All Things Considered? – Technology Design Decision-making Characteristics in Digital Startups

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Completed Research Paper

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Abstract

Digital startups offer innovative products, for which they require a suitable technology solution. Choosing an appropriate technology design among the range of available designs is crucial, as the wrong design decision could have disastrous consequences for product development and quality, and waste valuable resources. While the literature has highlighted the role played by the decision context, little is known about 'how' technology design decisions are reached in digital startups. Using an exploratory research design, we investigate how technology design decisions are made in digital startups, and identify decision-making characteristics, consisting of three decision paradigms and seven decision attributes. Our empirical evidence suggests that in addition to the decision context, these decision-making characteristics play an important role in enabling digital startups to reach satisfactory technology design decisions. Our study thus lays the basis for more research on the topic, contributing to knowledge and practice of digital startups.

Keywords: Digital Startups, Technology Design, Decision-making Characteristics, Multi-case Study

Introduction

Digital startups need to make fundamental design choices in order to be able to offer innovative digital products and services. One of the most essential decisions involves choosing an appropriate technology design (e.g., a set of concrete technologies, programming languages, components, and frameworks) with which to implement a technological foundation comprising an architecture, interfaces, and the interrelations between them (IEEE, 1990; Yoo et al., 2010). Yet, technology design decisions are fraught with complications. First, at the time of their foundation, digital startups have to make technology design decisions based upon an incomplete understanding of the needs of the customer, the exact solution to be built, and how a potential solution will be received by customers. Second, there are many technology design alternatives to choose from, each with its own capabilities and qualities, which require time to be analyzed. Third, digital startups are embedded in an environment characterized by uncertainty with regards to the market development, the competitive landscape, and technological advances (Packard et al. 2017; Steininger 2019), which makes it more difficult to weigh up the alternatives. Fourth, and an aggravating fact is that, once a technology design has been adopted, it inherently outlines and to some extent even restricts the space of what can be built, as well as creates dependencies that are not easy to resolve (Kraus et al. 2019; Paternoster et al. 2014). Unsurprisingly, then, technology design decisions constitute a landmark decision for any digital startup and hence cause for concern not only for entrepreneurs but also for the investors that finance them:

> *"A related problem [...] is choosing the wrong platform. For example, I think, a lot of startups during the Bubble killed themselves by deciding to build server-based applications on Windows. Hotmail was*

still running on FreeBSD for years after Microsoft bought it, presumably because Windows couldn't handle the load. If Hotmail's founders had chosen to use Windows, they would have been swamped. [...] Platform is a vague word. It could mean an operating system, or a programming language, or a "framework" built on top of a programming language. It implies something that both supports and limits, like the foundation of a house. [...] Java applets were probably the most spectacular example. This was supposed to be the new way of delivering applications. Presumably it killed just about 100% of the startups who believed that."

– Paul Graham (2006), Co-Founder Y Combinator

The literature on technology designs has found that design choices have a considerable impact on the ability of digital startups to grow into viable businesses that gain visibility very quickly (van der Ven and Bosch, 2013a). As the examples quoted above show, when the wrong (or poor) technology designs have been chosen, it has profound consequences for product development and quality, cause delays with product releases – all of which are able to cause digital startups to fail (Klotins et al., 2018). Therefore, defining an appropriate technology design plays a vital role in the development of new products and services early in the life of digital startups (van der Ven and Bosch 2013a). Especially for first-time entrepreneurs, technology design decisions in the face of such uncertainties are a challenge, considering their limited experience, as well as limited resources and time at hand. They have to decide, for example, who to involve in the design decisions, how much time to spend on conceptualizing technology design alternatives, and how to review them – in other words, they have to configure the characteristics of their decision-making process, aiming for high decision effectiveness (Dean and Sharfman 1996). The literature on decision-making highlights the importance of two factors underpinning decision effectiveness: (1) the configuration of decision-making characteristics (i.e. how a decision is being made), and the (2) decision context (i.e. external factors that cannot or only hardly need to be changed, but influence the decision) (Dean and Sharfman 1996; Thywissen 2015). Yet, up to now, the digital startup literature has only considered the decision context (e.g., dealing with uncertainty, a dynamic competitive landscape and ongoing technological change) which is held responsible for low decision-effectiveness of technology design decisions in digital startups (Giardino et al., 2014; Paternoster et al., 2014; Klotins, Unterkalmsteiner and Gorschek, 2018). The influence of specific decision-making characteristics and their configurations during technology design decisions is largely neglected, yet it is also a crucial factor for decision-effectiveness. As highlighted by Razavian et al. (2019), the question of how design decisions are being made is generally under-researched, and Unterkalmsteiner et al. (2016) particularly stress the need to understand design decisions in the digital startup context. Using an exploratory research design, we aim to address both gaps, and provide a first empirical basis on the subject of technology design decision-making characteristics and their configuration in digital startups through a multi-case study. Hence, we ask the following research question: *How are technology design decisions made in the context of digital startups?*

With this, we aim to contribute not only to design literature (Razavian et al. 2019; van der Ven and Bosch 2013b) but also to the understanding of managing technology uncertainty in digital startups (Unterkalmsteiner et al., 2016; Bohn and Kundisch, 2018). Once the decision-making characteristics of technology design decisions and their configurations are uncovered, technology design decisions in digital startups can be better understood and evaluated. Based on such insights, research could further investigate how decision-making characteristics should ideally be configured, so that digital startups select technology designs that help them achieve their goals and grow into viable businesses. Such insights also help entrepreneurs in evaluating their own decision-making characteristics during the technology design decision process (Unterkalmsteiner et al., 2016).

