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Disentangling the Digitality of Startups from an Enterprise Architecture Perspective

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Full research paper

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Abstract

In this paper, we pick up the recent discourse on "digital x" and advance the field of digital entrepreneurship by disentangling the digitality of startups from an enterprise architecture (EA) perspective. In doing so, we provide a taxonomy based on the development process of Nickerson et al. (2013) and Kundisch et al. (2022) to better distinguish between startups with a high and a low degree of digitality. Here, by drawing on architectural layers, related design objects, and their dependencies, we differentiate between two primary (i.e., distinctive) and three secondary (i.e., supportive) dimensions of digitality. Finally, we demonstrate the taxonomy's applicability to real-world startups.

Keywords: digital entrepreneurship, digital startups, digital technologies, enterprise architecture

1 Introduction

In today's shift from entrepreneurship to digital entrepreneurship, digital technologies (DT) open up a wide range of opportunities for startups to innovate and transform entire business models as well as to exploit (global) business opportunities by developing or improving products and services (Von Briel et al. 2018; Kollmann et al. 2022; Nambisan 2017; Sahut et al. 2021). At the same time, DT hold the potential to "fundamentally shape all aspects of organizing" (Bailey et al. 2022, p. 1) by enabling new opportunities for collaboration and innovation both internally (e.g., by supporting cross-departmental and agile collaboration) and externally (e.g., by supporting customer engagement) (Bailey et al. 2022; Chan et al. 2020). Therefore, DT, such as cloud computing, blockchain, digital platforms, 3D printing, artificial intelligence (AI), and the Internet of Things (IoT), can be classified in terms of their function (i.e., application or infrastructure) and scope (i.e., "cyber" or "cyber-physical") (Baier et al. 2023).

Due to the symbiosis between DT and the venture creation process, the question arises as to what makes startups digital. More specifically, the terminological heterogeneity of "digital x" and "information technology (IT) x" found in the tension between digitalization and digitization is echoed in the recent academic discourse (Baiyere et al. 2023; Rodriguez and Piccoli 2018). Here, in contrast to the comparatively narrow focus on DT of the digitization approach, a socio-technical perspective on digitalization is proposed that looks at the "broader individual, organizational, and societal context" (Legner et al. 2017, p. 301). This aligns, among others, with the article of Wessel et al. (2021), in which they distinguish between digital and IT-enabled transformation, as well as with the view of Ross (2017), who argues that "digitization is an important enabler of digital, but all the digitization in the world will not, on its own, make a business a digital company." However, the definitions and the inclusion and exclusion criteria (e.g., underlying digital artifacts, technologies, and infrastructure) used to define the "digital" in digital startups are manifold and lack a common understanding.

With our study, we aim to address this research gap and propose to disentangle the notion of "digital" in the startup realm by advancing the understanding of "degrees of digitality" through an EA lens. By holistically viewing the organization and its environment and by paying special attention to the alignment of business and IT (Aier and Winter 2009; Bui 2017; Kurnia et al. 2021; Simon et al. 2013), EA provides a solid basis for opening the black box of "digital" and for clarifying startups' degree of digitality by offering well-established concepts, frameworks, and relevant design objects. Thus, to advance the field of digital entrepreneurship and the digital x discourse, we followed the taxonomy design process of Nickerson et al. (2013), which was extended by Kundisch et al. (2022). In this context, the following research question served as the guideline for our study:

How can we leverage the EA perspective for disentangling the digitality of startups?

2 Theoretical Foundations

The discourse on "digital x" and "IT x" provides a general understanding of the terminological diversity of "digital" while highlighting the need for an unified terminological basis in theory and practice (Baiyere et al. 2023; Rodriguez and Piccoli 2018). To point out the advantages of disentangling startups' digitality from an EA perspective, we provide an overview of existing concepts and definitions from the digital entrepreneurship literature as a first step. Then, we present an overview of the current state of EA research as well as its frameworks and definitions to develop a better understanding of related EA layers and design objects as a basis for developing the taxonomy.

