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Digital Entrepreneurship: Toward a Digital Technology Perspective of Entrepreneurship

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New digital technologies have transformed the nature of uncertainty inherent in entrepreneurial processes and outcomes as well as the ways of dealing with such uncertainty. This has raised important questions at the intersection of digital technologies and entrepreneurship—on *digital entrepreneurship*. We consider two broad implications—less bounded entrepreneurial processes and outcomes and less predefined locus of entrepreneurial agency—and advance a research agenda that calls for the explicit theorizing of concepts related to digital technologies. In articulating the promise and value of such a digital technology perspective, we consider how it would build on and enrich existing entrepreneurship theories.

Introduction

A primary focus of entrepreneurship research has been on understanding the nature and sources of uncertainty that underlie entrepreneurial pursuits and the ways by which entrepreneurial actions unfold amidst such uncertainty (Kirzner, 1979; Knight, 1921; McKelvie, Haynie, & Gustavsson, 2011; Schumpeter, 1934). Indeed, uncertainty "constitutes a conceptual cornerstone for most theories of the entrepreneur" (McMullen & Shepherd, 2006, p. 133). In recent years, the infusion of new digital technologies—such as mobile computing, cloud computing, social media, 3D printing, and data analytics—into various aspects of innovation and entrepreneurship has transformed the nature of uncertainty inherent in entrepreneurial processes and outcomes as well as the ways of dealing with such uncertainty. In turn, this has opened up a host of important research questions at the intersection of digital technologies and entrepreneurship—on *digital entrepreneurship*—that call for careful consideration of digital technologies and their unique characteristics in shaping entrepreneurial pursuits.

Specifically, digitization has upended two broad assumptions that underlie our extant understanding of entrepreneurial processes and outcomes. First, digital technologies have rendered entrepreneurial outcomes and processes *less bounded*—a shift from discrete,

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impermeable, and stable boundaries to increasingly porous and fluid boundaries. In terms of outcomes, this relates to the structural boundaries of the product, service, etc. (for example, the features, scope, and market reach of an offering), and in terms of processes, this relates to the spatial and temporal boundaries of entrepreneurial activities (for example, when and where activities are carried out). Digitization of products and services allows for greater flexibility by separating function from form and contents from medium (Yoo, Henfridsson, & Lyytinen, 2010) making entrepreneurial outcomes "intentionally incomplete" (Garud, Jain, & Tuertscher, 2008)—i.e., the scope, features, and value of offerings would continue to evolve even after they have been introduced to the market or "implemented." Digitization of entrepreneurial processes has helped to break down the boundaries between the different phases and brought greater levels of unpredictability and nonlinearity into how they unfold (Huang, Henfridsson, Liu, & Newell, in press). Second, digitization has led to *less predefinition* in the locus of entrepreneurial agency (i.e., where the ability to garner entrepreneurial ideas and the resources to develop them is situated) as it increasingly involves a broader, more diverse, and often continuously evolving set of actors—a shift from a predefined, focal agent to a dynamic collection of agents with varied goals, motives, and capabilities. For example, new types of digital infrastructures—such as crowdfunding systems (Mollick, 2014), digital 3D printing systems and digital makerspaces (Mortara & Parisot, in press; Rayna, Striukova, & Darlington, 2015; Smith, Sabine, Sascha, Johan, & van Oost, 2013), and social media platforms (Fischer & Reuber, 2011)—have led to more collective ways of pursuing entrepreneurship (Aldrich, 2014). As we discuss in detail in the next section, changes in both of these assumptions—and the uncertainties they portray—limit the relevance and value of insights from existing research in entrepreneurship and demand novel theorizing of how entrepreneurial opportunities are formed and enacted in an increasingly digital world.

Given that unique characteristics and aspects of digital technologies shape these changes, we propose that such novel explanation will need to be informed by the *digital technology perspective*—one that incorporates digital-technology–related theories, concepts, and constructs. For example, consider the following questions. Why are some entrepreneurs (ventures) more successful than others in acquiring entrepreneurial resources through digital crowdsourcing and crowdfunding systems? How does the use of digital infrastructure (e.g., social media) by different entrepreneurs lead to different types of effectual cognitions and behaviors (and consequently different outcomes)? How does the generativity induced by digital artifacts and platforms shape the dynamic emergence of novel entrepreneurial opportunities? How do entrepreneurial narratives of opportunity get shared and co-created through interactions among diverse actors on digital forums? How does the collective nature of entrepreneurial agency enabled by digital technologies shape entrepreneurial processes and outcomes? Without explicitly theorizing about digital technologies and their characteristics—and integrating such a digital technology perspective with existing theories and concepts in entrepreneurship—we are unlikely to find reliable and valid answers to such questions.

Despite its contemporary significance, however, existing research in entrepreneurship has largely neglected the role of digital technologies in entrepreneurial pursuits. Prior research on technology entrepreneurship (Beckman, Eisenhardt, Kotha, Meyer, & Rajagopalan, 2012; Zupic, 2014) has by and large focused on entrepreneurship as practiced in technology-intensive environments (including digital technology), wherein technology is treated merely as a *context* for empirical work (e.g., Bingham & Haleblian, 2012; Vissa & Bhagavatula, 2012). Limited effort has been made on theorizing the role of specific aspects of digital technologies in shaping entrepreneurial opportunities, decisions, actions, and outcomes.

In this paper, we address two key questions associated with entrepreneurship in a digital world: (1) how does the richness of pervasive digitization such as its variability, materiality, generativity, and emergence create a need for new theorizing in entrepreneurship? and, (2) what should be the components of new theories in entrepreneurship that recognize and incorporate this richness? We address the first question by examining the impact of digitization on entrepreneurial boundaries and entrepreneurial agency and the associated issues. To address the second question, we advance a research agenda that involves the application of theoretical frameworks and concepts drawn from the digital technology literature (in conjunction with existing entrepreneurship theories) to gain a deeper understanding of the implications of more fluid entrepreneurial boundaries and distributed entrepreneurial agency and the associated entrepreneurial uncertainty. We articulate the key conclusions in the form of a set of research themes that could guide future conceptual and empirical work in this area.

We seek to make two main contributions to research and practice in entrepreneurship. First, we help to establish the relevance of digital entrepreneurship as an area of inquiry within entrepreneurship and elucidate the potential implications of such research for innovators and entrepreneurs in industries across the digital spectrum. In doing so, we illustrate the value of specific digital-technology–related theoretical concepts in informing such research and how they relate to (or complement/enrich) existing entrepreneurship theories and perspectives (e.g., opportunity creation perspective, narrative perspective, effectuation, etc.). Second, we emphasize the need to focus on the intermingling of human/social and material (here, digital technology) agencies to truly understand how entrepreneurial opportunities are formed and enacted in an increasingly digital world. Thereby, we contribute to the ongoing discourse in entrepreneurship about how opportunities emerge from such intermingling of social and material elements (e.g., Garud & Giuliani, 2013) and on the cognitive perspective of opportunity formation and enactment (e.g., Gregoire, Corbett, & McMullen, 2011).

We start by describing three distinct elements of digital technologies—digital artifacts, platforms, and infrastructure—and then expand on how the infusion of varied digital technologies questions the prevailing assumptions regarding entrepreneurial boundaries and entrepreneurial agency.

Digital Technologies and Entrepreneurship

Digital Artifacts, Platforms, and Infrastructure

Digital technologies manifest in the realm of entrepreneurship in the form of three distinct but related elements—digital artifacts, digital platforms, and digital infrastructure. We briefly define and describe each and then discuss their implications—both general implications for entrepreneurship as well as those with regard to the two assumptions questioned (entrepreneurial boundaries, entrepreneurial agency).