Background

Digital Startups

Digital startups aim to develop innovative digital products and services which serve unmet or newly revealed customer needs (Edison et al., 2018), frequently responding to technology or market opportunities (Unterkalmsteiner et al., 2016). Simultaneously, digital startups search for scalable and repeatable business models, which are suitable for their digital products and services (Ries 2011). With these, they aim to address high-potential target markets rather than individual clients (Paternoster et al. 2014). Startups commonly have very limited resources at their disposal, which creates time-pressure, and limits their understanding about the customer need and the required solution (Paternoster et al. 2014). Additionally they act in a context of absolute uncertainty (Packard et al. 2017), very volatile markets, competitive environments and technological landscapes that can experience disruptive trends (Paternoster et al. 2014; Steininger 2019). For these reasons, their environment includes many "unknown and unknowable" complications during the venture creation process (Packard et al. 2017, p. 845). Steininger (2019, p. 383) defines digital startups as new ventures that "use IT in the role of a ubiquity, meaning that they leverage completely IT-driven and digital business models for their value creation and capture" including that their products and services are digitally sold and delivered. Any changes that are being made to the digital products and services offered can require changes to design choices, as well as to customer interaction channels (Steininger 2019). As a result, growing into viable businesses does not solely depend "on the business itself, but rather on the architectural and technology decisions" (Kraus et al. 2019, p. 20).

Entrepreneurial Decision-making

Following Hastie (2002, p. 657) "decision-making refers to the entire process of choosing a course of action". This includes understanding the decision topic, i.e. the actual problem that needs to be solved, assessing which alternatives exist, building a rationale for each individual alternative, as well as for the preferred solution, and concluding the decision-process with making a choice (Hastie 2002). As such, decision-making explains 'what' is being done in order to determine a course of action. The way it can be performed differs, depending on the configuration of so-called decision-making characteristics (Sarasvathy 2001), which can be intentional or unintentional. Decision-making characteristics are part of the decision process and explain 'how' a course of action is determined. For example, the same decision-making process can comprise decision-making characteristics that either lead to a rash or a thoroughly considered decision. Similarly, decision-characteristics can, for example, create an encouraging or an obstructive attitude towards decision-making (Shepherd et al., 2015).

Decision-making characteristics can be differentiated into decision paradigms and decision attributes. Decision paradigms refer to the "general evaluation and choice behavior through which a decision is taken" (Thywissen 2015, p. 75), while decision attributes characterize the individual configuration of parameters, such as involvement, formalization, decision speed, and behavior patterns. Several decision paradigms have been identified and discussed with regards to strategic decision making in general and entrepreneurial decision-making in particular, including but not limited to causation, effectuation, bricolage, intuition and rationality (Eisenhardt and Zbaracki 1992; Fisher 2012; Sarasvathy 2001). Furthermore, decision-making characteristics have a decisive influence on decision effectiveness. Decision effectiveness describes "the extent to which a decision achieves the objectives established by management at the time it is made" (Dean and Sharfman, 1996, p. 372). Dean and Sharfman (1996) consider decision effectiveness to be a dimension of decision-making, since differently configured decision-making characteristics can result in different choices, each of which having a distinct influence on decision effectiveness. Such decision-making characteristics can then result in choices that are not suitable for the attainment of the desired goals. Thus, through a configuration of decision-making characteristics, decision effectiveness can be significantly influenced (Dean and Sharfman 1996).

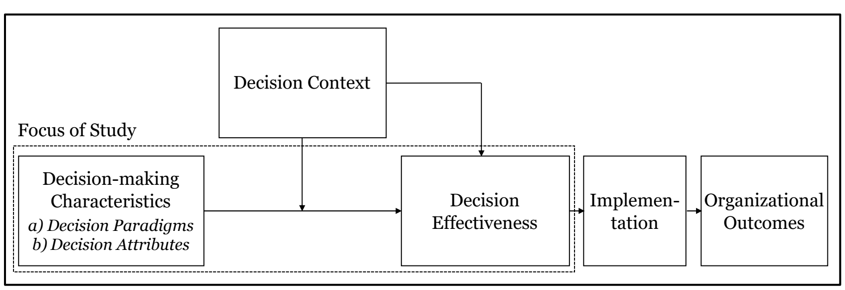

Figure 1. Influences on Decision Effectiveness (based on Thywissen (2015))

With regards to entrepreneurial decision-making, the literature has analyzed a wide range of fundamental decision types (Shepherd et al. 2015) including, but not limited to, (1) opportunity assessment decisions, (2) entrepreneurial entry decisions, (3) opportunity exploiting decisions, and (4) exit decisions. For each of these decision types, decisions have to be made on an operative level, and each can be configured individually by applying the decision-characteristics. With our study, we focus on the process of decisions made on the operative level subsequent to the exploitation decision in digital startups, i.e., the technology design decision. It is important to note here that we do not focus on another dimension of decision-making, i.e., the decision context (cf. Figure 1). The decision context includes, for example, the organizational environment, technological changes, or the competitive landscape (Dean and Sharfman 1996), all of which can influence the decision-effectiveness of entrepreneurial decisions (Busenitz and Barney 1997; Mullins and Forlani 2005). However, unlike the decision characteristics, the decision context is not directly controllable or adjustable. Although not part of our study, it is important to note that the decision context and the decision-making characteristics must ultimately be viewed together and that the decision context also has an effect on decision effectiveness.

