not only a critical adoption predictor but also a critical assimilation factor (Liang et al., 2007). However, the role of technical versus business manager may differ (Armstrong & Sambamurthy, 1999).

Opposing forces to innovation, such as innovation opponents (Cavusoglu, Hu, Li, & Ma, 2010) or a misaligned culture (Straub, 1994), are a rich (and understudied) source of new insights. It is important to know not only what drives adoption and assimilation but also what hampers it.

The adoption and diffusion research stream has contributed deep insights into factors associated with adoption decisions. It has also provided insights into underlying mechanisms and management practice regarding how to evaluate and assimilate IT innovations effectively. At the same time, knowledge generated from the "dominant paradigm" portion of this research stream—quantitative empirical analyses regressing the adoption decision against potential adoption antecedents—may be reaching diminishing returns (Fichman, 2004). In contrast, adoption and diffusion research examining alternative paradigms, assimilation dynamics, and opposing forces—and using diverse research

methodologies—has great potential for new theoretical and practical insights. For example, the knowledge and learning research stream (see below) suggests factors inhibiting knowledge application (and hence assimilation), including distrust of the knowledge source and risk aversion (Alavi & Leidner, 2001).

5.3 | Implement

Implementation refers to the complex set of organizational changes that occur during digital innovation initiatives. The core question of this research stream revolves around explicating the processes by which organizational change occurs in conjunction with an introduced IS. There is a logic of change in which change is a complex, nonlinear process within organization fields with feedback loops and unanticipated outcomes.

Our review of this research stream yielded several observations (Table 4). First, complex and difficult-to-predict phenomena arise at the interface of people and information technology within digital innovation initiatives. Time and again, identical information technologies implemented for similar reasons across different organizations yield vastly different outcomes (Wastell, 2006). These findings emphasize the oft-overlooked difference between technological and organizational enactment, for example, the need for alignment between strategy, structure, and IS (Bengtsson & Agerfalk, 2011; Mason, McKenney, & Copeland, 1997). Moving beyond the organization itself, the cultural and national context also shapes IS-enabled organizational change efforts (Avgerou, 2001; Avgerou, 2008; Melville, 2010). At the same time, the salience of local facts and specifics in digital innovation initiatives can contradict conventional wisdom, such as those emerging economies with poor information infrastructures are not a fit for digital innovation (Nidumolu, Goodman, Vogel, & Danowitz, 1996).

There is also a limit to how much managerial fiat can dictate the processes and outcomes of organizational change efforts. Change itself may be situated and determined by enacted and emergent actions of employees over long periods (Manning, 1996; Orlikowski, 1996). Given this, rather than a logic of determination, a logic of opposition examining forces supporting and hindering digital innovation efforts may yield deeper insights (Robey & Boudreau, 1999).

Finally, the microfoundations of IT-enabled organizational change efforts go beyond process characteristics (sense and observe, develop, implement, exploit) to include other dimensions, such as change levels (transactional versus transformational; Singh et al., 2011), change degree (incremental versus radical; Orlikowski, 1993), and boundary spanning (Levina & Vaast, 2005).

Taken together, articles within the implementation research stream emphasize that a wide variety of situational characteristics shape and are shaped by the introduction of IS in a codependent fashion resulting in organizational change. In contrast to the rapid pace of technological change, IS scholars have identified enduring and timeless phenomena at the rich boundary between people and technology within and across organizations.

5.4 | Exploit

Exploitation refers to leveraging existing systems and data sources to generate new innovations, which is analogous to an option as a financial instrument (Fichman, Keil, & Tiwana, 2005) and is steeped as much in folklore as in fact. Folklore promotes accidental or serendipitous exploitation of IS to create innovations, such as drug manufacturer Eli Lilly's exploitation of its database containing scientists' demographics and a listing of discovery challenges that eventually

TABLE 4 Implement—summary of key findings from literature review

Finding
Complex phenomena arise at the interface of people and information technology within digital innovation initiatives.
There is a limit to how much managerial fiat can dictate the processes and outcomes of organizational change efforts.
Microfoundations of IT-enabled organizational change efforts go beyond process characteristics.

led to the creation of the crowdsourcing business venture called innocentive.com (Burrus & Mann, 2011). Our goal here, however, is to assess the facts cited in a vibrant stream of scholarly work on how to exploit digital innovations, particularly in ways that exceed their primary goal, including domains of learning, sensemaking, recombination, knowledge absorption, and harvesting and appropriation.