A *digital artifact* is defined here as a digital component, application, or media content that is part of a new product (or service) and offers a specific functionality or value to the end-user (Ekbia, 2009; Kallinikos, Aaltonen, & Marton, 2013). The decoupling of information from its related physical form or device has led to the gradual infusion of such digital artifacts or components into a wide range of products and services (Lusch & Nambisan, 2015) and unleashed a plethora of opportunities for entrepreneurs in different industries (Porter & Heppelmann, 2014). Such digital artifacts or components are present not only on smartphones and other personal devices (e.g., apps that run on smart watch,

fitness watch, etc.) but also as part of home appliances, toys, apparel, shoes, automobiles, etc. (e.g., Amazon *Dash* button, Oral-B's connected toothbrush, Eight mattress cover, Babolat's tennis racket *Play*, Ralph Lauren PoloTech shirt, Nike+ *Sensor*, Nest's learning thermostat, etc.). Digital artifacts can be either stand-alone software/hardware component on a physical device or, as increasingly is evident, part of a broader ecosystem of offerings that operate on a digital platform.

A *digital platform* is defined as a shared, common set of services and architecture that serves to host complementary offerings, including digital artifacts (Parker, Van Alstyne, & Choudary, 2016; Tiwana, Konsynski, & Bush, 2010). For example, Apple's iOS platform and Google's Android platform enable apps to run on their respective smartphones. Similarly, Ford's SYNC 3 is a digital platform that hosts integrated communication, navigation, and entertainment apps in cars. Digital platforms provide a wealth of opportunities for entrepreneurs—opportunities that involve developing complementary products and services (Zahra & Nambisan, 2011). Such digital platforms (and associated ecosystems) are often marked by the role of a single firm, the platform leader, in establishing the modular platform and in orchestrating both value creation and value appropriation (Gawer & Cusumano, 2002; Nambisan & Sawhney, 2011). The potential for new ventures to deepen their specialization while offsetting their production, marketing, and distribution capabilities explain the attractiveness of digital platforms as a venue for entrepreneurship (Huang, Ceccagnoli, Forman, & Wu, 2013; Zahra & Nambisan, 2011).

In contrast to digital platforms, *digital infrastructure* is defined as digital technology tools and systems (e.g., cloud computing, data analytics, online communities, social media, 3D printing, digital makerspaces, etc.) that offer communication, collaboration, and/or computing capabilities to support innovation and entrepreneurship. Such digital infrastructures have led to the democratization of entrepreneurship (Aldrich, 2014), i.e., the engagement of a greater number and diverse set of people in all stages of the entrepreneurial process—from opportunity exploration to concept testing to venture funding and launch. For example, crowdsourcing and crowdfunding systems allow entrepreneurs to engage with potential customers and investors in acquiring varied resources (ideas, capital) on a global scale (Kim & Hann, 2013). Similarly, cloud computing, digital makerspaces, and data analytics have made it possible for new ventures to cost-effectively construct and test novel concepts involving a larger set of potential customers (Hatch, 2013). Indeed, new digital infrastructures have shown the capability to support end-to-end entrepreneurial activities.

Thus, digital technologies increasingly form an inherent part of the entrepreneurial opportunity in terms of both the outcome as well as the process. Specifically, drawing on Davidsson's (2015) entrepreneurial opportunity framework, digital artifacts and digital platforms serve as part of the new venture idea (outcome) while digital infrastructure serves as an external enabler (supporting the process). As we discuss next, the characteristics and other aspects of these digital technology elements critically shape the changing assumptions regarding the nature of innovation and entrepreneurial boundaries and the distribution of entrepreneurial agency.

Less Bounded Entrepreneurial Outcomes and Processes

Prior studies on innovation and entrepreneurship have, by and large, presupposed a stable or fixed and discrete set of boundaries for the new product (or service) idea that underlie an entrepreneurial opportunity (Davidsson, 2015; Short, Ketchen, Shook, & Ireland, 2010). To a great extent this has been informed by existing theories on product

life cycle (Utterback, 1994), architectural innovation (Henderson & Clark, 1990), product development process (Ulrich & Eppinger, 2011), etc., all of which assume relatively stable and well-defined boundaries around a product/service. With the infusion of digital technologies, however, such boundaries have become more porous and fluid because the scope, features, and value of product/service offerings continue to evolve even after the idea has been enacted. For example, by modifying digital artifacts or components, Tesla has been able to introduce new functionalities and value offerings into its cars even after they have been delivered to customers. Similarly, by modifying the digital analytic components in cars, companies such as Metromile (a California based start-up) have been able to offer continuously evolving "usage-based" insurance products to their customers. Unique characteristics of digital artifacts or components—they are reprogrammable, recombinable, and open (Yoo et al., 2010; Zittrain, 2008)—dress them with "ambivalent ontologies" (Kallinikos et al., 2013). Most digital product designs remain somewhat incomplete and in a state of flux where both the scale and scope of the innovation can be expanded by various participating innovation actors (Lyytinen, Yoo, & Boland, 2016). Further, the value and utility of these digital artifacts is often dependent on "shifting webs of functional relations with other artifacts across specific contexts and organizations" (Kallinikos et al., p. 357) and reveals the potential role of their characteristics or attributes in shaping and reshaping the structural boundaries of the novel opportunities that entrepreneurs form and enact.

Similarly, digital platforms infuse a degree of generativity, and hence an extent of unpredictability and fluidity, into entrepreneurial outcomes. Generativity refers to "a technology's overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences" (Zittrain, 2006, p. 1980). In the current context, generativity refers to the capability of digital platforms to allow for a recombination of elements and for assembly, extension, and redistribution of functionality (Yoo et al., 2010; Zittrain). For example, when Apple infuses new capabilities into its digital platform (iOS), it produces ripple effects wherein existing entrepreneurial opportunities (e.g., app development on iPhone) are transformed and/or radically new opportunities are generated (e.g., new ways of connecting to or using data from home automation devices)—in turn, refashioning the boundaries of the associated opportunity space. Digital platforms emphasize variability and agility, resulting in such cumulative and path-dependent innovation trajectories (Parker et al., 2016; Tiwana et al., 2010). Such generativity can emanate from the characteristics of the digital platform architecture and from the governance of the related ecosystem (Foerderer, Kude, Schuetz, & Heinzl, 2014; Um, Yoo, Wattal, Kulathinal, & Zhang, 2013), indicating digital technologies' role in shaping the fluid boundaries of entrepreneurial outcomes.

With digitization, entrepreneurial processes have also become less bounded, particularly in terms of their temporal structure. For example, new digital infrastructures (e.g., 3D printing, digital makerspaces, etc.) enable product ideas and business models to be quickly formed, enacted, modified, and reenacted in repeated cycles of experimentation and implementation (Ries, 2011), making it less clear as to when a particular phase starts and/or ends. Such variability in entrepreneurial activities is also enabled by the extreme scalability (i.e., the ability to rapidly enhance the capabilities and performance at low cost and with ease) afforded by new digital infrastructures such as cloud computing and mobile networking (Brynjolfsson & Saunders, 2009). For example, when Brian Chesky and Joe Gebbia launched their entrepreneurial initiative in 2007—which later became Airbnb—their initial focus was on meetings and events for which hotel space was sold out. However, soon they discovered that such demand for affordable accommodation existed year-around and internationally and scaled up their services rapidly, largely

enabled by flexible cloud computing services. Thus, digital infrastructures infuse a level of fluidity or variability into entrepreneurial processes, allowing them to unfold in a non-linear fashion across time and space.