Technology Design Decision-making

The technology design of digital startups represents the foundation for the products and services to be developed. It is concerned with the selection of "concrete technology solutions" (Soliman et al., 2016, p. 128), including identifying and selecting individual technologies, programming languages, components and frameworks (Razavian et al. 2019). Digital startups can choose from a variety of technology alternatives, which requires developing an understanding of each as well as investigating their respective benefits and drawbacks, before an evaluation and selection becomes feasible (van der Ven et al. 2011). The alternatives typically include choosing between (1) in-house self-developed components, and (2) external components such as open-source technologies or purchasing ready-made components from a third party supplier (Unterkalmsteiner, Gorschek and Klotins, 2018). The design choice should aim to present the best solution to the problem at hand, given its context (van der Ven and Bosch, 2013b). Put succinctly, the technology design decision enables and supports the development of appealing products and services of digital startups (IEEE, 1990; Abrahamsson et al., 2016). Once made, the technology design decision has a huge impact upon – among others – the feasible functionality, performance, and resilience of the final design, and can result in economic as well as technological constraints (Abrahamsson et al. 2010). It has been found that design decisions "accumulate and interact in such a way that whenever a decision needs to be revised, other design decisions may need to be reconsidered as well" (van Gurp and Bosch 2002, p. 106). Thus, technology design decisions are landmark decisions for digital startups, as they commit significant resources, substantially define the internal product structure, and set boundaries for future decisions.

Technology design decisions typically happen early in the life of digital startups, and the successful development of the product and the business model depend on them (Abrahamsson et al. 2010). Decisions have to take into account not only current goals but also the future evolution of the components and the potential occurrence of technological alternatives. Both aspects are fraught with uncertainty for digital startups (Unterkalmsteiner et al., 2016). The ability to assess design options is therefore crucial and, for digital startups, the challenge to define a design which allows to build a first product often "precedes any market or business-related difficulties" (Klotins et al. 2019, p. 1). Errors made in the technology design generally have a huge impact on a company's success (van der Ven et al. 2011). This is because low decision effectiveness can result in valuable resources being wasted, and complicate the efforts invested in developing and marketing the product and building a sustainable business (Klotins et al. 2019). An aggravating factor is that these decisions are commonly made by first-time entrepreneurs, i.e., those that have no prior experience in defining a technology design under the uncertainties and complications described above. Even if the entrepreneurs have prior experience of working as an IT professional, such positions would typically have involved far less uncertainty than is the case for digital startups because they would have been working to clear requirements from company stakeholders. The effectiveness of a decision becomes apparent very soon after the decision is made (van der Ven and Bosch, 2013b). Paternoster et al. (2014) recommend that, as part of the initial technology design decision, technological complications likely occurring before product revenue is achieved should be identified, and any potential redesigns delayed until after first revenues have been generated. The design decision should further integrate design practices and components that enable an extension of the design, resulting in a product that is resilient in the face of known uncertainties.

Although several decision-making characteristics have been identified in the entrepreneurship context in past research, it remains unknown which characteristics are specifically relevant for decision-making in technology design. A recent literature review on empirical research about design decision-making identified 38 relevant studies (Razavian et al. 2019). Of these, only one includes a research question explicitly addressing decision-making characteristics. In their study, Tofan, Galster and Avgeriou (2013) analyze two characteristics of design decisions in large enterprises through a survey-based approach, i.e., how long design decisions take and who is involved. They found that design decisions take on average 35 days and include about three parties directly and seven more indirectly. However, in contrast to our study, their research design was neither exploratory nor inductive, did not cover all relevant technology design decision characteristics, or was focused on the specific digital startup environment.

To summarize, the decisions made for technology designs play an important role for the ability of digital startups to grow into viable businesses. Considering the difficulties inherent in this decision, understanding the decision-making characteristics seems all the more important, especially as they can actively be configured. However, up to this point, the decision-making characteristics of design decisions in digital startups remain largely unknown, and research into the topic is needed (Paternoster et al., 2014, and Unterkalmsteiner et al., 2016). This paper aims to shed light on how technology design decisions are made in digital startups. In particular, we aim to explore the factors influencing the effectiveness of design decisions other than the contextual factors already explained in digital startup research. This can lead to theory development about technology design decision-making and reveal existing limitations of technology design decisions. Such knowledge can further support digital startups and the practitioners who coach them.

Method

In contrast to the literature on entrepreneurial decisions that typically aims to provide specific insights on one particular decision-making characteristic through one study (Shepherd et al. 2015), we aim to discover a set of decision-making characteristics relevant during technology design decision-making and their configurations observable in digital startups. This set of decision-making characteristics then aims to represent a reference for future research on the subject. Due to the nascent state of design decision-making characteristics in digital startups as a research area, an exploratory inductive research design has been chosen. We decided to conduct a multiple-case study, which is suitable in a research context where it is important to ask open-ended questions to gain a deep understanding of the subject (Gioia et al. 2012). It allows an in-depth investigation into how design decisions are being made and to compare findings across digital startups to increase the external validity of the results. In particular, decision-making is rarely documented in an entrepreneurial context due to limited resources and fast pace of the sector. By obtaining primary data, we can uncover the configurations of decision-making characteristics in order to find out 'how' technology design decisions are being made.