2.1 Existing Concepts for Disentangling Startups' Digitality

Definitions of digital entrepreneurship (e.g., Kollmann et al. 2022; Nambisan 2017) and DT (e.g., Baier et al. 2023; Vial 2019) provide initial insights about how to classify startups in terms of their digitality from a technology perspective. For example, Kollmann et al. (2022) present nine interchangeable terms to describe the phenomenon of digital entrepreneurship, thereby noting the relevance of DT. Moreover, Baier et al. (2023) provide a taxonomy that allows for a better understanding of what constitutes DT by classifying a total of 92 DT. They distinguish DT in terms of their role and scope, which provides useful insights into the relevance of these technologies for disentangling startups' digitality. The prominence of DT in this context is often reflected by their importance for infrastructure- and business model-related aspects (Nambisan et al. 2019; Steininger 2019; Veit et al. 2014). Here, digital infrastructure can be defined as "digital technology tools and systems [...] that offer communication, collaboration, and/or computing capabilities to support innovation and entrepreneurship" (Nambisan 2017, p. 1032). From a business model perspective, Veit et al. (2014, p. 48) define a business model as digital "if changes in DT trigger fundamental changes in the way business is carried out and revenues are generated." Moreover,

Steininger (2019) builds on the three business model pillars (product/service, infrastructure management, and customer interface) from Osterwalder et al. (2005) to define digital business models and startups.

However, while these approaches contribute to disentangling the "digital" in digital startups by grounding the term in a long list of diverse DT, the heterogeneity of classifications leaves some blurriness. Furthermore, business-IT alignment and DT pervasion are not addressed, although these play an important role in the digital evolution of startups.

2.2 Digital Startups from an EA Perspective

An EA view of the organization and its environment demonstrates the significance of DT for startups in its socio-technical intertwining with internal and external business processes (e.g., cross-departmental collaboration, customer and supplier interaction), business units, strategic goals, etc. This view also highlights the importance of aligning business with IT and paying special attention to the interdependencies of architectural layers (Aier and Winter 2009). In this context, architecture represents "the fundamental organization of a system, embodied in its components, their relationships to each other and the environment" (Institute of Electrical and Electronics Engineers Computer Society, 2000, p. 3).

Bui (2017), Haki and Legner (2021), and Rahimi et al. (2017) provide up-to-date overviews of the scope of EA and of influential publications, underlying definitions, frameworks, and design objects (artifacts) in this field. EA frameworks, such as the Open Group Architecture Framework (The Open Group 2018) and the Federal Enterprise Architecture Framework (Chief Information Officers Council 2013), offer practical guidance on aligning business with IT. Moreover, Bui (2017) makes a distinction between business (organizational structures, strategies, and models) and technical (hardware and software infrastructure) EA layers, while Winter and Fischer (2006) distinguish between business, process, integration, software, and technology (or infrastructure) layers. Here, key elements from the business model perspective (e.g., a view on products/services and customers) are taken into account and extended by more deeply considering the organization and its environment as well as technology and process dependencies. Bradley et al. (2011) and Ross (2003) highlight different stages of EA maturity, thus indicating the relevance of business–IT alignment for startups and the taxonomy development process. The EA perspective helps to overcome a purely technical understanding of "digital" by stressing the need to also consider the complex intertwining of DT with the organization. Hence, it adds a socio-technical perspective for disentangling startups' digitality while providing a structured approach to incorporate related design objects and their dependencies in this process.

3 Taxonomy Development Process

We aim to disentangle the "degree of digitality" of startups from an EA perspective for advancing the discourse on "digital x" (Baiyere et al. 2023; Rodriguez and Piccoli 2018) and its implications for classifying digital startups. For this purpose, we followed the extended taxonomy design process of Kundisch et al. (2022), which builds on the taxonomy development method of Nickerson et al. (2013) and the design science research method by Peffers et al. (2007). As taxonomies represent "classification systems that help researchers conceptualize phenomena based on their dimensions and characteristics" (Kundisch et al. 2022, p. 421), adopting this approach allows us to better distinguish between startups with a high degree of digitality and those with low digitality. Moreover, the iterative nature of the method, which includes multiple conceptual-to-empirical and empirical-to-conceptual cycles, grounds theory building, where theory is understood as "a set of constructs linked together in relationships that are supported by theoretical arguments (i.e., mechanisms) that seek to explain a focal phenomenon" (Eisenhardt 2021, p. 148).