These changes—less stable boundaries in both entrepreneurial outcomes and processes—have in turn led to changes in behaviors and actions on the part of entrepreneurs in the digital arena. Specifically, if entrepreneurial outcomes are amenable to continuous change and evolution, then entrepreneurial success may no longer be reflected by the enactment of a predefined opportunity or the execution of a predefined value proposition. Instead, entrepreneurial actions would need to be oriented toward facilitating a continuously evolving value proposition, i.e., actions that leverage the potential for the continuous re-scoping of the opportunity. Further, entrepreneurial actions are not limited to or bounded by a set of activities and timeframes specified in a business plan. Rather, entrepreneurs are called upon to chart more dynamic paths or trajectories—that are by nature more sporadic and parallel and involve the constant initiation, forking, merging, and termination of diverse activities—facilitated by digital technologies.

Traditional models and frameworks in entrepreneurship have by and large assumed relatively stable and fixed boundaries around an entrepreneurial opportunity—one wherein success is often defined in terms of how well an entrepreneur executes on the associated, well-defined business plan (e.g., Brinckmann, Grichnik, & Kapsa, 2010; Gruber, 2007; Honig & Karlsson, 2004). As such, studies in this vein hold limited insights on entrepreneurial actions, behaviors, and success in the digitized world. On the other hand, a more emergent stream in entrepreneurship research has offered alternate perspectives of opportunity formation and enactment that reflect such fluid boundaries in entrepreneurial outcomes and processes and their accompanying uncertainty, albeit largely in abstract terms. For example, the "opportunity creation" perspective (e.g., Alvarez, Barney, & Anderson, 2013) suggests that opportunities are emergent (actors wait for a response from their actions, usually from the market, and then adjust their beliefs and act again) and that the creation process is iterative and evolutionary (the opportunity co-evolves with the context in which it is situated) (Garud & Karnoe, 2003). Similarly, the "effectuation" perspective (e.g., Sarasvathy, 2001) suggests an iterative process wherein the entrepreneur engages in continuous cognitive re-evaluation of the means available to them and their effects thereby gradually shaping the offering (Read, Song, & Smit, 2009; Sarasvathy & Dew, 2005). The "narrative" perspective (e.g., Gartner, 2007; Garud, Gehman, & Giuliani, 2014) depicts "meaning making" associated with entrepreneurial opportunities as an ongoing process that unfolds through continuous interactions between actors and artifacts (Garud & Giuliani, 2013). While all of these perspectives seem to (directly or indirectly) imply the fluid boundaries associated with entrepreneurial processes and outcomes, the lack of focus on more concrete concepts and constructs that underlie digital entrepreneurship limit their potential to inform on the varied issues.

Alternative theories and conceptualizations are thus needed that incorporate new ways of evaluating entrepreneurial success and inform on the factors associated with more dynamic and continuously evolving entrepreneurial outcomes and processes. Importantly, as our discussion indicates, digital artifacts, platforms, and infrastructure play a crucial role in shaping such liminally bounded entrepreneurial outcomes and processes. As such, a fine-grained focus on specific aspects and characteristics of digital technologies may offer a promising path toward developing more accurate theoretical explanations of this phenomenon.

Less Predefinition in Entrepreneurial Agency

The extant literature in entrepreneurship has, by and large, focused on the role of a predefined founder (or set of founders) who drives the entrepreneurial idea from its inception to fruition. Indeed, much of the early literature has focused on issues at the individual-opportunity nexus (Sarason, Dean, & Dillard, 2006; Shane & Eckhardt, 2003) that inherently assumes such a primary role for the individual entrepreneur. With the infusion of digital technologies, however, the locus of entrepreneurial agency has become less predefined and more diffused (or distributed), wherein a dynamic and often unexpected collection of actors with diverse goals and motives engage in the entrepreneurial initiative. For example, digital platforms (e.g., SugarCRM, Open SYNC, etc.) allow shared value creation by groups of actors (including individuals and ventures). New digital infrastructures such as crowdsourcing and crowdfunding systems (e.g., Kickstarter), digital makerspaces (e.g., Instructables), work execution forums (e.g., GitHub), and dedicated social media (e.g., Open Stack) allow collectives (groups of entities with common interests) to pursue entrepreneurial initiatives. Importantly, such collectives are often dynamic as actors opt in and out based on their own individual goals, motivations, capabilities, constraints, and contributions. Their involvement (and contributions) cannot often be predicted and occur as they become aware of and partake in the opportunity formation and/or enactment processes.

The potential for the less predefined and distributed nature of entrepreneurial agency afforded by digital technologies, implies changes in entrepreneurs' beliefs, behaviors, and actions and raises new and important research issues and questions. First, are all opportunities amenable to such a collective mode of entrepreneurship? Or, what is the relationship between the nature of an opportunity and the distribution of the entrepreneurial agency associated with it? And, more importantly, how does less predefined and distributed entrepreneurial agency change the nature of entrepreneurial uncertainty and shape the trajectory of opportunity formation and enactment? Second, distributed entrepreneurial agency and the associated changes in entrepreneurial uncertainty warrant different types of entrepreneurial beliefs, actions, and behavior. For example, it is evident that entrepreneurial actions would need to be oriented toward facilitating a continuously evolving set of actors to participate in shared value creation and to contribute to a shared entrepreneurial agenda. However, who gets to participate in such distributed entrepreneurial initiatives? And, what determines the nature and structure of their participation and contribution? Further, the involvement of such a dynamic set of actors in forming and enacting opportunities holds implications for the nature of entrepreneurial cognition and decision making. Thus, more broadly, how do entrepreneurs' underlying beliefs and behaviors shape (and get shaped by) the collective nature of entrepreneurship facilitated by digital technologies?

All of these implications for entrepreneurial beliefs, actions, and behaviors call into question the relevance of existing entrepreneurship theories and concepts that assume a predefined and stable set of founders or entrepreneurial team members. One stream of entrepreneurship research has focused on the identity, beliefs, skills and capabilities, cognition, decision-making style, and other aspects of the dominant (individual) founder and the impact on venture success (e.g., Boeker & Karichalil, 2002; Chandler & Hanks, 1994; Fauchart & Gruber, 2011; Hmieleski & Baron, 2009). However, the underlying assumption of this research stream is that the locus of entrepreneurial agency is situated within this individual and as such issues at the individual-opportunity nexus assume prominence. A second stream of research has focused on entrepreneurial teams and on their formation, management, and success factors (e.g., Aldrich & Kim, 2007; Forbes, Borchert, Zellmer-

Bruhn, & Sapienza, 2006; Harper, 2008; Klotz, Hmieleski, Bradley, & Busenitz, 2014; Schjoedt, Monsen, Pearson, Barnett, & Chrisman, 2013). However, studies in this vein assume that the composition of the entrepreneurial team is relatively well defined and stable, with different team members playing largely complementary roles. When the locus of entrepreneurial agency is distributed and less predefined (or dynamic), insights from both of these research streams would likely hold less significance or relevance.

At the same time, as our previous discussion illustrates, characteristics of the enabling digital technologies could fundamentally shape the scope and the nature of distributed entrepreneurial agency—for example, new functions offered by the digital infrastructure (e.g., crowdsourcing system) could likely shape the "architecture of participation" (e.g., Majchrzak & Malhotra, 2013). Thus, theories and constructs that reflect the unique characteristics of digital artifacts, platforms, and infrastructure may be particularly useful in addressing the research issues and questions outlined earlier. For example, concepts related to platform architecture may inform on "who gets to play" in entrepreneurial initiatives hosted by digital platforms. Similarly, concepts related to technology affordances and constraints may provide valuable insights on how digital infrastructures offer "architecture of participation" for distributed entrepreneurial agency.