Data Collection

For digital startups to be included in our study, they had to fulfill the following eligibility criteria: they had to be first-time entrepreneurs who, after having decided upon their first technology design had subsequently implemented their choice. These criteria provided a comparable data basis with regards to the startup stage and prior experience, since "entrepreneurs are heterogeneous in the amount and nature of their experiences, and these differences have an impact on entrepreneurial decision-making" (Shepherd et al. 2015, p. 33). Lacking experience in handling uncertainty, the technology design decision is all the more challenging for first-time entrepreneurs, allowing us to explore the complications associated with this decision. The cases were selected to achieve theoretical saturation (Corbin and Strauss 1990) by investigating a broad variety of design decision-making characteristics that form part of technology design decisions in digital startups with different types of digital products, business models (i.e., business-to-business [B2B], or business-to-customer [B2C]), industries, and financing (Bhattacherjee 2012). While these differences support investigating a broad variety of technology design decision-making characteristics, the role played by any of these specific factors or differences on decision-making lies beyond this study. However, our approach paves the way for more research on the subject to investigate potential differences among decision characteristics.

As the first step of the data collection, we composed a semi-structured interview guide. In order to remove any ambiguities, feedback from two researchers was collected and used to improve the topic guide. We then conducted two pilot interviews to gain a first understanding of the subject and the results. After this, the interview guide was further refined through sub-questions which allowed to ask more detailed and specific questions (provided as an online resource: https://go.upb.de/5h4n) (Gioia et al., 2012). In a second step, we conducted seven more semi-structured interviews with first-time entrepreneurs, primarily those with technical responsibility (i.e., Chief Technology Officers), to collect primary data on their individual decision-making characteristics. All interviewees were young professionals aged between 20 and 30, with a university degree in computer science, and some prior experience of working in professional software engineering positions (between 1-4 years). In our interviews, we chose to focus on the description of the technology design as an introduction to talking about the design decision-making characteristics. We did not extensively question technical details, but focused on the decision-making characteristics and their configuration. In total, we conducted nine interviews with digital startup entrepreneurs, each of which covering one technology design decision (cf. Table 1). The interviews had an average length of 39 minutes, were recorded and transcribed in full (totaling about 57,500 words).

Case	Year Est.	Financing	Status	Business Model	Industry	Product Type
A	2016	Venture Capital	Maintenance	B2B	Gaming	Software-as-a-Service (SaaS)
B	2014	Venture Capital	Closed in 2018	B2C	FinTech	SaaS
C	2011	Venture Capital	Active	B2C & B2B	Transportation	Marketplace & Mobile App
D	2017	Venture Capital	Active	B2B	Entertainment	SaaS & Mobile App
E	2011	Bootstrapping	Active	B2B	Health	Standalone Software
F	2016	Bootstrapping	Active	B2C	Education	SaaS
G	2018	Bootstrapping	Active	B2C	Office Tools	SaaS
H	2015	Bootstrapping	Active	B2B	Real Estate	SaaS
J	2018	Venture Capital	Active	B2B	Marketing	SaaS

Table 1. Case Studies in this Study

Data Analysis

Our analysis of the transcribed interviews is structured following the procedure for inductive exploratory research by Gioia et al. (2012). They suggest an iterative approach to data analysis and theory building that involves moving back and forth between data and theory based on 1-st order analysis, 2n-order analysis, and aggregate dimension building. Further, we followed the guidelines for constant comparison techniques (Glaser and Strauss, 1967), using the qualitative analysis software Atlas.ti to support this procedure. Next, we describe the four steps that allowed the concepts, themes and aggregate dimensions to emerge, as well as their relationships, which constitute our findings. First, we started our analysis by highlighting and assigning 1st-order codes to transcribed passages that contained relevant information about design decision-making characteristics and their configuration, sticking closely to the words of the interviewees. Additionally, we highlighted evaluative statements about perceived decision-effectiveness. We initially developed an extensive number of 1st-order codes, which we then discussed and refined iteratively, while we also consolidated redundant codes (Gioia et al. 2012). This led us to a final set of 77 1st-order codes assigned to all the statements made about technology design decisions. Throughout this first step, we started to observe the reoccurrence of individual characteristics and to understand their importance for the technology design decision-making process of first-time entrepreneurs.

Second, we continued by actively seeking similarities and differences among the 1st-order concepts. Based on this analysis, we grouped 1st-order concepts to identify and develop relevant 2nd-order themes describing the decision-making characteristics configuration. Throughout this step, we iterated between our empirical data and the literature on technology design and software engineering in digital startups to interpret the data based on existing contributions. This step is described by Gioia et al. (2012, p. 20) as becoming “knowledgeable agents”. Through this, our research switched from a purely inductive approach to an abductive approach. In a cross-validation process among one author and a research colleague, the themes were iteratively refined and relations within and between cases identified, to ensure the result were robust and reliable.