Several perspectives in exploitation of digital innovations are supported by theories that emphasize organizational learning and organizational change capabilities (Table 5). Collectively, these perspectives support the development of managerial capabilities to learn new knowledge, to make sense of problem-solving situations in which to apply the knowledge, and to creatively (re)combine the knowledge to create new capabilities. Given that managers have limited capacity to absorb new learning, they must deal with organizational change to execute learning. For instance, interaction among managers across departments, business units, and with partner organizations requires adjustments in organizational culture and establishment of new forms of communication. Similarly, changes are required in how managers approach IS investments that have a future payoff and in how they exploit past IS investments.

Exploitation of digital innovations manifests as discovery of nuggets of knowledge through analytics, such as data-mining algorithms (eg, see review in Thangavel & Pethalakshmi, 2009), forensic accounting (Chang et al., 2008), and data discovery (Marshall, McDonald, Chen, & Chung, 2004), as well as a number of narratives documenting the use of business analytics among practitioners (Davenport, Harris, & Morison, 2010). Although serendipity has a role in exploitation, it has been argued that serendipity helps those who are best prepared to take advantage of innovations (Andre, Schraefel, Teevan, & Dumais, 2009). Organizational learning theory suggests that individuals' ability to exploit innovations and to create new knowledge is dependent upon their cognizance of the context, the ability to explore, and the intention to exploit (Nambisan, Agarwal, & Tanniru, 1999). Using the theoretical basis of disruptive innovation (Christensen & Raynor, 2003), Dyer, Gregersen, and Christensen (2011) propose that innovative skills can be learned by building capabilities that include associations or connections between questions, problems and ideas from unrelated fields, and experimentation by constructing interactive experiences that offer opportunities for new insights.

The sensemaking perspective (Weick, 1995), when applied to work systems and technology systems, suggests that continued IS use leads to greater returns for the firm through learning and exploitation (Hsieh, Rai, & Xu, 2011). Continued use and exploitation also expand a decision-maker's understanding of the context and how decision variables relate to each other. This understanding can be further expanded through exploration and exploitation of opportunities (Yao, Kohli, Sherer, & Cederlund, 2013). Therefore, sensemaking serves as a precursor to managers' ability to integrate knowledge for expected as well as serendipitous appropriation of value from digital innovations (Graebner, 2004).

Another view is that exploitation results from creative new uses of existing IS already in use. Componential theory of creativity proposes that individual and team creativity occurs when individuals' skills overlap with their interests or motivations to ask questions and to seek answers (Amabile, 1997). As such, firms must enact management practices and resources that foster creativity (Bharadwaj & Menon, 2000). Such management practices and organizational design are especially important for firms that partner with other firms in interorganizational innovation systems (de Jong, Marston, & Roth, 2015). The knowledge-sharing ambidexterity framework argues that commitment to system design ontology facilitates mutual exploration, as well as exploitation, by partners and offers greater recognition of opportunities for joint innovative products and services (Yoo et al., 2005).

TABLE 5 Exploit—summary of key findings from literature review

Finding
Rich in folklore and anecdotes; serendipity plays a role but not a decisive one
Organizational learning and change management are critical to exploit
Sensemaking through continued use enhances exploit opportunities
Knowledge sharing among partners, internal and external, leads to greater recognition of exploit opportunities

Another perspective is that digital innovation exploitation occurs when organizations make appropriate changes and adapt to new ways to use IS. This perspective argues that innovative ideas and learning capabilities cannot be successfully exploited unless organizations address the change in how they operate. Organizational change theory suggests that to exploit digital innovations, business leaders must make deliberate efforts to make changes in processes, organizational design, and technology use (Seo, Putnam, & Bartunek, 2004). Such organizational change is particularly needed when firms merge or when they acquire or partner with another firm so that the combined resources can be synergistically exploited. The convergence of people from disparate organizations often leads to a combination of ideas that create serendipitous value (Graebner, 2004). Although this involves serendipity and chance, organizations improve the odds by making deliberate investments in IS, such as NASA's "innovation garages," that promote collaboration, learning, and experimentation in pursuit of future opportunities (de Jong et al., 2015).