In summary, our discussion so far indicates the potential for a fine-grained theoretical focus on digital technologies to contribute to a better understanding of the above two phenomena—less bounded entrepreneurial initiatives and less predefined entrepreneurial agency—and, more broadly to our understanding of entrepreneurial uncertainty in a digital world. In the following sections, we examine this in more detail (see Table 1). Given that digital artifacts and platforms form part of the new venture idea and digital infrastructure serves as an external enabler, in our discussions, we first focus on digital artifacts and platforms and then on digital infrastructure.

Less Bounded Entrepreneurial Initiatives

Digital Artifacts, Platforms, and Entrepreneurial Boundaries

We consider three sets of related issues and questions that underlie the role of digital artifacts and platforms in shaping the ways in which the boundaries of entrepreneurial initiatives (in terms of outcomes and processes) are rendered more fluid and open.

Generativity of Digital Artifacts and Platforms and Emergence of New Entrepreneurial Opportunities. How do digital artifacts and platforms induce shifting or fluid innovation boundaries? And, how do these shifting innovation boundaries imply the emergence and evolution of novel entrepreneurial opportunities? We suggest that the concept of *generativity* (Zittrain, 2006) could help address these questions and complement extant theories in entrepreneurship on the creation of opportunities. Specifically, characteristics of digital artifacts and platforms, on their own and in conjunction with other factors, enable them to infuse new functionalities in different market contexts, thereby refashioning existing pathways or opening new pathways to create value, i.e., rendering existing offerings and market opportunities less bounded.

First, consider two characteristics of digital artifacts: *reprogrammability* and *re-combinability*. Reprogrammability relates to the ability to be "accessible and modifiable by (an object) other than the one governing their own behavior" (Kallinikos et al., 2013, p. 359). Such modifications involve changes in the logical structure that govern the object thereby infusing new functionalities. Unlike analog products and devices, a digital

Table 1

Toward a Digital Technology Perspective of Entrepreneurship

Assumptions of entrepreneurship theories that digitization implies	Potential research issues	Sample digital technology theoretical perspectives and concepts
Less bounded entrepreneurial processes and outcomes: With digitization, (1) continuously shifting structural boundaries for entrepreneurial outcomes; and (2) continuously shifting spatial and temporal boundaries for entrepreneurial processes	• How do digital artifacts and platforms induce shifting or fluid entrepreneurial boundaries? How do these shifting boundaries imply the dynamic emergence and evolution of novel entrepreneurial opportunities? How do the characteristics of digital technology artifacts and platforms interact with human agency in the evolution of such entrepreneurial opportunities? • Why do some entrepreneurs (and not others) form and exploit an opportunity? How do varied interpretations (or meaning-making) of digital artifact capabilities by different entrepreneurs (individuals and collectives) lead to different entrepreneurial possibilities and actions? • How do digital artifacts and platforms enable/constrain entrepreneurial experimentation and imbue fluidity in entrepreneurial processes? What new methodological approaches may help discover the complex and dynamic interactions of digital artifacts and platforms with entrepreneurial processes? • How does the use of new digital infrastructures lead to the emergence of new social connections/practices and institutional arrangements in entrepreneurship? How do digital infrastructures and their associated sociotechnical processes (1) imbue flexibility in entrepreneurial processes, and (2) impact entrepreneurs' action-specific uncertainty and consequent variance in entrepreneurial outcomes?	• Technology generativity (Zittrain, 2006) and the role of platform architecture and governance (Foerderer et al., 2014; Um et al., 2013) • Characteristics of digital artifacts such as reprogrammability, recombinability, and expansibility (Kallinikos et al., 2013; Yoo et al., 2010) • Sociomateriality perspective (Orlikowski, 2007; Orlikowski & Scott, 2008) and the role of sociomaterial routines (Gaskin, Berente, Lyytinen, & Yoo, 2014) • Design capital and design moves (Woodard, Narayan, Tschang, & Sambamurthy, 2013) • Design science perspective (Hevner, March, Park, & Ram, 2004; March & Storey, 2008) • Digitalization (Tilson, Lyytinen, & Sørensen, 2010) and the role of sociotechnical processes
Less predefinition in entrepreneurial agency: With digitization, a shift from predefined set of entrepreneurs (founders) to continuously evolving, entrepreneurial collectives with diverse goals, motives, and capabilities	• What new theories and concepts inform on the relationship between the nature of an opportunity and the distribution of entrepreneurial agency associated with it? Who gets to participate in distributed entrepreneurial initiatives? What characteristics of digital artifacts and platforms shape entrepreneurs' (individual and collective) perceived uncertainty and willingness to bear uncertainty and thereby their participation in distributed entrepreneurial initiatives? • What aspects of digital infrastructures determine the nature and structure of entrepreneurs' participation and contribution in distributed entrepreneurial initiatives?	• Characteristics and tensions in digital platform governance (Bresnahan & Greenstein, 2014; Tiwana et al., 2010) • Layered modular architecture of digital platforms (Yoo et al., 2010) • Innovation asset leverage (Iansiti & Levien, 2004; Nambisan & Sawhney, 2011) • Technology affordances and constraints theory (Leonardi, 2011; Majchrzak & Markus, 2013) • Architecture of participation in digital forums (Majchrzak & Malhotra, 2013)

Table 1

Continued

Assumptions of entrepreneurship theories that digitization implies	Potential research issues	Sample digital technology theoretical perspectives and concepts
	• How does entrepreneurial cognition (and decision making) occur when collectives are involved? How does the use of digital infrastructure (e.g., social media) by different entrepreneurs lead to different types of effectual cognitions and behaviors (and consequently different outcomes)? • How does the collective nature of entrepreneurial agency shape the trajectory of opportunity formation and enactment? How do distributed entrepreneurial initiatives enabled by digital infrastructure shape entrepreneurial processes and outcomes?	

component is *reprogrammable*, enabling separation of the semiotic functional logic of the device from the physical embodiment that executes it (Yoo et al., 2010). Recombinability relates to the ability to associate with and build on other digital artifacts or components. Separation of the content from the medium enables digital components to access and combine data and functionalities originating from heterogeneous sources, transcending industry, market, and product boundaries (Yoo et al.).

In certain instances, these characteristics on their own may give rise to new functionalities and help generate new entrepreneurial opportunities. For example, the recombinability of digital search components and digital archives have led to new value-creation opportunities in different markets such as the music industry (on-demand music), transportation industry (navigation), etc. In other instances, the interaction of these digital artifact characteristics with other contextual characteristics (e.g., new regulations, new pricing mechanisms, etc.) may radically change the definition of value in a market. For example, with the adoption of new FAA regulations, drones—a digital device originally developed for military applications—have in recent years been reprogrammed to find new opportunities and value pathways in a broad range of industries including the real estate industry (aerial videos to showcase homes), logistics (package delivery), agriculture (monitoring crops), etc. In some other instances, the second-order effects of specific digital artifacts may open up entirely new opportunities that could then be exploited by employing other digital artifacts. For example, the use of data analytics artifacts along with "big data" acquired through social media apps (such as Twitter) and Internet of Things (IoT) has opened new pathways to create value in healthcare (identification of depression), predictive car maintenance, disaster and environment management, advertising and brand management, etc. In all of the above cases, the ability to easily modify (or repurpose) and/or combine the functionalities of one or more digital artifacts shifts the

boundaries of existing entrepreneurial opportunities in ways that developers of the original digital artifact could not have envisioned.

Importantly, these characteristics of digital artifacts, in conjunction with an important characteristic of digital platforms, contribute to their underlying generativity and the dynamic emergence and evolution of entrepreneurial opportunities. Specifically, digital platforms exhibit a layered modular architecture (a hybrid of modular and layered architecture)—wherein individual components are not product-specific and each platform layer may be associated with a different functional design hierarchy (Yoo et al., 2010). Thus, the multiple components across the different layers of a digital platform are not bounded by a product or are product agnostic (Gao & Iyer, 2006).

