Dec 12th, 12:00 AM

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Digital Affordances and Digital Capabilities: Evidence from Six AI Startups

Short Paper

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Abstract

Many digital startups fail in their pursuit of niche business value for three reasons: underdeveloped digital affordances, inadequate digital capabilities, and perhaps most importantly, a misalignment between digital affordances and digital capabilities. Digital affordances depict the potential involvement of digital technologies by groups in value creation while digital capabilities represent the ability to leverage and make changes to digital resources to fulfil specific objectives (e.g., affordance actualization). Based on insights derived from a longitudinal in-depth case study of six AI startups, we propose a co-evolution framework that illustrates several iterative loops between digital capabilities and digital affordances. Our analysis also reveals key properties of digital affordances and digital capabilities. Specifically, we find that digital startups with mutually reinforcing digital affordances and digital capabilities are most likely to succeed. We also develop a typology of digital startups using a 2 by 2 affordance-capability matrix.

Keywords: Digital startups, artificial intelligence, digital capabilities, digital affordances

Introduction

Digital startups – new companies that rely on digital technologies to deliver new value propositions or fulfil existing value propositions in innovative ways – experience intense competition and high mortality rates (Cantamessa et al. 2018). Evidence suggests that about 90% of digital startups eventually fail (Kalyanasundaram 2018). To increase the chances of survival, digital entrepreneurs need to know why some business ideas are inherently better than the others, why some startups are more capable of idea validation and execution, and why some startups can repeatedly pivot successfully while others cannot.

We seek to address the questions above by examining how the potential of digital technologies are conceived and pursued to create a business niche – a segment of the broader market that is defined by the unique offerings of the startup. Originating in the information systems (IS) literature, the concepts of digital affordances and digital capabilities are increasingly being used to study how digital technologies affect the outcomes and trajectories of entrepreneurial innovation (Henningsson et al. 2021). In this study, we define digital affordances as action possibilities that are attainable to a startup with the use of digital artifacts for specific goals (Majchrzak and Markus 2012), and digital capabilities as a startup's ability to acquire and mobilize digital resources to support effective business development (Bharadwaj 2000). Digital affordances and digital capabilities jointly define the magnitude of business value that can be realized by a digital

startup. Whereas digital affordances delineate specific digitally-enabled value that a startup can pursue, digital capabilities support the execution needed to validate, create and capture such value (Li et al. Forthcoming). The misalignment between digital affordances and digital capabilities can significantly hinder the development of digital startups (Liu et al. 2022; Majchrzak and Markus 2012).

To date, however, digital affordances and digital capabilities have largely been studied separately in the digital entrepreneurship literature despite their conceptual connections. The two research streams have remained parallel and there is limited discussion of the interplay between digital affordances and digital capabilities. The entrepreneurial journey, however, is not a linear or routinized process. It is iterative and includes unexpected new directions. Either research stream alone is inadequate to provide a complete theoretical explanation of the developmental process of a startup. As digital startups inevitably undergo frequent pivots to radically change or redefine their business niches, scholarly attention is therefore needed to examine the relationships between digital affordances and digital capabilities as well as their co-evolutionary paths in entrepreneurial settings. To help address this significant research gap, this study aims to answer the following research question: *how do digital affordances and digital capabilities mutually influence each other in the course of startup development?*

Based on an in-depth case study of six artificial intelligence (AI) startups over the time span of three years, we inductively develop a co-evolution framework to explain the iterative loops between digital affordances and digital capabilities. The study findings suggest that digital affordances motivate the application, development, assessment, and reconfiguration of digital capabilities, and that digital capabilities facilitate affordance actualization, validation and calibration, as well as new affordance identification. We also find that startups with mutually-reinforcing digital affordances and digital capabilities are mostly likely to succeed. Moreover, our analysis reveals key properties of digital affordances and digital capabilities in an entrepreneurship context. Using these properties as our evaluation criteria, we associate different affordance-capability combinations of startups with their entrepreneurial outcomes, and propose a typology of digital startups using a 2 by 2 matrix.