Third, after a workable set of 32 2nd-order themes was achieved and theoretical saturation reached, we further analyzed and distilled our findings into seven aggregate dimensions. Once the dimension had been aggregated, we had they basis for building a data structure (cf. Figure 2). Here, the aggregate dimensions represent the decision-making characteristics and the 2nd-order themes their identified configuration. The full data structure is provided as an online resource: https://go.upb.de/5p8q. Based on this data structure, we then derived our findings about the configuration of technology design decision-making characteristics as presented in the next section. Our data structure further provides an illustration of how we processed raw interview data into concepts and themes throughout the analysis, demonstrating the rigor of this qualitative research design (Gioia et al. 2012).

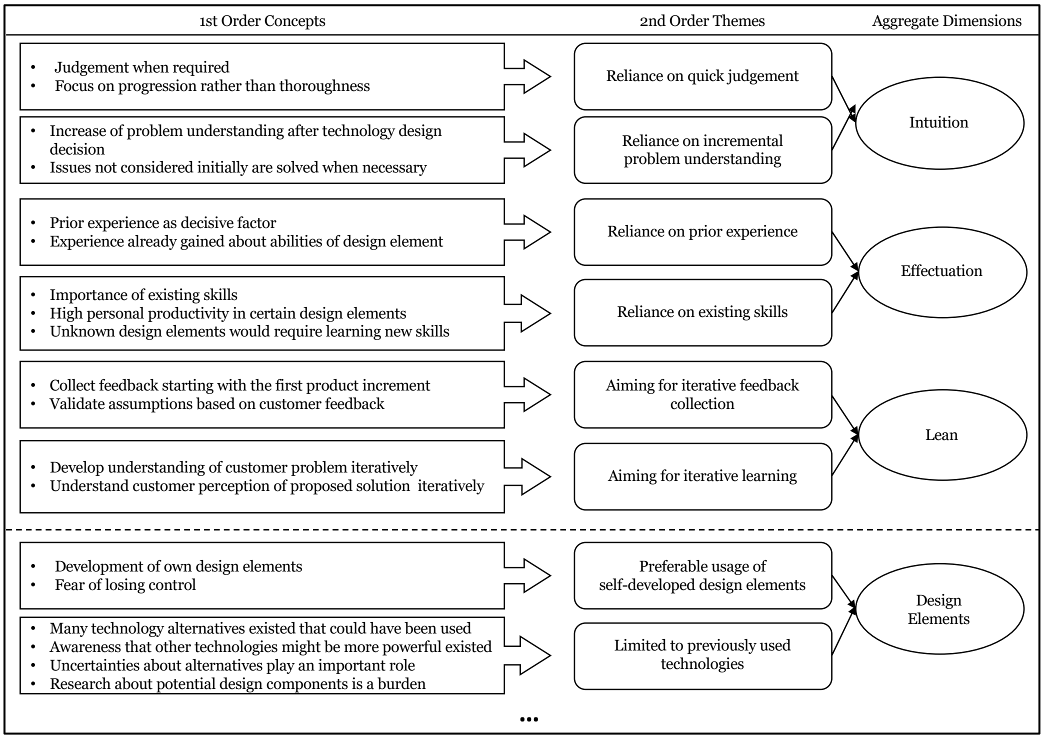

Figure 2. Data Structure Excerpt (Full Data Structure: https://go.upb.de/5p8q)

We then derived the perceived decision effectiveness influence for each of the configurations of the decision-making characteristics based on the statements initially highlighted. For this, we assigned labels to the statements made about each configuration item that indicated whether they either supported, had a neutral influence, or worsened the perceived decision effectiveness. For example, a configuration item was considered supportive for the perceived decision effectiveness when the interviewees used positive statements (such as "it was important", "had a positive impact", "I believe that was right" – among others) or argued in favor of a particular configuration item. Similarly, when interviewees used negative statements (such as "we should have instead", "I wasn't aware", "there was a lack of" – among others) or argued against a particular configuration item, it was considered to worsen perceived decision effectiveness. When neither positive nor negative statements were made, the influence was deemed neutral.

2nd-order themes and 1st-order codes	Representative Quotes
Overarching Dimension: Design Elements	
1. Preferable usage of self-developed design elements	
A. Development of own design elements	A1. "Because in a startup you tend to do everything yourself" – Case C A2. "We also build the data management ourselves" – Case D
B. Fear of loosing control	B1. "It's a kind of a stupid abstract fear that if you include something already existing, that you have no control over it and at some point this will become problematic" – Case H B2. "I just feel safer knowing what the technology actually does. If I choose a lot of open source components, then either I don't know or I have to invest a lot of time to get an understanding" – Case F
Overarching Dimension: Design Requirements	
2. Emphasis on bringing first product to market quickly	
C. Realize short time to market	C1. "That was the result of the Time-to-Market pressure, so you had to choose" – Case C C2. "We said, we need to have something fast" – Case D
D. Obtain first usable product fast	D1. "The very first goal was to have a finished product, which you can test very quickly, and go live" – Case D D2. "We have taken some shortcuts in the design selection. That was good because we quickly had a product that we could show. So that was good" – Case H

Figure 3. Illustration of 1st-order Code Assignment to Direct Quotations

Furthermore, in order to ensure the high quality of our study results, we applied the criteria by Lincoln and Guba (1985), paying close attention to internal validity, external validity, reliability, neutrality and authenticity. For internal validity, we used theoretical replication as a case study selection approach. For external validity, we provided detailed information about the coding approach and descriptions of the analysis. In Figure 3, representative quotes and 1st-order codes are displayed, on the basis of which 2nd-order themes and aggregate dimensions were developed. For reliability, we used theoretical sampling (Glaser and Strauss, 1967), in which the sample is not fixed from the outset, but is progressively selected against the background of the study until theoretical saturation is reached, i.e., new insights are no longer generated. We also aimed to include heterogeneous cases to achieve a broad coverage of the subject under investigation. For neutrality, we explicitly separated 1st order concepts and 2nd-order themes and discussed data per case and across cases with a researcher that was otherwise not involved in this study. This allowed to resolve disagreements about individual codes. For authenticity, we provide information about the individual cases and interviewees above (cf. Table 1).