For example, the different components of Apple's iPhone connect with different functional hierarchies and enable usage in conjunction with a wide range of products. Similarly, consider Google Maps. While Google Maps (a digital artifact) can be used as a standalone component, the layered modular architecture that underlie different digital platforms enable the use of Google Maps in a variety of other ways. Specifically, it can be reprogrammed and recombined with a wide range of other digital artifacts and devices including in cars (connected cars), digital cameras, drones, etc. In other words, novel entrepreneurial opportunities can be inductively enacted by orchestrating and reprogramming/recombining an ensemble of digital artifacts from a set of heterogeneous layers of multiple digital platforms (Yoo et al., 2010). This reflects the *generativity* afforded by the layered architecture of digital platforms in conjunction with the characteristics of digital artifacts (Foerderer et al., 2014; Um et al., 2013).

Such generativity forms a crucial vehicle to understand the state and the effect uncertainties (McKelvie et al., 2011) associated with digitally infused entrepreneurial opportunities. In other words, it allows us to analyze the cascading effects of the continuously shifting boundaries of digital entrepreneurial initiatives, i.e., the richness and intensity of entrepreneurial opportunities that may be unleashed at different layers of a digital platform due to changes in another layer. Generativity, and the material agency of the digital artifacts and platforms that underlie it, could also inform the ongoing debate on the discovery and creation of entrepreneurial opportunities (Alvarez et al., 2013) by focusing attention on the ways by which human (entrepreneur) agency is enjoined by material agency in creating variations that lead to novel opportunities. More broadly, a fine-grained focus on the characteristics and aspects of digital artifacts and digital platforms that reflect their inherent generativity could inform on the fluidity and uncertainty associated with entrepreneurial boundaries and the nature of emergence and evolution of new opportunities.

> **Research Theme 1**: *Incorporation of theoretical concepts and constructs that reflect digital artifacts and platforms and their interactions with one another (and with other contextual characteristics) in entrepreneurship research could offer critical insights on the generativity exhibited in digital entrepreneurial contexts and the ensuing shifting and fluid boundaries of entrepreneurial initiatives.*

Sociomaterial Routines (Involving Digital Artifacts) and Entrepreneurial Actions. Why do some entrepreneurs (and not others) form and exploit an opportunity? One stream of entrepreneurship research has focused on knowledge (e.g., Gaglio & Katz, 2001; Shane, 2000) and its impact on entrepreneurs' perceived uncertainty (e.g., McMullen & Shepherd, 2006) in addressing this question. Here, we suggest that *sociomaterial routines* involving digital artifacts may form the basis for such knowledge creation (and

uncertainty reduction), thereby offering an alternative explanation for variations in opportunity formation and enactment across individuals (and collectives).

Specifically, new entrepreneurial opportunities in the digital landscape are often created through a process of intertwining digital artifacts and the related practices, norms, and perspectives of people using (or interacting with) such artifacts. Digital artifacts can be viewed as embodiments of narratives that are interpreted and reinterpreted by entrepreneurs (individuals and collectives) in different contexts to fashion new entrepreneurial opportunities. From such a "narrative perspective," opportunities are formed as "entrepreneurs plot sets of social and material elements from the past, present, and future into a comprehensible narrative" (Garud & Giuliani, 2013, p. 159). As such, beyond a focus on the individual characteristics of digital artifacts and platforms, we also need to consider how different actors interpret the boundaries associated with a digital entrepreneurial opportunity differently—an intermingling of human and material (digital) agencies—that in turn informs on opportunity formation and enactment. The recent focus in the information systems field on the sociomateriality approach (Orlikowski, 2007; Orlikowski & Scott, 2008) indicates a promising avenue to further advance our understanding of this.

Sociomateriality refers to the duality of social and material, or as Orlikowski (2007, p. 1437) notes, "the social and the material are considered to be inextricably related—there is no social that is not also material, and no material that is not also social." The sociomateriality approach could inform on how the enactment of a set of activities—sociomaterial routines or practices (Gaskin et al., 2014)—that meld materiality (here, digital artifacts and its capabilities) with human actors, organizations, and institutions may lead to the creation of novel entrepreneurial opportunities. As Davidson and Vaast (2010) note, sociomateriality "emerges from the mutual exploitation, adjustment and enactment of means-end relationships between human and non-human actors" (p. 4) including the entrepreneur and the digital artifact. And, such sociomaterial routines or practices involving a given digital artifact in different contexts may give rise to different narratives or entrepreneurial possibilities. For example, many of the entrepreneurial possibilities opened up by Twitter have involved sociomaterial routines involving actors and a digital artifact (Twitter) in different contexts—e.g., farming, amateur astronomy, art installation, etc. (Elliott, 2016). Similarly, diverse narratives that embed new digital devices such as Apple Watch, Nike + Sensor in everyday practices and activities lead to the dynamic evolution of novel opportunities.

Such a sociomateriality perspective of digital artifacts is also related to the emerging notion of user entrepreneurship (Chandra & Coviello, 2010; Shah & Tripsas, 2007). Specifically, the sociomateriality perspective may provide an understanding of how one individual's enactment of a digital artifact (in a local context) may lead to a wider and socially accepted practice that in turn creates a broader market opportunity that awaits exploitation. This is what happens when users interpret new meanings that evolve into a wider entrepreneurial opportunity. Thus, the sociomateriality lens may throw new light on how users are able to identify diverse market needs by building on their own experiences in the digital world and having a deep appreciation for the context of these needs—or on how opportunities emerge in and through "interactions between actors and artifacts that become entangled with one another" (Garud & Giuliani, 2013, p. 159). For example, a recent study (Kelestyn & Henfridsson, 2014) explored through multiple case studies (in healthcare, education, transportation) how digitally empowered users engender future shaping practices (practices derived from mundane and embedded exercises of everyday life) to envision new entrepreneurial opportunities.

More broadly, the sociomateriality perspective and the ensuing focus on routines that involve the intermingling of actors and digital artifacts in diverse contexts could inform on how varied interpretations of digital artifact capabilities by different "entrepreneurs" (individuals or collectives)—and the knowledge so created—may lead to different entrepreneurial possibilities and actions.

> **Research Theme 2**: *Incorporation of sociomateriality and related theoretical perspectives and concepts—that reflect the intermingling of human (entrepreneur) and material (digital) agencies in diverse contexts—in entrepreneurship research could offer critical insights on the variations in entrepreneur knowledge ("narratives"), in their perceived uncertainty and in the ensuing entrepreneurial actions.*

Entrepreneurial Experiments and Variability in Entrepreneurial Activities. If entrepreneurship can be viewed as experimentation (e.g., Kerr, Nanda, & Rhodes-Kropf, 2014), then the constraints on the ability to experiment would shape when entrepreneurial initiatives are likely to occur and how they would unfold. Digital artifacts and platforms by way of their unique structure and characteristics shape the nature and extent of such idea incubation and experimentation and thereby imbue greater variability in the very process of opportunity formation and enactment.

As noted previously, digital artifacts are editable (can be modified or updated continuously and systematically), open, and distributed (not contained within a single source or institution) (Ekbia, 2009; Kallinikos et al., 2013). Further, they possess infinite expansibility (can be built on endlessly, limited only by processing and networking capabilities) (Faulkner & Runde, 2009). These characteristics facilitate greater degree of trial and experimentation in how entrepreneurs go about building their business models, developing and testing solutions, and more broadly addressing new opportunities. Consider the scope of the opportunity itself. As more and more functionalities underlying an entrepreneurial opportunity are digitized, it becomes easier for entrepreneurs to gradually enhance the scope of their offerings. For example, the development of Pebble (the popular Kickstarter-launched smart watch) is a classic case in such "scope creep." Originally started as InPulse (a watch created in 2010 for BlackBerry), the scope of Pebble evolved over time through trial and experimentation from its initial focus on two core functions—phone call and notifications—to an expanding list of digitized activities including linkages with cars (Mercedez-Benz), camera (GoPro), smart home (iControl), etc.