To avoid a large number of (un)related characteristics and, thus, "naive empiricism" (Nickerson et al. 2013), we sought for "digital" in an entrepreneurial context as a meta-characteristic, meaning that "all the following characteristics and dimensions of the taxonomy must relate to this meta-characteristic" (Kundisch et al. 2022, p. 429). Regarding the definition of ending conditions, the method will end when "both objective and subjective conditions have been met" (Nickerson et al. 2013, p. 348). Here, the objective ending conditions entail that no new dimensions or characteristics were added in the last iteration and that no dimensions or characteristics were merged or split in the last iteration. The subjective ending conditions are met when the taxonomy is concise, robust, comprehensive, extendible, and explanatory. However, when considering the multitude of potential dimensions that emerge during the iterations, it is important to note that robustness must be considered in its tension with the need for integration, which puts greater emphasis on other subjective ending conditions, such as conciseness and

extendibility. Finally, the evaluation goal is to classify startups' degree of digitality, as "characteristics and dimensions serve as a scheme to classify" (Kundisch et al. 2022, p. 432).

3.1 Design and Development

In designing and developing the taxonomy, we went through five iterations (conceptual-to-empirical/ empirical-to-conceptual). During this procedure, we constantly revised the taxonomy by adding, updating, and deleting characteristics and dimensions based on new empirical and conceptual insights.

Iteration I: By following a conceptual-to-empirical approach, we started to screen relevant literature from the IS, entrepreneurship, and general/strategic management disciplines. We searched the databases for peer-reviewed articles in high-ranked journals (table 1) and selected conference proceedings, such as the *International Conference on Information Systems* and the *European Conference on Information Systems*, with "digital" in their titles, focusing on the term's association with "entrepreneurship," "startups," "SMEs (small- and medium-sized businesses)," "business models," "infrastructure," and "technologies." In addition, we conducted a backward reference search to create a more comprehensive overview of existing (and relevant) definitions, concepts, dimensions, and characteristics for disentangling startups' digitality.

Information Systems	**Entrepreneurship**	**General/Strategic Management**
European Journal of Information Systems	Entrepreneurship: Theory and Practice	Academy of Management Journal
Information Systems Journal	Journal of Business Venturing	Organization Science
Information Systems Research	Strategic Entrepreneurship Journal	Journal of Management
Journal of Information Technology	International Small Business Journal	Strategic Management Journal
Journal of Management Information Systems	Journal of Small Business Management	Administrative Science Quarterly
Journal of the Association for Information Systems	Research Policy	Management Science
Journal of Strategic Information Systems		
Management Information Systems Quarterly		

Table 1. Selected Journals Included in the Review (Adapted from Steininger, 2019)

Besides benefiting from this body of knowledge, this process allowed us to consider pertinent literature reviews whose "primary purpose [was] to synthesize and interpret the body of literature in a given domain" (Schryen et al. 2017, p. 557). For instance, Steininger (2019) describes typical co-occurrences of IT use in entrepreneurial business models to distinguish between digital, IT-mediated, IT-facilitated, and IT-bearing startups. By picking up the articles of Wessel et al. (2021) and Baiyere et al. (2023), distinctive characteristics were later integrated into the taxonomy, for example reflected in the "digitality of processes." While this first iteration served as a sound basis for developing the taxonomy from a technology and business model perspective, qualitative attributes, such as robustness and explainability, were not met in this iteration.

Iteration II: We continued with an empirical-to-conceptual approach. In this iteration, we drew on two entrepreneurial organizations from a former interdisciplinary three-year research project on digital entrepreneurship in which we collaborated with 21 local companies. Despite having developed a comprehensive dataset of the architectural layers of company α, supported by additional insights from company β, there was still no conceptual clarity to serve as a basis for a concise classification of startups' degree of digitality. An overview of the companies examined in the empirical-to-conceptual iterations (II and IV) can be found in table 2.