Findings

As a result of analyzing our dataset we were able to identify the decision-making characteristics of technology design decisions separated into three decision paradigms and seven decision attributes.

Decision-making Characteristics

Among the decision paradigms, we found indications for the use of intuition, for effectual and for lean thinking (Ries, 2011; Sarasvathy, 2001). Among the decision attributes we identified distinct attributes ranging from the considered set of design elements to the parties involved. A description of each of the identified decision-making characteristic is provided in Table 2. Their relations are displayed in Figure 4 and explained in the respective paragraphs of each decision characteristic below.

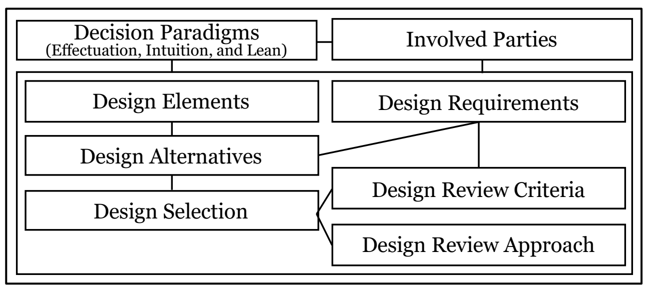

Figure 4. Technology Design Decision-making Characteristics

Decision Paradigms and Attributes Configuration

We identified 32 2nd-order themes that represent the configurations of the identified decision paradigms and attributes (cf. Table 2). The configuration of each of the decision paradigms and attributes is explained in detail in the following, along with its influence on the perceived decision effectiveness and illustrative quotes from our collected data. We also indicate whether the configurations of the decision paradigms and attributes supported (+), had a neutral influence (○), or worsened (-) the perceived decision effectiveness. All direct quotes were translated by the authors from the interviewees' native language.

Intuition: We found that intuition, i.e., the subconscious processing of information without recourse to reasoning, is widely applied by entrepreneurs throughout the decision-making process in the form of 'reliance on quick judgment' combined with 'incremental problem understanding'. This was particularly noticeable when the technology design decision-making was limited in scope and took place over a relatively short space of time. While reliance on quick judgement was evaluated as neutral by our interviewees, an 'incremental understanding of the problem' was seen as complicating the technology design decision:

> *"I think our design decision had happened relatively quickly. We sat down together, we said, do we want to build this company, do we want to start this venture and how can we do that?" – Case A*

Effectuation: We found that the technology design decisions were mostly driven by effectuation logic, in which the means currently obtained, i.e., the 'existing skills' and knowledge about individual design elements and 'prior experience' provide an important anchoring point and serve as a main reference (Sarasvathy 2001). Obtaining new knowledge and skills about unknown design elements is not desired at this point and the application of effectuation logic was generally viewed positively with regards to the perceived decision effectiveness. This means that digital startups start with the means they have and work towards a goal not yet fully understood. This stands in contrast to intuition, which focuses on how information is processed during a decision, while effectuation focuses on the means that are considered to form part of the decision-making.

> *"I just didn't know anything else. [...] if there had been a requirement that we do it in another technology, that would have meant for me that I would have had to get trained in something. That wasn't the main goal at the time, I don't know if I would have wanted that at that point." – Case F*

> *"So my impression is that really important factors are always 'what do I know' and 'what am I familiar with'. These should not be underestimated." – Case E*

In this regard, aspects such as positive and negative 'prior experience', personal productivity in different technologies, as well as skills and knowledge about individual design elements all play a crucial role.

> *"Back then, I was just super productive in this technology, and I knew right away that there was a solution or there was a problem and [...] I knew all the steps I had to take to get a solution." – Case B*

> *"I've done similar things in PHP before, for another platform, so that I was able to assess whether based on the building blocks that it provides, whether it would be feasible." – Case F*