Another exploitation perspective proposes that organizations must develop the capability to appropriate past "options" investment and to create new options. Options theory proposes that firms must make investments in initiatives, such as new IS platforms for social media analytics, that if successful will result in new innovations (Fichman et al., 2005). Organizations incur costs in redirecting resources to create options and assume risk of options failure, both of which require organizational change in how managers make the business case for IS investments. An options approach also requires organizational flexibility to deploy resources to activate options. Previous research has argued that organizations with better-developed bundles of options are more aggressive in growing markets as well as more resilient in downturns (Bowman & Hurry, 1993). To exploit options, organizations must build capabilities to adapt to the changes that each market brings.

5.5 | External competitive environment

The external competitive environment is a diverse digital innovation research stream that focuses on how managers use digital innovation with a view to aligning their actions with the realities of the competitive environment (Table 6). There is a logic of *external attention* that seeks to determine the optimal actions for a firm with respect to digital innovation within the context of its external environment. What have we learned from the strategic perspective digital innovation research stream? First, to apply *external attention* logic, firms must first develop capabilities that enable them to sense the competitive environment accurately. This capability has been referred to as "entrepreneurial alertness" (Sambamurthy et al., 2003) and has roots in the strategic management and entrepreneurship literatures (Zaheer & Zaheer, 1997). Second, after applying the external logic, firms must develop strategic capabilities to respond to such sensing. One perspective is framing, in which organizational capabilities serve as complements to managers' technological frames related to digital innovation (Mishra & Agarwal, 2010). Another is analysis of strategic planning processes and the insight that different approaches may yield different outcomes in terms of digital innovation efficacy (Segars & Grover, 1999). Third, and in line with the logic of the external, is the idea that digital innovation may itself change the competitive environment by altering the forces of competition (Mata, Fuerst, & Barney, 1995). Thus, any representation of the competitive environment within a conceptual framework of digital innovation must incorporate 2-way causality, as we elaborate in the next section.

Our understanding of the digital innovation research stream focusing on strategic perspectives is that it represents the most theoretically and intellectually diverse streams, with many overlaps to other streams. For example,

TABLE 6 External competitive environment—summary of key findings from literature review

Finding
Alertness and environmental scanning are "sensing" capabilities that encourage digital innovation
Managers synchronize internal capabilities and determine optimal actions to respond to competition
Sense and respond capabilities must be integrated with the strategic planning process
IS play a critical role in developing sense and respond capabilities

entrepreneurial alertness includes aspects of knowledge management while strategic planning includes a design school of thought. We build on these ideas in the next section by reframing these apparently disconnected digital innovation research streams as a conceptual framework with clearly interrelated parts.

5.6 | Internal organizational environment

As digital innovation is embedded in the internal organizational environment, it is shaped by its features and dynamics and may in turn shape them (Table 7). Learning is a primary organizational lens through which digital innovation has been viewed from the perspective of the internal organizational environment. For example, learning can be viewed as a bridge between routine work (static, resistant to change) and innovation (disruptive but often necessary; Brown & Duguid, 1991; Henderson & Lentz, 1995-96; Huang, Makoju, Newell, & Galliers, 2003). Moreover, learning is often necessary (although not sufficient) for digital innovation. For example, in the case of externally adopted IS, knowledge drives opportunity sensing, which in turn drives experimentation and subsequent innovation (Carlo et al., 2012), consistent with the result that the IT knowledge of business managers increases the likelihood of their intention to champion IT projects (Bassellier et al., 2003). Previous research has long cited top management support as fundamental to success of innovations such as implementation of electronic data interchange in the transportation industry (Premkumar, Ramamurthy, & Crum, 1997). Senior management engagement and support for knowledge sharing and experimentation paves the way for a learning culture and rewards digital innovations, for example, through interactions with the chief information officer (CIO) in management control system innovations (Lee, Elbashir, & Sutton, 2014).

Information systems targeted at enhancing learning and knowledge management have mixed effects, often depending on organizational and other specifics (Huber, 2001; Srivardhana & Pawlowski, 2007). For example, access to knowledge management systems strengthens the association between an innovation culture and innovation outcomes but diminishes the association between an autonomous culture and innovation outcomes (Durcikova, Fadel, Butler, & Galletta, 2011). Related to this finding, using IS to enhance knowledge capabilities may enable continuous innovation (Joshi, Lei, Datta, & Shu, 2010).