This study contributes to the digital entrepreneurship literature in two meaningful ways. First, we introduce a co-evolution framework that explains the relation between digital affordances and digital capabilities in an entrepreneurship context. Such a framework provides valuable insights into questions like how a startup's present digital capabilities influence the recognition and prioritization of digital affordances, and how digital affordances shape the development and usage of digital capabilities. Second, this line of research advances scholarly understanding of how digital startups navigate in a hyper-competitive landscape and strategize their digital paths. For example, the dynamic balance between digital affordances and digital capabilities may account for why some digital startups persist in pursuing the same business goals after gaining initial traction, while others continue exploring and expanding the boundaries of their niche markets. The current study also informs practice. Not only can the findings help entrepreneurs foresee the risks and opportunities inherent in digital businesses and address them proactively, but they can also help investors, business incubators, and organizations that want to be more engaged with entrepreneurial innovation assess the underlying qualities of digital startups in an accurate and informative manner.

The remainder of the paper is organized as follows: In the Theoretical Background section, we survey the relevant literature on digital affordances and digital capabilities. After this, we explain our research design and approaches to data collection and analysis. In the Findings section, we present our research framework using a case illustration. We conclude by discussing our future research plans.

Theoretical Background

Digital Affordances

In their seminal paper, Markus and Silver (2008, p. 622) defined the functional affordances of an IT object as the possibilities for goal-oriented actions perceived by specified user groups of the given object. Adapting this conceptualization to the entrepreneurial setting, we define digital affordances as the involvement of a digital technology by user groups in delivering proposed value propositions. While IS scholars hold different views on whether user intentions necessitate affordances and whether an affordance can be both enabling and constraining, they mostly agree that affordance is a relational concept (Majchrzak and Markus 2012; Volkoff and Strong 2017). That is, a digital affordance arises from the relationship between a goal-directed

actor and a digital artifact (Leonardi 2011; Markus and Silver 2008). The existence of a digital affordance is in part determined by the properties of a digital technology, and in part dependent on the goals and capacities of its users (Henningsson et al. 2021; Hutchby 2001; Norman 2013). Some IS scholars suggest that digital affordances can be enacted by actors with or without consciously knowing the presence of these affordances (e.g., Volkoff and Strong 2017). In the present research, we focus on examining digital affordances of which startups are aware and which startups intend to enact to support their niche value creation.

In their affordance-actualization theory, Strong et al. (2014) differentiate the concepts of affordance and affordance actualization. Whereas affordances delineate the possibilities of actions available to a goal-oriented actor through the use of digital technologies, affordance actualization explicates the actions which one takes to achieve goals through the use of digital technologies (Strong et al., 2014). The actualization process is iterative and tightly bounded within its social context (Volkoff & Strong, 2017). In the case of digital startups, for example, we see that they pursue a wide range of distinctive digital affordances associated with unique value propositions, and use different strategies and resources to actualize the digital affordances pursued (Volkoff & Strong, 2017). When specific affordance actualization actions take place, they lead to "immediate concrete outcomes" (Strong et al. 2014, p. 70) which provide the feedback to indicate whether any adjustments are needed for those actions as well as the digital affordance.

Instead of focusing on a single affordance, IS researchers are generally interested in bundles of affordances available to users from one or multiple technologies (Volkoff & Strong, 2017). In general, a high-level, abstract affordance is nested in a network of specific, basic affordances (Burton-Jones and Lee 2017). As such, the actualization of a complex digital affordance often relies on effective actualization of many rudimentary affordances (Volkoff & Strong, 2017). For example, without pooling information on passengers and drivers as well as sharing real-time traffic data, the business value of *Uber* app would be impossible to materialize. Past empirical research implies that the presence of certain digital affordances can increase the value of possibilities associated with a higher-level affordance (Karahanna et al. 2018; Majchrzak et al. 2013; Strong et al. 2014). Leonardi et al. (2013), for instance, found that the copresence of visibility and persistence – two essential affordances of enterprise social media – improves social learning possibilities in workplace, an affordance that can further lead to transformative changes in communication patterns.