#	F*	Industry	Country	E*	Interview(s)/ Discussion(s)	Secondary/Archival Data (Selected)	I*
α	2009	Marketing	GER	150	2 x CEO (I & D) 1 x CEO (I) 4 x Manager (I) 1 x Employee (I)	Rich business process and EA descriptions from the three-year research project; multilevel workshops on digital transformation strategy with two out of four CEOs responsible for IT and operations	II
β	2015	Electronics	GER	85/35*[1]	CFO (I) COO (D)	Rich descriptions of digital transformation-related challenges, lecture presentations, and discussions with the COO on strategy and IT	II
γ	2017	Accounting	NZ	65	CEO (I)	Press reports, website, financial and funding statements, and social media posts	IV
δ	2015	Energy	USA	42	COO (I)	Documentation of technology approach, software and system architecture, and platform roadmap	IV
ε	2019	Logistics	EST	40*[2]	Cofounder (I)	Press reports, website, and financial and funding statements	IV
ζ	2018	Education	FRA	40	CEO (I)	Press reports, website, product descriptions, financial and funding statements, and social media posts	IV

= Company; F* = Founded; E* = Number of employees (end of 2021); *[1] = Highest number of employees vs. end of 2021; *[2] = end of 2022; I* = Iteration

Table 2. Sample of Companies Examined during the Iterations

Iteration III: We proceeded with a second conceptual-to-empirical approach, paying greater attention to the discipline of EA as it provides a structured approach to viewing startups from a technological, business, or organizational perspective. Here, we screened the literature in search of EA definitions, concepts, theoretical boundaries, and design objects in selected IS journals (table 1) as well as journals and conferences from related fields (e.g., *Business and Information Systems Engineering*, *International Enterprise Distributed Object Computing Conference*). Again, we performed a backward reference search. Moreover, we used layers and design objects from the EA discipline to inspire and develop our interview guideline for the following iteration as we sought to enrich the taxonomy through (technological) dependencies across layers. When aligning dimensions from the technology and business model perspective with EA layers and related design objects, for example, the articles by Fritscher & Pigneur (2011) and Petrikina et al. (2014) provided a deeper understanding of underlying conceptual similarities and differences. In this process, we gave greater consideration to organizations' (EA) maturity (Bradley et al. 2011; Ross 2003) and the integration layer in terms of business-IT alignment, which was later added to the taxonomy as a secondary dimension. Although a large number of related EA design objects proved suitable for classifying the digitality of startups, some of them (e.g., "location" and "roles") were only peripherally useful for that purpose; thus, they were excluded from further taxonomy development.

Iteration IV: Next, we conducted four additional semi-structured interviews with top managers of rapidly growing startups of varying ages, sizes, and nationalities as part of another empirical-to-conceptual approach. In the following, we provide a brief overview of these companies and their digital specifics.

Company γ: This software-centric company was selected due to its salient "digital-first" approach. Another reason was the company's need for a high degree of integration in its (agile) software development and sales activities. Moreover, the company's almost seamlessly integrated cloud infrastructure met the demands for flexibility and scalability during phases of rapid growth.

Company δ: This hardware-centric company was selected due to its strong business–IT alignment, a choice that builds on EA principles. At the same time, the company exhibited a high degree of DT pervasion in payment processing (blockchain) and platform development (cloud technology); it was also significantly supported by crowdfunding initiatives. This deepened the understanding of the importance of digital infrastructure integration and of the supporting role of DT in enhancing the business.

Company ε: This software-centric company was selected because it operated (almost) entirely virtually. The company did not have an office; customer meetings that demanded being physically present were held in coworking spaces or cafés. Moreover, the company showed a high degree of artificial intelligence (AI) know-how aimed at product development.

Company ζ: This enterprise was selected because it was able to operate fully digitally from the outset and showed a high degree of DT use (e.g., virtual reality, blockchain). Its business model was based on the development and offering of IT micro-certificates. Moreover, its highly integrated cloud infrastructure enabled increased reliance on data-driven decisions concerning product evaluation.

The semi-structured interviews supported the validation of the dimensions by offering a broader perspective on the use of DT in product development and operations (from a process perspective), leading to greater consideration of EA in the design of the taxonomy. Moreover, this provided useful insights on the cross-layer dependencies of business and technology from an EA perspective.