Knowledge sharing in communities may also enhance digital innovation (Huysman & Wulf, 2006; Malhotra et al., 2005; Wang & Ramiller, 2009). For example, knowledge sharing to promote digital innovation may occur from consultants to clients via knowledge-related, motivational, and communication-related mechanisms (Ko et al., 2005). However, an organization's ability to absorb new knowledge is critical to digital innovation (Roberts, Galluch, Dinger, & Grover, 2012).

Taken together, these articles tend to focus on either the role of IS in shaping the working, learning, innovation sequence, or on the direct impact of knowledge management and learning on digital innovation outcomes. At the same time, given the complexity of learning and knowledge management phenomena, we identified several outlier studies focusing on such topics as an agent-mediated knowledge management process (data are transformed into information, information to knowledge, knowledge to creativity, and creativity to innovation; Datta, 2007), architectural knowledge development in interorganizational digital innovation (Andersson, Lindgren, & Henfridsson, 2008), and specific tactics for enhancing organizational creativity (Couger, Higgins, & Mcintyre, 1993).

TABLE 7 Internal organizational environment—summary of key findings from literature review

Finding
Managers create an environment conducive to digital innovations
A learning culture promotes opportunities for digital innovation
Senior management support is critical for digital innovations to take hold
Ability to absorb new ideas is critical to digital innovation

5.7 | Digital innovation outcomes

Arguably, the most important feature of digital innovation is successful generation of new IT-enabled products, processes, and services. Despite its salience, exploration of digital innovation outcomes has received very little attention in the literature. Our literature review revealed a mere handful of studies, suggesting a significant opportunity for future research. As such, we outline a few dimensions of the problem and use the few studies available as motivation (Table 8).

Outcomes of digital innovation appear in numerous locations and in diverse forms. Given that innovation is often considered an outcome of research and development initiatives, the number of patents is the most common metric to measure digital innovation (Cockburn & Griliches, 1988; Gittelman & Kogut, 2003). Among the outcomes of digital innovations are the impact on productivity, profitability, risk mitigation, and customer loyalty. Several internal outcomes have been the subject of measurement such as process redesign and simplification (productivity), increase in sales, higher margins (profitability), and reduction in error, risk mitigation such as liability insurance premium (Menon & Kohli, 2013) and market-facing metrics such as market share and consumer satisfaction. Given that innovation involves novel ways of doing things, outcomes such as time-to-market, product features, and consumer reach play an important role in measuring innovation outcomes.

6 | APPLICATIONS, OPPOSITIONS, AND TENSIONS

To further illustrate, develop, and refine the theoretical framework of digital innovation (Figure 1), we next describe oppositions and tensions using vignettes drawn from practice. The oppositions and tensions serve 2 purposes. First, they illustrate the applicability and usefulness of the digital innovation framework itself. Second, they suggest useful areas of future research in the areas of theory development and empirical validation encapsulated in a set of 3 research questions. Note that although the identities of organizations have been anonymized, the events and contexts are faithfully represented.

6.1 | Initiation and human agency

6.1.1 | Large media organization responding to competitive pressure

Several years ago, a well-known media organization suffered from diminishing revenue due to new digital competitors. Illustrating the role of the external competitive environment, the CEO tasked a senior leader with gathering innovative minds from the newsroom to develop effective means by which to enhance revenue. A small innovation team was formed comprising employees from strategy, digital, design, and business functions. The team spent a few months of investigative reporting of various stakeholders internal and external to the organization, as well as gathering relevant reports, articles, and data sources—all of which exemplify initiation capabilities for detection of opportunities in the external environment. Moreover, this focus on local facts and specifics represents a form of inoculation against following IT fashions (Wang, 2010).

The team's focus then shifted to analyzing gathered data and developing an initial sense for opportunities and challenges to thriving in the rapidly changing competitive environment. On the basis of gathered evidence and analysis, the team's initiation activities shifted from the mandate of identifying revenue-generating digital products and services to changing the core of the organization. This shift in mission illustrates a learning trajectory from data

TABLE 8 Outcomes—summary of key findings from literature review

Finding
Firms generally measure digital innovation outcomes through number of patents.
Digital Innovation outcomes are measured through internal metrics (productivity, profitability, risk mitigation) as well as market-facing metrics (market share, time-to-market).

collection (what are competitors doing with digital, what capabilities are needed, etc) to knowledge generation (potential fruitful new ideas and directions) to understanding (shift in mission from narrow product development to holistic business-model transformation). Finally, on the basis of the shift in mission, several suggestions were proffered, including a new leadership position for audience development, better integration of news with business, and development of a strategy to stay abreast of the latest digital developments.