More research, however, is needed to study the interdependencies among multiple digital affordances (Volkoff & Strong, 2017). We argue that this line of research inquiry is particularly critical and informative for digital startups. Our reason for making this argument is twofold. First, studying the evolution and connections of digital affordances offers a new angle to explain how a vague idea, step by step, leads to a great business opportunity. A close look into digital affordances based on their interdependencies can provide valuable insights into the deliberation and sequencing of digital affordances in action (Strong et al. 2014). Second, the limited related practical findings on this research topic are mostly based on large, established organizations, and cannot be easily applied to startups (Du et al. 2019). Empirical work is thus needed to test and expand our current knowledge base.

Digital Capabilities

Following the extant literature, we define digital capabilities as the extent to which a startup is able to mobilize and deploy digital resources to effectively support business development in combination or co-present with other resources and capabilities (Bharadwaj 2000; Sambamurthy et al. 2003). According to Yoo et al. (2010), the unique advantages of digital technologies (e.g., the re-programmability that allows a technology perform diverse functions) have led to the emergence of new organizing logics of digital innovation. For example, the *LEGO* group has adopted an open innovation platform to benefit from crowd creativity and improve customer engagement (El Sawy et al. 2016). *Instacart* has built its grocery delivery services based on a mobile network of temporarily idle transportation resources (Deighton and Kornfeld 2015). Facing a variety of readily available, more powerful yet less expensive digital offerings, organizations have come to realize that the game changer in competition is not what digital resources they have, but how proficient they are in leveraging these resources (Li and Chan 2019). Digital startups, in particular, have high demands for digital capabilities, which can be among the very few technological constraints that limit the functions, scope, and market reach of digital offerings (Nambisan 2017).

Digital capabilities are useful in stable business environments but are critical in turbulent ones (El Sawy et al. 2010). Unpredictability and complexity in business environments have long been viewed as drivers of

digital capability development. To understand how digital technologies can help organizations survive and thrive in a hypercompetitive landscape, IS scholars have updated the concept of digital capabilities to address the dynamism faced by modern organizations (e.g., Dong et al. 2009; Mithas et al. 2011; Tan et al. 2015). Lim et al. (2011, p. 47), for example, defined digital capability as a firm's ability to manage digitally-enabled business processes "*in order to align with a rapidly changing competitive environment.*" This sense of adaptiveness in digital capabilities is particularly relevant to an entrepreneurship context (Nambisan 2017). From initial launch to early growth, scaling, and establishment, startups face challenges at an escalating scale and magnitude, and have diverse business objectives to achieve, which inevitably lead to shifting requirements for digital capabilities. While the importance of digital capabilities to modern organizations has been repeatedly demonstrated (Li et al. 2018; Lu and Ramamurthy 2011; Tan et al. 2015), we know very little about the role of digital capabilities in an entrepreneurial setting, not to mention the processes through which startups build, leverage, and refine these capabilities. This research aims to fill this research gap.

Research Design

Following the procedure suggested by Yin (2017), we conduct a longitudinal case study of six AI startups (i.e., new ventures specialized in AI-enabled products and services). AI has become a "general purpose technology" that supports a broad range of business applications (Brynjolfsson and Mitchell 2017). An in-depth analysis of AI startups helps to reveal the general processes through which a digital startup leverages digital technologies to succeed. To ensure a thorough investigation of the focal phenomenon, the current study pays special attention to the digital affordances of AI (referred to hereafter as AI affordances). In this way, we are able to capture how the interplay between AI affordances and digital capabilities step by step lead to the creation of niche value by each sample startup.

A case-based approach is considered appropriate for this study as it focuses on answering questions related to how and why a phenomenon occurs, for theory-building purposes (Eisenhardt and Graebner 2007; Myers 2019). The case study method is particularly useful when investigating a contemporary phenomenon that is hard to investigate separately from its emerging context (Yin 2017). Moreover, this research deploys a multiple-case design, because compared to a single-case design, findings from a multiple case design are often regarded as more robust due to the increased ability to develop generalizable theoretical propositions (Herriott and Firestone 1983; Yin 2017). The methodology of this study is summarized in Figure 1.