Iteration V: To ensure that both objective and subjective ending conditions had been met (Nickerson et al. 2013), we conducted another conceptual-to-empirical approach. Here, we repeated the classification of startups' degree of digitality by applying the taxonomy to the companies from iterations II and IV. In doing so, we were able to classify all the companies in terms of their degree of digitality based on their products/services and internal/external processes (primary dimensions) as well as to link the secondary dimensions to support the primary ones. Doing so provided a more detailed view of the organizations' degree of digitality.

Finally, we developed a taxonomy that met the objective and subjective ending conditions.

3.2 Demonstration

In table 3, we present an overview of which objective and subjective ending conditions were (not) met in each iteration and why. Moreover, we provide details of major changes during the taxonomy development process. By building on degrees of digitality as characteristics, we ensure that the elements are mutually exclusive and collectively exhaustive.

I*	A*	D/C*	Major Changes	EC* Selection (Not Exhaustive)
I	C2E	3(+7)/ 1(+)5	Three primary dimensions from the business model pillars (product, customer [interface], and infrastructure management); seven secondary dimensions (e.g., key activities, value proposition, and partner); degree of digitality as main characteristic (with five digitality degrees [extensive to absent]); second-level grouping of dimensions	Subjective ending conditions not met: - not concise (not meaningful without being unwieldy or overwhelming) - not comprehensive (not all dimensions identified) - not robust (not enough to be of interest)
II	E2C	4(+8)/ 1(+5)	Adding one primary dimension (DT usage) and one secondary dimension (software integration)	Subjective ending conditions not met: - not explanatory (classification is impeded by a lack of descriptions)
III	C2E	5(+9)/ 1(+4)	Adding EA layers as primary dimensions (e.g., business, organization, and software) and integrating dimensions from the business model perspective; integrating degrees of digitality (low and absent) and adding definitions	Subjective ending conditions not met: - not concise (enough) - not explanatory (enough) Objective ending conditions not met: - adding and merging dimensions

IV	E2C	2(+3)/ 1(+4)	Consolidating product(s)/service(s) and internal/external processes as primary dimensions; digital infrastructure integration as secondary dimension (from integration layer); adding (relative/ domain-specific) DT pervasion to support a deeper understanding of the digitality of the primary dimensions; adapting definitions	Objective ending conditions not met: - merging and splitting primary dimensions of digitality
V	C2E	2(+3)/ 1(+4)	No further taxonomy modifications	All subjective and objective ending conditions met

I* = Iteration; A* = Approach (C2E = conceptual-to-empirical; E2C = empirical-to-conceptual); D/C* = Dimensions/ Characteristics; EC* = Ending conditions

Table 3. Details of the Iterative Taxonomy Development Process (Adapted from Baier et al., 2023)

3.3 Evaluation and Communication

The evaluation of the final taxonomy, as well as of its previous versions, took place during the whole taxonomy development process and across all iterations. From the second iteration, as part of the interdisciplinary research project on digital entrepreneurship, digitality was examined from different angles, continuously scrutinized, and dimensionally and characteristically revised in the taxonomy. We conducted multiple discussions with researchers from related disciplines, such as organizational science, general/strategic management, entrepreneurship, and IS; these were enriched by discussions with students in related courses, which fed into the taxonomy development process. At the same time, cross-regional startups and SMEs offered in-depth, practical insights into their organizational structures and use of DT, which allowed us to refine the dimensions and characteristics. Later iterations of the taxonomy and its elements were presented in (international) research colloquia and validated through exchanges with other researchers from the EA field acting as evaluation partners.

4 Findings

In this section, we present the taxonomy developed during the five iterations (table 4) and apply the taxonomy to two of the startups in our sample (table 5).

To disentangle the digitality of startups, we differentiated between primary (i.e., distinctive) and secondary (i.e., supportive) dimensions of digitality. Here, we drew on existing concepts (i.e., digital from a technology and business model perspective) and their underlying characteristics from the digital entrepreneurship literature, as well as on the notion of architectural layers and related design objects.