6.1.2 | Oppositions and tensions

As evidenced by the paucity of research on initiation exposed by our literature review and synthesis, existing knowledge provides few insights into the process by which the organization arrives at a consensus of what observed signals mean. In particular, the digital innovation literature is largely silent on the role of human agency in recognizing, agreeing upon, and formulating the problem or opportunity. Human agency is a critical component in how firms separate "signal" from "noise" or distinguish between fads or fashions and mindful change (Abrahamson, 1991). How does digital innovation proceed if knowledge gathering during the initiation phase delivers findings that contradict executive beliefs? Related to this, how do power structures influence related decision-making?

Previous research perspectives view organizational innovation as a nebulous phenomenon as if the entire organization were speaking with one voice. In practice, initiation of digital innovation is laced with assessments of individuals whose judgements are influenced by power, individual, economic, and other forces. Accurate and impartial assessment of gathered information may be an essential first step to creating a mechanism to challenge underlying assumptions and to engage in double-loop learning (Argyris & Schon, 1978).

Organizational capability theories suggest that a competitive environment influences digital innovation. However, sensing and observation mediates the external business environment and the organization's internal change practices. What is the form of such capabilities and routines and how might they be cultivated? In contrast, if firms do not have well-developed capabilities, is institutionalization of other innovation-related capabilities inhibited? Two related questions are as follows: Do firms use *ad hoc* sensing and observation processes such as relying upon sales personnel to observe opportunities? And is problem identification a random occurrence driven by factors in the external environment, such as a regulatory mandate or technological change?

It is unclear how such tradeoffs are considered and how firms handle related conflicts. In the context of digital innovation research, it is important to develop mechanisms to arrive at impartial agreement on what is the signal and what is the noise. Given that human agency plays an integral role, should firms proactively invest in sensing capabilities, or should they let them organically emerge after IT and human capabilities are acquired? In both cases, we assume purposive and contingent behavior (Schelling, 1978), yet the implications of the 2 alternative modalities for digital business capabilities for initiation are significant. We encapsulate the above arguments in the following research question:

Research Question 1: How do organizations initiate digital innovation, what internal organizational and external environmental conditions cause alternative mechanisms to be more or less binding, and which initiation mechanisms are more effective than others and under what conditions?

6.2 | Design of systems versus design of practices

6.2.1 | Patient-centered records system at health care system

In a multi-hospital regional health care system, patients complained about difficulties in making doctor appointments and accessing clinical records of their prescriptions and test results. Given these patient issues and emerging regulations concerning digitizing health records, a team of internal technology personnel and physicians, as well as external consultants, developed a new health care IS. The team also drafted a new set of associated business processes and work practices. After the system was implemented within a single hospital, best practices learned from the first rollout were applied to implementation in the remaining hospitals. The health care system reported the successful rollout of

the new patient-centered records system in its annual reports, media statements, and blogs by senior management, suggesting enhanced patient care and decreased costs.

Six months later, usage logs and ethnographic observation of system use revealed that many patients did not use the system at all, others logged on once in response to an invitation and never revisited the system, and still others did not use it after viewing the online tutorial.

6.2.2 | Oppositions and tensions

As described in earlier sections, design research yields several perspectives that can inform the apparent dissonance in the patient-centered records system outcome. A large stream of research views design as the design of a technical artifact, such as a new software application or systems to support software development. In contrast, other design studies suggest that design is a holistic activity involving the design of technical artifacts, business processes, work practices, and other pertinent contextual features (Yoo et al., 2010). What are the boundaries of design and what do such boundaries imply for design outcomes?

When design boundaries are blurred, prior research consistently demonstrates that outcomes can be negatively impacted. It may be folly to focus on artifacts and their design and features rather than on organizational routines and practices (Pentland & Feldman, 2008). The folly of focusing exclusively on artifacts is suggested by theories of design. It is well understood that a technical artifact yields affordances (Gibson, 1977), which leads to framings about what is possible and how the new artifact is to be used. Such affordances may also be a product of both organizational and technical features (Zammuto, Griffith, Majchrzak, Dougherty, & Faraj, 2007), suggesting that design focusing on one or the other may lead to suboptimal outcomes or ineffective ISs. Design thinking also suggests that separating artifacts from their contextual applications is not only unwise but also impossible (Beckman & Barry, 2007), as suggested in the IS literature (Lee, 1999).