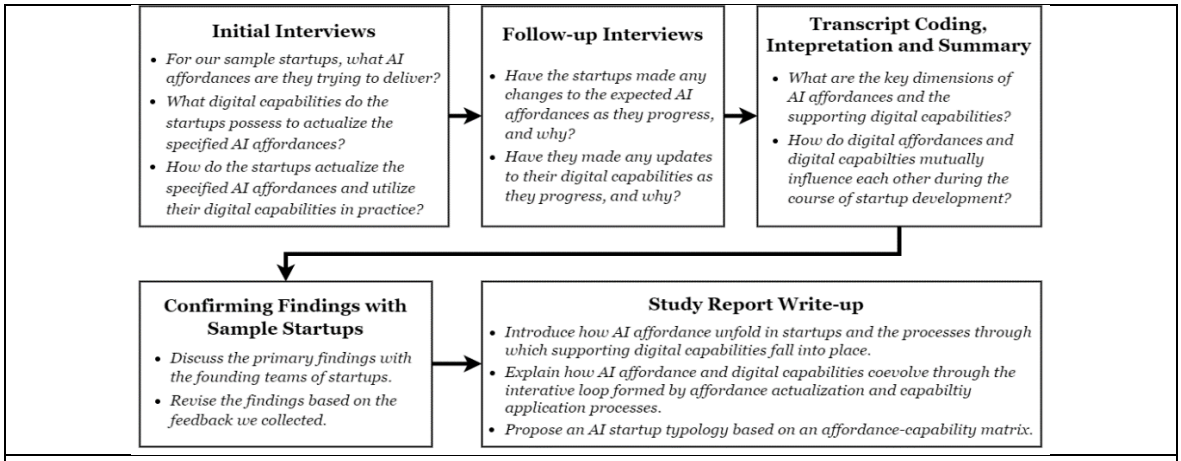

Figure 1. Methodological Procedures of this Study

Instead of writing a case report to summarize findings from each AI startup, we adopted the coding technique of grounded theory approach for data analysis, which has detailed analytical procedures to follow, and allows for the emergence of original and rich findings (Myers 2019; Strauss and Corbin 1998). Our coding of the initial and follow-up interviews is an iterative dialogue between our prior knowledge of the relevant literature and the startup-specific insights (Yin 2017). Adopting the coding procedure suggested by Strauss and Corbin (1998), we use *open coding* to identify concepts and categories in addition to those already identified using prior knowledge, and *axial coding* to develop explanations and gain novel insights

into phenomena of interest (Matavire and Brown 2013; Strauss and Corbin 1998). As we code, we closely capture the connections between digital affordances and digital capabilities, and their evolutionary paths.

This study was funded by the Social Sciences and Humanities Research Council (SSHRC). All six AI startups were recruited from a metropolitan area in Canada, and have been tracked for three or more years. Following the replication logic used in multiple experiments, this study selected AI startups that are expected to generate somewhat similar findings (i.e., a literal replication) in order to derive nuanced insights (Yin 2017). To do this, we established three sample selection criteria: (1) actualized AI affordances that must be directly associated with the business niche, (2) a minimal viable product (MVP) that is available or soon to be available, and (3) a startup that had not yet reached the scaling stage when the initial interview took place. Below, we briefly introduce the six AI startups and their developmental trajectories.

Case Descriptions

Startup A – A live chatbot for customer engagement. The founders developed an interactive and customizable virtual assistant solution to engage customers at each stage of their online shopping journeys. A chatbot application was designed to allow online retailers to collect conversational consumer feedback surveys and replace conventional form-based online customer surveys. Two years after this study began, startup A was acquired by a well-known media and entertainment firm to strengthen its customer analytics.

Startup B – Portable detectors for impaired driving. Advanced by AI-based eye-tracking functions, startup B designed a device to collect an individual's physiological indicators (i.e., eye patterns) based on a series of standard tests. It could then assess if the person was currently impaired due to alcohol or other substances use. Today, it has finished its second prototype which integrates additional standard tests to improve the device's accuracy. The startup has also raised more than one million dollars.