First, by giving special attention to the business architecture, we distinguished between two primary dimensions (products/services and internal/external processes). This highlights differences in the digital nature of products (e.g., developing/producing physical goods/products in contrast to developing software products or virtual games) and services (delivering "traditional" or online services), and the degree to which internal/external processes are digitized (compared to "paper-based" processes). Second, with regard to the integration and technology architecture as secondary dimensions, the a) degree of digital infrastructure integration and b) (relative) DT pervasion (of products/services and internal/external processes) supports the classification of startups' digitality by giving greater relevance to the symbiosis of technology- and business-related activities. In this context, the degree of digital infrastructure integration (e.g., to enable data-driven decisions for the placement of marketing campaigns or the co-creation of products) highlights the need of aligning business with IT. Accordingly, startups that offer traditional goods or services can also exhibit a high degree of digitality when considering the secondary dimensions of digitality (e.g., through an advanced/extensive degree of DT pervasion). In contrast, startups that exhibit an advanced degree of digitality in their products do not necessarily rely on an integrated digital infrastructure (e.g., to align software development activities with other business processes due to cross-departmental customer projects) or use DT to support their business (e.g., relying on data-driven decisions enabled by AI).

		Degrees of Digitality (Characteristics)			
		Absent/Low	**Moderate**	**Advanced**	**Extensive**
Business Architecture (Primary Dimensions)	**Products/ Services**	(almost) no product/service is digitized	some products/ services are digitized	most products/ services are digitized	(almost) all products/services are digitized
	Internal/ External Processes	(almost) no processes are digitized	some processes are digitized	most processes are digitized	(almost) all processes are digitized
Integration Architecture (Secondary Dimensions)	**Digital Infrastructure Integration**	(almost) no internal/external process is digitally integrated (e.g., to support business needs such as data-driven decision-making or cross-departmental collaboration)	some internal/ external processes are digitally integrated (e.g., to support business needs such as data-driven decision-making or cross-departmental collaboration)	most internal/ external processes are digitally integrated (e.g., to support business needs such as data-driven decision-making or cross-departmental collaboration)	(almost) all internal/external processes are digitally integrated (e.g., to support business needs such as data-driven decision-making or cross-departmental collaboration)
Technology Architecture (Secondary Dimensions)	**(Relative) DT Pervasion: Products/Services**	(almost) no product/service is complemented by DT (e.g., 3D printing, IoT, drones, digital twins, virtual/augmented reality, virtual assistants)	some products/ services are complemented by DT (e.g., 3D printing, IoT, drones, digital twins, virtual/ augmented reality, virtual assistants)	most products/ services are complemented by DT (e.g., 3D printing, IoT, drones, digital twins, virtual/ augmented reality, virtual assistants)	(almost) all products/ services are complemented by DT (e.g., 3D printing, IoT, drones, digital twins, virtual/ augmented reality, virtual assistants)
	(Relative) DT Pervasion: Internal/ External Processes	(almost) no internal/external process is supported by DT (e.g., AI for data-driven decision-making, cloud computing to support digital collaboration)	some internal/external processes are supported by DT (e.g., AI for data-driven decision-making, cloud computing to support digital collaboration)	most internal/external processes are supported by DT (e.g., AI for data-driven decision-making, cloud computing to support digital collaboration)	(almost) all internal/external processes are supported by DT (e.g., AI for data-driven decision-making, cloud computing to support digital collaboration)

Table 4. Taxonomy of Start-Ups' Digitality

While the classification of startups' digitality by products/services (e.g., based on the value proposition/ product pillar of business models) and processes (e.g., based on key activities/ customer interface pillar of business models) is widely used, we deepen this view by adding secondary dimensions which pay special attention to the layers of EA. In addition to considering the business and technology architecture and related design objects, we highlight cross-layer dependencies ("integration layer") against the backdrop of the prominence of business-IT alignment in IS research and propose to add the degree of DT pervasion (relative to other businesses in the domain). In contrast to the categorization of the startups' digitality by the three business model pillars, we retain the product pillar, introduce an internal and external process perspective (which includes the customer interface), and give greater attention to business-IT alignment in terms of digital infrastructure integration. Finally, four degrees of digitality

(absent/low, moderate, advanced, extensive) indicate the different characteristics of the respective primary and secondary dimensions to accommodate the digital nature of products/services, the digitization of internal/external processes, and the evolution of digital in general.