The editability, openness, and expansibility of digital artifacts make such "scope creep" cost-effective (i.e., the contours of the original opportunity can be expanded with lower marginal innovation cost), thereby infusing greater levels of flexibility in opportunity enactment. As noted previously, product ideas can be quickly formed, enacted, expanded, and re-enacted through repeated cycles of experimentation and implementation, making it less clear as to when a particular phase starts and/or ends.[1] This in turn helps brings a greater level of overlap in the time horizons of different phases or stages and helps break down the boundaries between them. Thus, a focus on specific

1. This is the key idea underlying the lean entrepreneurship technique (Ries, 2011) that originated in the software industry but has now found wider application across industries (Power, 2014). Specifically, the minimum viable product (MVP) reflects an approach that exploits the ease that digitization affords for scope creep.

characteristics of digital artifacts could bring more insights on the nature of entrepreneurial process flexibility and the conditions under which such flexibility is afforded.

For example, recently, Woodard et al. (2013) introduced the concept of *design capital*—the cumulative stock of digital designs owned or controlled by a firm—to examine one such condition in the context of digital platforms. A new venture's design capital could enable or constrain its future design moves and thereby shape its ability to experiment with and respond to emerging opportunities on a digital platform. Thus, the notion of design capital could prove to be helpful in understanding how different new ventures may exercise the process variability inherent in digital artifacts and platforms for pursuing new opportunities—in some instances, design capital might expand the entrepreneurs' options with regard to exploring an opportunity and thereby make it more attractive, whereas in other instances, the reverse may be true.

Beyond such research on specific factors that induce process flexibility in digital entrepreneurship, future research may also consider a different methodological approach to study this phenomenon. Specifically, the *design science perspective* that has been studied well in the information systems literature (e.g., Hevner et al., 2004; March & Storey, 2008) may be particularly helpful in developing new theories in this regard. Design science offers an apt analytical framework to gain a deeper understanding of the interactions of the characteristics of the digital artifact/platform (the potential "solution") and the very process of building or designing it. For example, Peffers, Tuunanen, Rothenberger, and Chatterjee (2008) propose a design science research methodology—including a nominal process model involving six methodological steps—that could be invaluable in this regard. Importantly, such an approach aligns well with the recent focus on studying entrepreneurship as a science of the artificial (e.g., Selden & Fletcher, 2015; Venkatraman, Sarasvathy, Dew, & Forster, 2012) and on applying the principles of the design science perspective to understand opportunity formation (e.g., Dimov, in press).

> **Research Theme 3***: Incorporation of theoretical concepts and methodological approaches that reflect the incremental and nonlinear paths that digital artifacts and platforms facilitate in entrepreneurial initiatives could offer critical insights on the fluid and shifting boundaries of entrepreneurial processes and their implications.*

Digital Technology Infrastructure and Entrepreneurial Boundaries

As noted previously, new digital infrastructures (e.g., crowdfunding, 3D printing, digital makerspaces, etc.) help digitize entrepreneurial processes (Aldrich, 2014) and hold the potential to infuse greater level of variability into how and when such processes unfold and what outcomes they lead to. Such process variability afforded by digital infrastructure would likely shape entrepreneurs' "action-specific uncertainty"—both feasibility assessment and desirability assessment (McMullen & Shepherd, 2006)—and thereby shape their actions.

The use of digital infrastructures is a sociotechnical process—*digitalization* (Tilson et al., 2010)—that imbues significance to the accompanying changes at the cognitive, social, and institutional levels. Specifically, with digitization, dependencies between entrepreneurial processes and outcomes become more complex and dynamic. For example, Dougherty and Dunne (2012) demonstrated that the use of digital tools during new drug discovery led to knowledge divisions between digital scientists and traditional "wet

lab" scientists that had to be addressed through a new set of activities, with implications for innovation outcomes. Similarly, Bailey, Leonardi, and Barley (2012) showed that the consequences of deploying digital tools and associated processes in car design generated unintended design outcomes due to the entrance of new actors (simulation specialists) into the design process. These and related issues have been illustrated in other studies as well (e.g., Boland, Lyytinen, & Yoo, 2007; Lee & Berente, 2012).

In the current context, a fine-grained focus on such digitalization could potentially inform on the emergence of new actors (e.g., customer investors) and the social ties among them in entrepreneurial processes, the adoption of new cognitive models by individual actors as well as collectives, and the impact of social norms/practices by entrepreneurs and other actors (e.g., sharing of experiences and narratives). New digital infrastructures together with the associated social, cognitive, and institutional elements may shape the entrepreneurial processes and outcomes, making them less predictable.

For example, consider the implications on entrepreneurial cognition. It is well acknowledged that entrepreneurs draw on their memory and prior experiences to compare and analyze the "superficial features" of a new stimulus in deciphering a new opportunity (e.g., Baron, 2006). However, comparison of structural relationships—"links that unite different superficial features within a mental representation" (Grégoire, Barr, & Shepherd, 2010, p. 416)—call for a higher order reasoning process (Gentner, 1983). Such higher order reasoning processes could be facilitated by unique aspects of new digital infrastructures (e.g., 3D printing, virtual prototyping, web-based fab-spaces) that offer richer mental representations of the stimuli (e.g., Mortara & Parisot, in press)—for example, how would a new digital artifact operate (a first-order structural relationship) or how would the operation of a digital artifact or platform impact that of another device or process (a second-order structural relationship). The social ties and interactions among entrepreneurs and other actors facilitated by digital infrastructures may further enhance these effects—for example, interactions with customer investors on crowdfunding platforms, sharing and critiquing with peer entrepreneurs and other collectives on 3D printing forums, etc. (Rayna et al., 2015). Future research that considers the affordances or constraints that digital infrastructure place on entrepreneurs' (at both individual and collective levels) cognitive efforts at structural alignment could prove invaluable in understanding the varying interpretations of the same stimuli by different entrepreneurs (or different collectives) with implications for entrepreneurs' action-specific uncertainty (McMullen & Shepherd, 2006), and thereby, on their future actions and outcomes.

More broadly, with digitization, entrepreneurial processes and outcomes go increasingly hand in hand, shaping and being shaped by the other—thereby, leading to less bounded entrepreneurial initiatives. A granular focus on the nature and characteristics of digital infrastructures and their accompanying cognitive/social/institutional context may offer critical insights on this—in ways that enrich our understanding of their impact on entrepreneurs' action-specific uncertainty and the consequent variance in entrepreneurial outcomes.

> **Research Theme 4**: *Incorporation of theoretical concepts and constructs that reflect digital infrastructures and their underlying sociotechnical processes—for example, digitalization—in entrepreneurship research could offer valuable insights on their ability to imbue fluidity or variability in entrepreneurial processes and outcomes and enrich our understanding of entrepreneurs' action-specific uncertainty.*

Less Predefined Entrepreneurial Agency

As entrepreneurial agency becomes less predefined and distributed among a broader set of participants, two key questions assume considerable significance: Who gets to participate in such entrepreneurial initiatives (or, who gets to play)? And, what determines the nature and structure of their participation and contribution (or, how do they play)? We suggest that a closer look at the characteristics and aspects of digital technologies could inform on both these issues.