Startup C – A text mining service provider. Startup C leverages machine learning technologies to help advertising agents identify online opinion leaders for target marketing campaigns. The startup developed a text mining algorithm that could automatically analyze data from social media channels, and identify a list of social media influencers who would be most liked or followed by the prospective customer segment. The startup leverages this text mining technique to expand its client base and service portfolio.

Startup D – A provider of a sociable carpooling experience. Startup D targeted college students as potential customers and designed an application to improve users' carpooling experiences by connecting like-minded people. The application deployed algorithmic technologies to match drivers and riders based on user profiles. The startup was recently acquired by another carpooling platform provider.

Startup E – Document extraction for investment analysis and asset management. Startup E offers AI-based software that analyzes financial documents in different digital formats as well as supports automated underwriting processes. Its business expanded to offer application programming interfaces (APIs) to clients. As such, automated document extraction and processing can be performed on the clients' in-house digital infrastructure in order to maintain data confidentiality. The startup is at the scaling stage.

Startup F – An AI shopping assistant. Startup F developed a virtual assistant to help customers find the right size or style of garment in online stores. The virtual assistant could be installed as a web browser extension. Upon the first use, a customer could either enter body measurements or upload a photo of themselves to obtain an estimate of their measurements. The development progress of this prototype was stalled due to an unexpected malfunction of the algorithms.

Findings

Mutual influences between AI affordances and digital capabilities are summarized in Figure 1. We observed multiple rounds of iterations between AI affordances and digital capabilities in all startups in our sample. Our data suggests that neither the actualization of AI affordances nor the application of digital capabilities is a linear process: startups can encounter capabilities gaps and have to pause their affordance actualization while they develop capabilities, or stumble over under-developed affordances that need to be validated or calibrated. We also find that relatively more successful startups in our sample are better than their peers in building a reinforcing loop between AI affordances and digital capabilities. That is, an updated digital capability portfolio developed to actualize a particular digital affordance helps startups identify new digital

affordances, which stimulate another round of capability development. Meanwhile, the loop can also become mutually-constraining if there exists significant misalignment: if an affordance is far beyond the startup's reachable execution ability within a maximum tolerable period, there would be no meaningful capability development or application, resulting in poor affordance actualization.

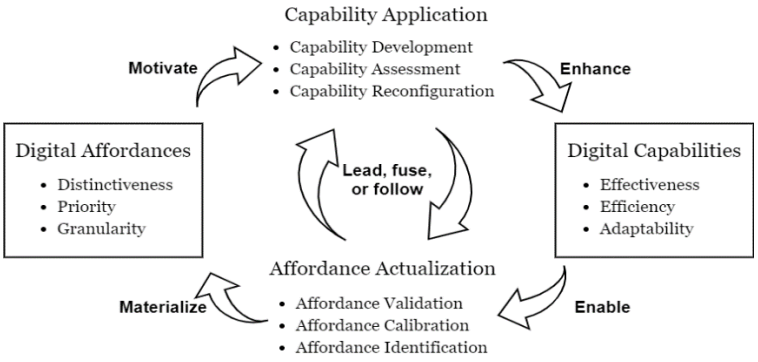

Figure 2. The Co-evolution between Digital Affordance and Digital Capabilities

To explain how digital affordances and digital capabilities co-evolve (i.e., as signaled by changes in properties) through iterations, we report a simplified journey of Startup C as a case illustration in Table 1. Our data reveals three key properties for digital affordances: distinctiveness, priority, and granularity. *Distinctiveness* represents the extent to which a digital affordance can be uniquely actualized by a startup. A digital affordance is regarded as highly distinctive when it can only be actualized by a very limited number of startups. *Priority* refers to the extent to which the actualization of a digital affordance can enhance the actualization of other affordances that are compatible with the goal of niche value creation or constrain the actualization of affordances that are incompatible with the value creation goal. *Granularity* is a concept proposed by Volkoff and Strong (2017). In this study, we define it as the extent to which a digital affordance comprises a collection of other discrete, distinguishable digital affordances. We find that the digital affordances pursued by more successful startups, all possessed relatively high distinctiveness, priority, and granularity, while those pursued by less developed startups were low in at least one of these properties.