Table 5 illustrates the importance of adding secondary (i.e., supportive) dimensions to the primary (i.e., distinctive) dimensions by providing a deeper understanding of what makes a startup digital.

	Company β	**Company ζ**
Products/ Services	Absent to low: selling tech and lifestyle products that contain (almost) no "digital elements"	Extensive: platform-driven delivery of IT micro-certificates supported by gamification
Internal/External Processes	Extensive: besides "blue collar activities," the company had the ability to operate (almost) fully remote due to highly digitized processes	Extensive: the company had the ability to operate fully remote due to highly digitized processes
Digital Infrastructure Integration	Advanced: while some software silos existed, most internal/ external processes were sufficiently integrated (e.g., to support the co-design of products with suppliers and to enable comprehensive data-driven decisions)	Extensive: the company's modularized approach (in terms of software solutions embedded in the digital infrastructure) significantly supported cross-departmental collaboration and to efficiently integrate the operations of its subsidiaries
(Relative) DT Pervasion: Products/Services	Absent to low: (almost) no product was complemented by DT	Extensive: (almost) all products were complemented by DT (e.g., virtual reality, blockchain).
(Relative) DT Pervasion: Internal/External Processes	Moderate: some of the processes were supported by DT (e.g., AI (experiments) for evaluating product performance, cloud computing for co-creation)	Extensive: (almost) all processes were supported by DT (e.g., blockchain for payment processing, cloud computing for co-creation)

Table 5. Exemplary Application of the Taxonomy

5 Discussion and Limitations

From a theoretical perspective, we advance the field of digital entrepreneurship in two ways. First, we enrich the discourse on digital x by adding "degrees of digitality" to the ontological foundations of digital(ity) in an entrepreneurial context. Here, we link the digitality of startups to EA by considering common layers (business, integration, and technology architecture), related design objects, and their dependencies. Second, with our taxonomy, we provide a direction for how startups can be classified in terms of their degree of digitality while addressing the inherent terminological heterogeneity of the term "digital." Here, we extend the discourse on digital x by introducing primary and secondary dimensions of startups' digitality. In addition, from a practical perspective, this paper supports drawing a line between different types of digital startups as it highlights that companies offering physical goods can also vary in their digitality and being considered as "digital startups."

This study has also some limitations. First, from a methodological perspective, it seems promising to develop the literature review systematically and to include "grey literature" to gain a deeper understanding of existing concepts. Moreover, to demonstrate the validity of the taxonomy dimensions, this may be supported by more empirical data (e.g., in-depth case studies or interviews) of startups from different national systems of innovation and of different ages, growth stages, and sizes. Second, from a terminological perspective, further research in the entrepreneurial context may enrich our findings through a more integrated and, thus, holistic perspective of digital and IT. In this context, consideration can be given to quantifying the dimensions of digitality related to maturity models (e.g., 0 = absent/low; 1 = moderate; 2 = advanced; 3 = extensive), and to what extent an above-average score across all dimensions contributes to the classification of a digital startup, or not. Third, given the increasing accessibility of DT (e.g., cloud technology) for startups, this leads to the question whether startups with

an advanced/extensive degree of digitality in products/services can operate without an advanced/extensive degree of digitality in internal processes (searching for the "black swan").

Finally, we suggest three fruitful avenues of future research on digital startups and, thus, on digital entrepreneurship. First, as DT hold the potential to permeate entire organizations and their ecosystems, it seems important to further examine startups' digital or IT-related challenges (e.g., aligning business with IT or building an integrated digital infrastructure that supports scalability and flexibility) at different stages of growth. Second, due to the availability of best practices as well as the embedding in entrepreneurial ecosystems (e.g., startups guided by venture capitalists or angel investors), it is interesting to question whether all future (high growth) digital startups are, on an abstract level, technologically identical and what influence regional and national systems of innovation, and globalization have on this. Third, when digital startups grow rapidly, socio-technical tensions may arise which may be examined in more detail from an EA perspective. This can provide practical guidance for startups while enriching the fields of IS, organization science, and digital entrepreneurship.

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