Decision-making Characteristics		Description
Decision Paradigms	Effectuation	A decision-paradigm describing the reliance on a set of means and skills available at the point of decision-making based on which a decision is made among alternative results that can be created with that set of means and skills, without obtaining any additional means and skills unavailable at the point of decision-making (Sarasvathy 2001).
	Intuition	A decision paradigm referring to decision-making without much deduction or reasoning, recognizable by relying on quick judgment but incomplete information. In which "a non-sequential information processing mode" is applied, combined resulting in "direct knowing without any use of conscious reasoning" (Sinclair and Ashkanasy 2005, p. 353).
	Lean	A decision paradigm describing the aim to continuously collect customer feedback and iteratively learn about unknowns (Ries 2011).
Decision Attributes	Design Elements	The set of technologies (e.g., programming languages, frameworks, components, i.e., the technological building blocks) under consideration in the definition of technology design alternative (IEEE 1990). It ranges from the consideration of a wide variety of technologies to a narrow selection thereof.
	Design Requirements	The condition or capability requirements considered to achieve an objective during the technology design decision (IEEE 1990). The aim is that the chosen technology design satisfies the requirements.
	Design Alternatives	The properties leading to the generation and definition of different technology design alternatives, each consisting of a set of design elements (IEEE 1990).
	Design Review Approach	Approaches, methods, and techniques used to critically review technology design alternatives and present them to personnel, customers, or other interested parties for comment or approval (IEEE 1990).
	Design Review Criteria	The criteria considered to review individual design alternatives (IEEE 1990).
	Design Selection	The configuration of the final choice making, as a result of the decision-making, and which determines the course of action.
	Involved parties	The general or temporal involvement of internal and external parties in the technology design decision-making process.

Table 2. Identified Decision-making Characteristics of Technology Design Decisions

Lean: We further found that lean thinking is clearly observable in technology design decision-making. It was evident in the form of 'aiming for iterative learning' about the customers' problems and their perception of potential solutions. Furthermore, 'aiming for iterative feedback collection', to validate assumptions and gain feedback, starting with the first product iteration, show strong overlaps with lean principles (Ries 2011). Both of these are considered conducive for the perceived effectiveness of a decision.

> *"How can we reach a result as quickly as possible that we can show to the customer [...]. To identify what the customer wants to see is important." – Case H*

> *"It was our goal to see whether the solution brings added value. Do we get a positive reaction to what we have created?"* – Case F

Design Elements*:* As part of the technology design decision, a 'preferable usage of self-developed design elements' was observable. This preference is driven by the aim to come to a design decision rather quickly and start the product development process as soon as possible, while ignoring maintenance costs and complications related to self-developed design elements that would occur further down the line. This initial preference is considered to negatively affect decision effectiveness.

> *"Because in a startup you tend to do everything yourself." – Case C*

> *"We even built the data management ourselves." – Case D*

Self-developed design elements were also preferred independently of whether external alternatives already existed because external design elements were associated with a fear of losing control.

> *"It's a kind of a stupid abstract fear that if you include something already existing, that you have no control over it and that at some point it will become problematic."* – Case H

In sum, a reluctance to use design elements beyond those previously known shapes significantly how the design decision is being made.

> *"Looking beyond the end of your nose means that you first have to familiarize yourself with technology alternatives and thus lose time." – Case J*

Decision-making Characteristics		2nd-order Themes: Configuration "Technology Design Decision"	Configuration Influence on Perceived Decision Effectiveness
Decision Paradigms	Intuition	Reliance on quick judgment	○
		Reliance on incremental problem understanding	-
	Effectuation	Reliance on prior experiences	+
		Reliance on existing skills	+
	Lean	Aiming for feedback collection	+
		Aiming for iterative learning	+
Decision Attributes	Design Elements	Preferable usage of self-developed design elements	-
		Limited to previously used technologies	○
	Design Requirements	Reliance on vision as baseline for requirements	+
		Emphasis on bringing product to market quickly	+
		Enable fast development speed	+
		Iterative product development	+
		Continuous collection of feedback	+
		Usage of non-discardable technology design	-
	Design Alternatives	Consideration of limited design alternatives	+
		Implicit design alternative generation	-
	Design Review Approach	Reliance on desk research	○
		Reliance on prototyping	+
		Negligence of design review	+
	Design Review Criteria	Emphasis on agnosticism	+
		Emphasis on maturity	+
		Emphasis on data layer	+
		Negligence of system quality attributes	-
	Design Selection	Decision despite uncertainties	○
		Selection without consequence awareness	-
		Single decision-maker	-
		Selection under pressure	-
		Short decision time	-
		Neglecting documentation about design selection	-
		Decision without guidance	-
	Involved parties	Limited internal parties	-
		Limited external parties	-

Table 3. Identified Configuration of Decision-making Characteristics of Technology Design Decisions and Their Influence on Perceived Decision Effectiveness

Design Requirements: We identified that how design capabilities were considered is an important part of the overall decision-making characteristics configuration. Technology design decisions show a 'reliance on the vision as a baseline for requirements', from which functional requirements are derived. Overall, the configuration of the design requirements decision attribute is considered conducive to decision effectiveness.

> *"In the beginning it was quite clear that we have a product vision and for this we need to build a specific product. It was clear that we needed a website and that it should be a single page application." – Case A*

Lean Startup principles (Ries 2011) provide further technology design requirements, such as 'bringing a first product to market quickly', 'enable fast development speeds', and an 'iterative product development', with the goal of 'continuous collection of feedback' and an increase in problem understanding:

> *"So for us the most important point back then was how can we achieve progress as fast as possible as a small team [...] we looked at ways that allow us to have fast development cycles." – Case E*

Yet, in our sample, the technology designs were explicitly designed as 'non-discardable' and were not to be replaced once crucial learnings were generated.

> *"Back then I thought differently about starting the whole application over again. You should have a prototype first, and the prototype remains a prototype [...] but what was done is that the prototype got developed further and further." – Case B*

Design Alternatives: We found evidence for the 'consideration of limited design alternatives' of technology designs. The generation of alternatives is very limited in scope and effort and in our sample consisted almost exclusively of 'implicit design alternative generation'.