Digital Artifacts, Platforms, and Entrepreneurial Agency

Existing research in entrepreneurship has examined entrepreneurial action from two perspectives—as facilitated by the unique knowledge and awareness possessed by an entrepreneur or venture (perceived uncertainty) and as motivated by favorable attitudes toward risk-taking (willingness to bear uncertainty) (e.g., McMullen & Shepherd, 2006). The question of "who gets to play" in digital platforms and ecosystems can be addressed by considering both platform-related and entrepreneur (venture)-related factors. Specifically, decisions and choices made by the digital platform leader regarding the platform architecture and ecosystem governance—for example, the degree of technological openness, nature of decision rights allocation—could shape the appeal and accessibility of entrepreneurial opportunities offered by the platform and thereby impact both entrepreneurs' perceived uncertainty as well as their willingness to bear uncertainty.

As Bresnahan and Greenstein (2014) note, nonhierarchical (or more open) governance structures promote experimentation on the part of entrepreneurs that renew or enhance the life of a platform. Such open governance structures enable entrepreneurs to become aware of and be more willing to pursue emerging opportunities on the digital platform. For example, arguably, a higher number of novel complementary applications (apps) has appeared on Google's Android platform compared to that on Apple's competing, and relatively more closed, iOS platform. Importantly, open platform architectures (e.g., open interface design) would enable entrepreneurs with limited experience on the platform to exploit such new and emerging opportunities. In other words, they would offer a lower knowledge threshold for pursuing the opportunity as well as reduce their initial learning cost (Zahra & Nambisan, 2011).

Similarly, platform leaders' decisions regarding innovation asset leverage—provisioning or sharing and reuse of technologies, processes, intellectual property, and other innovation assets by members of a platform-based ecosystem[2] (Iansiti & Levien, 2004; Nambisan & Sawhney, 2011)—may further contribute to reducing knowledge gaps associated with emerging entrepreneurial opportunities. Higher levels of asset leverage (greater number and scope of such leverageable assets) on digital platforms reduce not only innovation costs and time but entrepreneurs' perceived uncertainty as well.[3] Similarly, a higher degree of layered modularity protects entrepreneurs' investments from changes happening elsewhere on the platform and thereby encourages greater levels of willingness to pursue newer opportunities. More broadly, such digital-platform–related factors could potentially impact entrepreneurs' "opportunity confidence" (Davidsson, 2015) and shape

2. The term "leverage" applies if the value generated by the assets divided by the cost of creating, maintaining, and facilitating their sharing (or reuse) increases rapidly with the number of network members that use or deploy them (Iansiti & Levien, 2004).
3. In this regard, digital platform leaders can also provide incubation centers (e.g., Google for Entrepreneurs) that host digital ventures and provide technical and other support for opportunity exploitation activities.

their decision to participate, and thereby, the extent to which entrepreneurial agency is distributed on a digital platform.

Prior research also suggests that path dependencies may exist that shape entrepreneurs' ability to participate in entrepreneurial initiatives both within the context of a single digital platform as well as across multiple platforms. For example, within a platform, the technological distance of a digital venture from the platform leader could potentially shape which new opportunities it can exploit and how well. Technological cognitive distance is the extent of overlap in foundational technologies and tools (technical competencies) between two network members (e.g., Wuyts, Colombo, Dutta, & Nooteboom, 2005), here the platform leader and the new venture. Similarly, path dependencies may also factor when entrepreneurs evaluate and pursue opportunities in adjacent platforms. For example, Srinivasan and Venkatraman (2013) show that in the video gaming market, path dependencies (architectural similarity) prevent digital ventures from exploiting new opportunities in adjacent platform markets.

Further, the interaction of these digital-platform–related factors and entrepreneurs' (or ventures') own capabilities could shape the performance of the ventures, and thereby indirectly, the success of a digital platform as a venue for distributed entrepreneurship. While considerable literature exists on the impact of entrepreneurs' individual-level capabilities on venture performance (e.g., Hmieleski & Baron, 2009; Zhao, Seibert, & Lumpkin, 2010), research has also shown that such relationships are more positive in "weak" situations (ones in which individuals have considerable latitude of behavior) than in "strong" situations (ones in which situational constraints restrict expression of these individual-level variables) (e.g., Mischel, 2004). If that is so, then the extent of monitoring and governance enforced by a platform leader may be a key factor in shaping venture success. For example, entrepreneurs may have more leeway to deploy their individual skills and capabilities in ecosystems with more open governance structure ("weak" situations) than with more closed structure ("strong" situations). As such, the nature and characteristics of digital platform governance (e.g., Bresnahan & Greenstein, 2014; Tiwana et al., 2010) may serve as an important set of moderating variables in the relationship between entrepreneur capabilities and venture performance. Recent studies (e.g., Nambisan & Baron, 2013) that have explored related issues indicate promising steps in this direction.

Our discussion so far indicates that digital-platform–related factors could potentially play a crucial role—both directly and indirectly (in association with human agency)—in shaping entrepreneurs' perceived uncertainty as well as willingness to bear uncertainty and thereby help address the question, "who gets to play" in distributed entrepreneurial initiatives on digital platforms. We capture these ideas in the form of the following research theme:

> **Research Theme 5**: *Incorporation of theoretical concepts and constructs that reflect digital platforms' architecture and governance (and their interactions with entrepreneur and/or venture-level capabilities) in entrepreneurship research could offer critical insights on entrepreneurs' ability (knowledge) and willingness (motivation) to pursue novel opportunities, and thereby on the nature and extent of distribution of entrepreneurial agency.*

Digital Technology Infrastructure and Entrepreneurial Agency

Digital technology infrastructure plays an important role in facilitating distributed entrepreneurial agency. For example, a wide range of community/social-based digital

forums—ranging from social media to crowdsourcing/crowdfunding systems—have been used to provide an organizing structure for diverse entities to come together and socially construct entrepreneurial opportunities (e.g., Belleflamme, Lambert, & Schwienbacher, 2013; Mollick, 2014). A few recent studies have examined such digital-infrastructure–facilitated distributed entrepreneurship in more detail. For example, Arriaga-Azkarate and Croasdell (2013) examined how electronic networks of practice supported partly by a social media platform (Twitter) fostered entrepreneurship among a group of Navarrese businessmen and women. The study highlighted the potential for group mechanisms enabled by social media and related digital infrastructure to serve as the conduit for entrepreneurial idea generation and development. Similarly, Fischer and Reuber (2011) adopted the effectuation perspective and examined how social interactions—specifically, interactions via social media (Twitter)—impacted effectual processes and thereby the formation of entrepreneurial opportunities. Despite these studies, little is known with regard to the impact of specific aspects or characteristics of digital infrastructures on the nature and structure of distributed entrepreneurial agency.

Digital-technology–fueled social processes form the foundation for distributed entrepreneurial agency. How do we analyze such processes and their impact on the nature and structure of actors' (entrepreneurs') participation and contribution in the entrepreneurial initiative? *Technology affordances and constraints theory* (Gibson, 1979; Leonardi, 2011; Majchrzak & Markus, 2014) offers a promising lens to investigate this. An affordance (or a constraint) is defined as an action potential offered by the digital technology; it is a relation between a technology with certain features and a user's intent or purpose for which this technology is to be used (Majchrzak & Markus). Thus, the focus is not on what features digital tools and infrastructures possess, but how actors' goals and capabilities can be related to the inherent potential offered by those features. By looking at technology use as sets of affordances and constraints for particular sets of actors, entrepreneurship researchers can explain how and why the "same" digital infrastructure (for example, crowdfunding system) has different entrepreneurial outcomes in different contexts.

Indicative of the promise of this approach, recently, Ingram, Teigland, and Vaast (2014) combined concepts from institutional theory and technology affordance literature to examine the reasons for low usage of crowdfunding systems by a set of Swedish entrepreneurs. They found that entrepreneurs' prior cognitive norms and biases (related to existing institutional logics for funding) shaped their perceptions regarding the features of the crowdfunding system (and their affordances), and thereby, the nature of usage and the entrepreneurial outcomes.