Contradictory to these arguments, design science research implicitly focuses on technical and closely related artifacts such as data warehouses, software reuse metrics, and internet-based voice and video software (Peffers et al., 2007). The technical artifact is placed at the core of IS research frameworks producing guidelines for design research (Hevner et al., 2004). Moreover, the technical artifact has been called the "core subject matter" of IS research (Orlikowski & Iacono, 2001). Only rarely is this view broadened to a perspective on IS design that includes material artifacts, theories, and subjective human understanding of artifacts (Gregor & Jones, 2007). We summarize these arguments in the following research question:

Research Question 2: How can organizations combine the design of digital information systems with the design of organizational routines and practices to develop effective digital innovation outcomes of new products, services, and outcomes?

6.3 | Implementation as a directed versus an organic process

6.3.1 | Big data at Global Bank

A large bank adopted and implemented Splunk, a system designed to search and analyze machine-generated social media big data to track market trends and customer response to advertising campaigns. Over a period, managers in the credit card division of the bank explored Splunk's features that integrated disparate data sources and deployed Splunk for credit card fraud detection. When a customer made a purchase, the credit transaction was routed through Splunk, which in turn sprinted it through various databases to validate the transaction by examining purchase behavior, locations of other transactions and past fraudulent transactions. The use of the Splunk system organically grew from a social media tracking application to an innovative application for fraud detection, operational monitoring of IT systems, and capacity planning. These uses were unintended and were not designed when the system was implemented.

6.3.2 | Oppositions and tensions

In the case of Splunk, its use over time led to alternative applications that were not anticipated at the outset. This evolution is consistent with framings of implementation of digital innovation as a gradual and organic process in which ongoing use and adaptation influence the shape, outcome, and ultimate success of the initiative. However, as discussed earlier, IS design theories (ISDT) specify methods for artifact creation that are driven primarily by engineering principles rather than by ongoing use. ISDT provides general processes and approaches for designing classes of IS artifacts, such as IS security policies (Siponen & Iivari, 2006) and systems to support emergent knowledge processes (Markus et al., 2002) and are generally nonadaptive.

A critical component of an ISDT is testable hypotheses used to determine the effectiveness of the design method: did the method yield an artifact that met the requirements (Walls et al., 1992)? Examples of requirement evaluation criteria include algorithm execution time (March & Smith, 1995) and total cost of security actions (Siponen & Iivari, 2006). Hypotheses are tested in various ways, including demonstrating that a designed artifact solves a problem instance via simulation, case study, etc, and by evaluating empirical evidence quantifying the impact of the artifact (Peffers et al., 2007) and using "well-executed evaluation methods" such as observational, analytical, experimental, testing, and descriptive (Hevner et al., 2004, p. 85). In sum, the perspective of IS design science research is that appropriate design methods can be deliberately developed and applied to create effective IS artifacts in use.

An alternative perspective is that during the implementation phase, newly introduced IS artifacts emerge over time according to situational specifics and the effectiveness of the IS artifact becomes known only through these emergent processes (Brown & Duguid, 1991; Mumford, 2003; Orlikowski, 1996; Pentland & Feldman, 2008). According to this view, which emerges from organizational change theories, designing an artifact when what is desired is a way of doing (Pentland & Feldman, 2008) may be one reason that digital innovation suffers from such high failure rates (Nelson, 2007). While this tension is related to the acknowledged debate about how general an ISDT proposition needs to be (works only in certain situations; Gregor & Jones, 2007), it is different in kind. For example, is the evaluation component of an ISDT limited to narrow functional or technical characteristics, or intended to be broad enough to encompass organizational changes enabled by new IT artifacts? Resolving this tension is important for organizations to develop strategies that will lead to successful implementation of digital innovations.

On the basis of the tension of implementation as prespecified versus emergent process and its relationship to design, we state the following:

Research Question 3: How can organizations integrate the tension of implementation as a directed versus organic process into the design of digital artifacts to achieve successful outcomes?

7 | REFLECTIONS, LIMITATIONS, AND EXTENSIONS

The integrative conceptual framework of digital business innovation capabilities resulted from a nonlinear and extended researching process. This process followed a set of iterations involving research, insights, more research, more insights, and so on. For example, we did not set out to develop a new literature review methodology. Rather, upon realizing the enormous breadth and depth of the digital innovation literature and our inability to understand its essence using existing approaches, we shifted to a focus on our requirements, features of existing literature review methodologies, and the search for and eventual development of the hybrid literature review methodology. Although we believe that the results and implications of our iterative, nonlinear process of researching are accurate and reliable and that the insights provide a solid foundation upon which to build new research, our research is not without limitations.