Time	Entrepreneurial Actions	Relations to the Framework
t_0	Startup C originally developed text-mining algorithms to identify opinion leaders on social media for online word-of-mouth marketing campaigns.	The affordance recognized by Startup C at t_0 had a high priority because its actualization could directly help Startup C to realize its initial value propositions.
t_1	Startup C went through a very difficult software development journey which involved numerous trial-and-error attempts. Eventually, the startup was able to deliver an MVP that allowed client companies to enter queries and find opinion leaders that met their demands.	The outcomes derived from the actualization of Affordance t_0 triggered capability development, assessment and reconfiguration.
t_2	Initial user feedback suggested the MVP was not very useful as the client companies that got the recommended list of opinion leaders still needed to go through tedious recruitment processes. With improved text-mining expertise, startup C decided to change its target user segments to advertising agencies who readily engage with opinion leaders.	The updated digital capability portfolio (Capability t_1) prompted the validation and calibration of Affordance t_0 to Affordance t_2. The levels of priority and distinctiveness of the affordance became higher.
t_3	One advertising agency interested in the offering of startup C requested that the software must be able to set more sophisticated search criteria than what startup C offered in its MVP, and the software function must be provided through APIs so that the agency can give priority to their contracted opinion leaders without given this critical information away (Affordance t_3).	The actualization of Affordance t_2 entailed a phase of affordance identification. The outcomes obtained from enacting Affordance t_2 *allowed the startup to recognize an additional affordance* t_3 *that could further enhance the niche value creation.* Affordance t_3 is characteristic of the higher levels of granularity and distinctiveness.

Time	Entrepreneurial Actions	Relations to the Framework
t_4	Through many rounds of major revisions, startup C finally established a text-mining platform, where marketing agencies can submit queries and find opinion leaders on major social media channels in real time.	The actualization of Affordance t_3 *triggered the phase of capabilities development* (t_4).
t_5	With the text-mining platform established, startup C realized that they could easily move to adjacent markets where real-time insights from social media channels are appreciated. After careful evaluation of candidate AI affordances, startup C pursued the one that helps clients identify issues (e.g., high churn rates) by analyzing customer experience disclosed through various channels.	The immediate outcomes from the actualization of Affordance t_3 *allowed the startup to identify an additional affordance with a higher level of distinctiveness.*

Table 1. An Illustration of the Iterative Loop

Our study also identifies three key properties of digital capabilities – effectiveness, efficiency, and adaptability – which can be used to assess if a startup's current capability portfolio is adequate to support digital affordance actualization. In the journey of actualization, e*ffectiveness* refers to whether the specific goal associated with a digital affordance can be achieved using the current capability set, *efficiency* represents the ease and speed during goal achievement, and *adaptability* stands for how change-friendly the current capabilities are to accommodate new or revised goals.

We differentiate three sub-processes that may occur during affordance actualization. *Affordance validation* refers to the process through which a digital startup assesses and confirms the outcome obtained from an occurrence of affordance actualization. *Affordance calibration* takes place when a startup fine-tunes the elements characterizing a digital affordance for improved actualization possibilities or outcomes. *Affordance identification* occurs when a startup is made aware of a new digital affordance. Although digital affordances can be actualized in an intended or an unintended manner (Volkoff & Strong, 2017), we suggest that the awareness of digital affordances is likely to evolve as digital startups engage in actualization actions and generate concrete outcomes. In the current study, we suggest that the newly recognized affordances may enhance or hinder the actualization of other digital affordances pursued by the startup. We also find three sub-processes that accompany the application of digital capabilities by startups: the *development of new capabilities* for affordance actualization, the *assessment of the current capability portfolio* based on affordance actualization outcomes, and the *capability reconfiguration efforts* when new arrangements of digital capabilities may generate better actualization outcomes (often the results of capability assessment).