Further, there is growing recognition that distributed entrepreneurial agency calls for the explicit articulation of the *architecture of participation*. Specifically, if entrepreneurs are going to involve a collective (group of actors) in their entrepreneurial pursuits (as evidenced on crowdfunding systems and social media), then how do they plan for the *desired* nature and structure of their participation? The technology-affordance perspective could offer valuable insights in this regard too. For example, in a recent study, Majchrzak and Malhotra (2013) identified three types of tensions or conflicts that are inherent in the co-creation of ideas or opportunities on crowdsourcing systems—simultaneously encouraging competition and collaboration; idea evolution takes time but crowd members spend little time; creative abrasion requires familiarity with collaborators, yet crowd consists of strangers—and discussed the potential to apply the notion of technology affordances (Majchrzak & Markus, 2013) to alleviate or resolve those tensions. For example, four affordances of social media that shape knowledge sharing and narrative building are metavoicing, triggered attending, network-informed associating, and generative role-taking (Majchrzak, Faraj, Kane, & Azad, 2013). Such affordances bring to the fore the

need to examine how characteristics of the digital infrastructure shape entrepreneurs' "conversations" on digital forums and thereby the very process of opportunity formation and enactment by collectives.

The potential to combine such theoretical concepts with existing entrepreneurship theories and concepts portend valuable research avenues to understand distributed entrepreneurial agency. For example, as our discussion indicates, new digital infrastructures afford a group of entrepreneurs to tussle with and rapidly edit, share, and build upon one another's ideas or narratives in the process of opportunity formation. Implicit in this is the need to combine concepts and constructs that reflect the digital infrastructure with those of the narrative perspective (e.g., Garud & Giuliani, 2013) to inform on how narratives take hold on digital forums and delineate the emergent entrepreneurial opportunities (Müller & Becker, 2013; Nambisan & Zahra, 2016). Similarly, if interactions that entrepreneurs engage in via Twitter (or any other social media) can trigger effectual cognitions regarding the means and the effects, then a focus on the technology affordances and constraints for such interactions may enable us to develop a deeper understanding of the conditions under which entrepreneurs' use of social media (and any other such digital infrastructure) may facilitate cognitions and behaviors that ultimately result in opportunity creation and enactment. For example, weak affordances and/or high constraints may lead to "effectual churn" ("a continuous looping between interactions through Twitter and the reassessment of means and effects achievable, without progression through the effectuation process"—Fischer & Reuber, 2011, p. 2) and thereby to negative entrepreneurial outcomes.

Research Theme 6: *Incorporation of theoretical concepts and constructs that reflect the nature of use of digital infrastructures—for example, technology affordances and constraints—in entrepreneurship research, in conjunction with extant theoretical perspectives (e.g., effectuation, narrative perspective, etc.), could offer valuable insights on the nature, structure, and outcomes of distributed entrepreneurial agency.*

Discussion and Conclusions

Digital technologies herald a new era in entrepreneurship, one in which the traditional ways and forms of pursuing entrepreneurial opportunities are increasingly questioned and refashioned. Gaining a deeper understanding of the underlying issues calls for integrating digital-technology–related concepts and constructs with those in existing entrepreneurship theories. The research agenda and the theoretical issues outlined here are meant to both illustrate the significance of digital entrepreneurship as an area of inquiry as well as offer pathways for pursuing research in this area.

At a broad level, our discussion shows that digitization of entrepreneurial initiatives implies a new set of accompanying assumptions—(1) more fluid or less bounded entrepreneurial processes and outcomes, and (2) less predefined and more distributed entrepreneurial agency. In turn, these assumptions demand novel theorizing in entrepreneurship that would benefit from the careful incorporation of digital-technology–related theoretical perspectives, concepts, and constructs. Importantly, the research issues highlighted here are centered on enhancing our understanding of a more central concern in entrepreneurship: the nature of entrepreneurial uncertainty and the ways in which entrepreneurs (individually and collectively) address it.

As our discussion further indicates, the adoption of appropriate theoretical perspectives (e.g., sociomateriality, technology affordance, generativity, digitalization, etc.) that

allow for the joint consideration of entrepreneur/venture (individual, group, firm level) constructs and digital-technology–related constructs could help decipher the intermingling of human/social/institutional and material agencies in entrepreneurial pursuits and offer critical insights on how digitally fuelled entrepreneurial processes unfold and on how entrepreneurs' interactions and actions both shape and are shaped by the use of digital technologies. Importantly, as is evident from our discussion, such research would need to consider issues that span multiple levels—individual entrepreneur, groups or collectives, venture and ecosystem—and relate to recent calls in this regard (e.g., Shepherd, 2011).

While the research directions outlined here give primacy to the role of digital technologies, they would also need to build on (relate to) several important existing theoretical perspectives and research streams in entrepreneurship—for example, entrepreneurial uncertainty (McKelvie et al., 2011; McMullen & Shepherd, 2006), opportunity creation (Alvarez et al., 2013), effectuation (Sarasvathy, 2001), narratives (Garud et al., 2014; Garud & Giuliani, 2013), entrepreneurial cognition (Gregoire et al., 2011), user entrepreneurship (Shah & Tripsas, 2007), etc. As such, future studies that pursue the research agenda proposed here could potentially both enrich and extend a range of existing and emergent research streams in entrepreneurship.

Further, digital-technology–related theoretical concepts and constructs considered here—for example, generativity, technology affordance, design capital, etc.—are highly amenable to future empirical work. For example, recent studies on digital innovation (e.g., Huang et al., in press; Majchrzak et al., 2013; Svahn, Mathiassen, & Lindgren, in press) show how these and other concepts can be operationalized and incorporated in rigorous empirical work. The new digital-technology–related theorizing elements suggested here may also imply the need to adopt novel methodologies that have not been used to a great extent in entrepreneurship research. New techniques such as computational social science (e.g., Gaskin et al., 2014; Pentland, Haerem, & Hillison, 2010), configurational analysis (Ragin, 2008), and methods for identifying complex emergent phenomena (Kane, Johnson, & Majchrzak, 2014) may help develop more nuanced understanding of the underlying issues. For example, computational social sciences refer to a set of methodologies for exploring human behavior computationally (i.e., applying powerful data mining and machine learning techniques to analyze "big data" related to human interactions, behaviors, and relationships) and may be particularly helpful in analyzing entrepreneurs' use of social media in opportunity formation. Studies that incorporate these and other such new methodologies may better serve to help us understand the complex and dynamic phenomena that underlie entrepreneurship in a digital world.

Finally, research on digital entrepreneurship holds, broader public policy implications. For example, analysis of big data in domains such as public health, transportation, and education has helped citizens and nonprofit organizations to discover social problems that in turn lead to entrepreneurial opportunities (e.g., Datakind, Portland CivicApps) (Nambisan & Nambisan, 2013). "Open data" policies on the part of organizations (government, private, and nonprofit) provide the setting for citizen entrepreneurs to discover new opportunities. At the same time, such a process of opportunity discovery is facilitated by new digital infrastructure including data analytics, mobile computing, and social media. Research on the potential interaction effects of digital infrastructure and data policies could contribute to building better theories related to digital social entrepreneurship and also inform on public policies and practices in this area.

In conclusion, with the rapid digitization of products and services across industries, the entrepreneurial opportunities in these markets are also increasingly infused with digital technologies. The digital entrepreneurship research agenda proposed here rests on this

premise. The research questions and issues outlined here would hopefully not only motivate but also guide future research efforts in this area.

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