7.1 | Digital innovation—to what end?

While we addressed the issue of "whither digital innovation," we did not address the issue of "to what end?" Who is benefiting from digital innovation, and who makes value judgements about the long-term impact of IS research

(Constantinides, Chiasson, & Introna, 2012)? From the early days of digital innovation involving automation of routine tasks to today's era of informating and transforming every task imaginable (Zuboff, 1984), from driving a connected car to simultaneous language translation, the possibilities for the future appear without bound. But how long will human labor be able to "upskill" and maintain a lead over smarter and more intuitive non-human labor? And what is the responsibility of IS researchers in responding to such ethical questions?

7.2 | Inclusion of design science

Design is typically thought of as a distinctive research stream. Design science "has staked its rightful ground as an important and legitimate Information Systems (IS) research paradigm" (Gregor & Hevner, 2013, p. 337). Yet herein we claim that design—and by extension design science research—falls within the digital innovation research paradigm. This might appear to be a contradiction and might be criticized as reductionist or an unnecessary attempt to integrate diverse streams of research. Why not maintain design as a completely separate research stream? As we have demonstrated in our conceptual framework, design capabilities are intimately related to other digital business innovation capabilities, including initiation and implementation. Again, although some may disagree, it is our view that sufficient conceptual overlap and intersecting phenomena exist to warrant an integrative framework including design. Ultimately, resolution of this tension will occur over time as a social process within IS scholarship.

7.3 | Reductionist fallacy

Although our identification of 4 core activities of digital innovation followed from our literature review and prior research, these may be difficult to separate in practice. In parsing the complex process of digital innovation, we may be subject to the reductionist fallacy that digital innovation comprises the 4 core activities identified, rather than their texture, form, essence, or nature. In this way, we may be missing important phenomena. It is possible that viewing digital innovation from alternative framings—for example, as emergent, complex phenomena (Janssen, van der Voort, & van Veenstra, 2015) involving self-organization (Nan & Lu, 2015)—may yield complementary and powerful insights.

7.4 | Deliberate versus *ad hoc*

The developed theoretical framework implicitly assumes that organizations approach digital innovation in a deliberate, mindful way. Much empirical evidence supports this view. However, there is also evidence of the opposite: *ad hoc* approaches to digital innovation. For example, a new hire in the marketing group champions social media as a better way to connect with customers given her prior experience in another organization. An *ad hoc* process ensues given the lack of existing expertise within the organization (champion sets up a Twitter account, writes a short protocol for using social media, and begins to tweet about company products). Although we might be able to interpret the actions according to the framework, there is no clear linkage in stories and language used that strongly ties one with the other. Critics may correctly emphasize the sometimes *ad hoc* approaches that fall between the cracks of the 4 activities explicated herein.

8 | CONCLUSION

The focus on digital innovation as a business objective ebbs and flows with the vagaries of markets and business cycles: "During a recession, when many companies face declining revenues and earnings, executives often conclude that innovation isn't so important after all" (Rigby, Gruver, & Allen, 2009, p. 79). In contrast, conceptual understanding of digital innovation is developed according to Kuhnian paradigms (Kuhn, 1962) that enjoy popularity until displaced by new perspectives. In this paper, our objective was not to displace existing theory paradigms of digital innovation,

rather to synthesize prior research within a simple theoretical framework and examine what we know and do not know about each of its facets.

To catalyze future research, we undertook a systematic review of the digital innovation literature according to a theoretical framework comprising 7 dimensions: initiation; development; implementation; exploitation; the role of the external competitive environment; role of internal organizational environment; and product, service, and process outcomes. From a macro perspective, we identified uneven coverage of research streams, both diversity and diffusiveness, and knowledge and learning as an underlying conceptual pillar. Combined with our discussion of tensions and oppositions motivated by real-life digital innovation vignettes, we identified several areas of future research. Overall, despite its limitations and complexities, this review and synthesis of digital innovation may move scholarship forward by acting as a key knowledge "mile marker" as well as an "illustrated map" to move knowledge forward in this rapidly changing yet critically important research stream.

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