Our study findings suggest that digital startups can be affordance-driven or capability-driven at the ideation stage, but to sustain growth, they will eventually reconcile and bolster digital affordances and digital capabilities. Startup B, for example, set off to achieve a very noble AI affordance (i.e., integrating AI algorithms to a portable device to detect impaired driving), and was later forced to hire more computer engineers to bridge digital capability gaps during MVP development. With a stronger programming team, startup B not only developed the first MVP in time, but also discovered additional product features that have been incorporated. With input from their initial clients, they prioritized and refined their understanding of two of the most-wanted features and incorporated them in their second MVP. Another example is Startup E. The founder is an expert on AI-based document extraction technology, and the business started as an attempt to commercialize this capability. Through many rounds of digital affordance identification, validation and calibration, startup E gained initial traction in the field of legal documents (e.g., leases) underwriting commercial real estate companies.

A Typology of Digital Startups

Our initial findings confirm two necessary conditions for entrepreneurial success: well-defined digital affordances and well-developed digital capabilities. Both conditions are context-specific, and their adequacy may change over time as startups strive to meet emerging business demands. Using the key properties of digital affordances and digital capabilities as evaluation criteria, we develop a typology of digital startups based on a 2 by 2 matrix (see Figure 3). We argue that misalignments between digital affordances and digital capabilities can result in two types of below-optimum startups: the *visioners* who have identified distinctive digital affordances but fail to develop adequate digital capabilities, and the

executers who have impressive digital capabilities but fail to identify and calibrate digital affordances for best actualization outcomes.

Startup F is, based on this typology, a visioner. With the founder's expertise in both the fashion and computing industries, the company aimed ambitiously to develop a virtual assistant that recommends stylish garments with accurate sizing information based on photos uploaded by customers. Although each desired function of the virtual assistant seemed technically attainable, realizing the functions and integrating them to work cohesively turned out to be an impossible mission. Neither was the company able to progressively update its digital capability portfolio to address the need for sophisticated affordance actualization, nor was it able to calibrate the digital affordances to be more granular and more executable. The progress of startup F has been stalled for over six months as we write this paper.

Startup A is a typical executer. Although the core product of this company is also a virtual assistant, startup A has a much narrower focus compared with startup F. The company pursed a very specific set of digital affordances: providing real-time and meaningful customer feedback solutions for the hospitality industry. Its MVP leverages AI-based algorithms to collect, process and analyze consumers' conversational survey answers. After the initial traction was developed, startup A soon became an expert in AI-based conversational agents and created an exclusive hospitality industry database. The company, however, did not parallel its affordance exploration and validation efforts with a strengthened digital capability portfolio, and missed the opportunity to unleash the full potential of its analytic power. With no new revenue streams established, the company experienced a bottleneck to growth and was acquired by an established company.

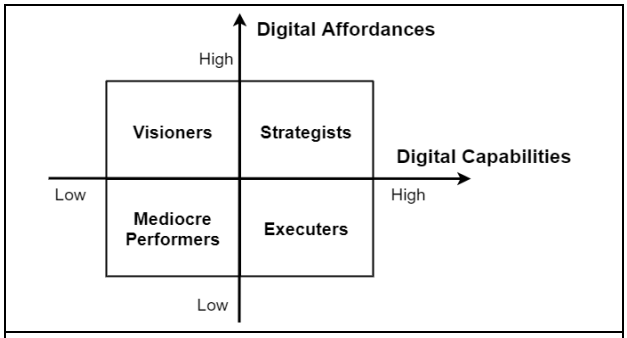

Figure 3. A Typology of Digital Startups

Conclusion

This paper presents preliminary findings of an ongoing research project. The purpose of the current project is to advance our understanding of the interplay between digital affordances and digital capabilities in an entrepreneurial setting. Using longitudinal data collected from six AI startups, we inductively develop a co-evolution framework that illustrates the impact and process of digital affordance and digital capability iterations. Our findings suggest that startups must align their efforts of digital affordance actualization and digital capability development for sustained growth. Moving forward, we will continue to study the development of AI and other digital startups, and report these expanded findings in future publications.

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