> *"So it was, I don't think, an explicit design. The only explicit design considerations were, as I said, at the database level." - Case C*

The considered design elements and given design requirements guide the generation of design alternatives. Justifications for extensive research into design and conceptualization alternatives is difficult to communicate among founders, and discussions about design alternatives are either limited or non-existent.

> *"You have to explain it [design effort] every time [...], because they [the co-founders] kind of expect somebody to hit the keys somehow, for a period X, and at the end of period X the development is done. It's just hard to convey [...] that after period X only the design answer comes out, we use this or that. [...] The development output is expected much more directly" – Case B*

Instead, design alternatives are being defined mainly as part of thinking-through potential technology designs, based on the prevailing design elements and design requirements. This process is limited in time, with the aim to progress quickly. It also lacks an explicit visualization of the design alternatives.

> *"I don't think I had the time and although I learned it, I didn't have the time to say, oh stop, now you have to... [...], I would have to stop and stand at the whiteboard. You have them [the technology design alternatives] in your brain already." – Case C*

While considering a limited number of design alternatives was seen as supporting the perceived decision effectiveness, conducting an implicit conceptualization of design alternatives was considered negative.

Design Review Approach: The digital startups in our sample reviewed technology design alternatives predominantly based on two approaches, 'desk research', i.e., by reading who else has used a similarly defined design and what their experiences were, as well as by 'prototyping' to evaluate design behavior.

> *"We researched and read reports of experiences, [but] I'm sure that we haven't talked to experienced people at this point." – Case E*

> *"We took a look at both alternatives, wrote small prototypes for both, and evaluated them." – Case D*

The interviewees reported also that 'negligence of design reviews' occurred and potential mistakes were accepted. This is because there is a general fear of over-analyzing the technology design alternatives at the beginning to an extent where this is not required or able to give a pay back (thus wasting resources).

> *"I mean, there are a lot of different choices to start something like that and to go through something like that down to the last detail and say that these are the pros and cons and it takes a lot of time, is very expensive and it is hard to evaluate whether it turns out to be really better in the end." – Case F*

> *"At the time, I didn't even know that we would ever see such complications as we are seeing now. It would have been a very theoretical design exercise, which I couldn't accept to happen." – Case C*

The perceived decision effectiveness of this decision attribute was generally described as positive with regards to performing prototypes or ignoring a design review and learning about issues on the go. Desk research was seen neither as positive nor negative with regards to perceived decision effectiveness.

Design Review Criteria: The prevailing criteria to review a technology design in our sample is (technology) 'agnosticism', following the design requirements to create a flexible design that allows iterative development and collection of customer feedback. Our interviewees stated that agnosticism (or being unbiased towards particular technology designs) can best be achieved based on a well-defined 'data layer', which they consequently reviewed wisely.

> *"I am a great advocate of aiming for high agnosticism. That's why I prefer to focus on the data layer longer. If the data layer is good, you can do all kinds of things." – Case C*

> *"We chose MongoDB because it offers a lot of flexibility, you don't have to build a schema. [...] so that was definitely a point why we chose Mongo because it would allow us to keep being flexible." – Case E*

Furthermore, for design elements that were not self-developed, their 'maturity' was evaluated, including the availability of references and whether a sufficiently large community existed. Through this, it could be avoided by using experimental design elements.

> *"So there needed to be a community behind it at the time, and I think that's an important point with all the other things we've decided technologically, too, that you don't select something completely niche. That definitely plays a role, the maturity is important." – Case D*

> *"There was a new programming language, related to Scala, [...] and we had heard that other companies, e.g., Twitter, decided to use it a lot. For us, that was an important indicator." – Case E*

At the same time, 'negligence of system quality attributes', such as performance, maintainability or scalability was reported. The perceived decision effectiveness with regards to the configuration of the design review criteria is described positively, only the disregard of system quality attributes is described negatively in retrospect.

> *"In terms of performance and scalability, I tolerated future potential problems." – Case C.*

Design Selection: Design selection describes the conclusion of the decision-process by a choice being made. This conclusion is initially configured to be made 'despite uncertainties', which can mean that the technology design is chosen wrongly. Yet, during the design selection, there was 'no awareness about the consequences' that this selection implies and which complications might arise subsequently, especially considering the limited design review criteria and review approach that first-time entrepreneurs apply.

> *"I was not aware of the design decisions implications, yet I think it would be very valuable to be aware of this [...]. But the first time you are founding a company, that's a lot to ask for. If you were founding your next company, you would have the understanding required." – Case C.*

> *"In fact, I didn't even know that the initial design decision was a problem [...] If you perhaps don't inform yourself properly, then you just run into technical difficulties. In any case, I would never choose the same technology design again." – Case G*

The selection is done by a 'single decision maker', who feels 'under pressure' to conclude the design decision process, which results in a 'short decision' time-frame based on the design alternatives generated.

> *"It was quite a lonely decision in the end. [...] The input of the other team members was to make a decision as quickly as possible, preferably by yesterday. [...] I noticed that it is hard to discuss technology topics honestly with non-technologists." – Case B*

As part of the selection, little to 'no technology design decision documentation' is being created that for example explain the rationale of the decision, or consider the pros and cons of individual alternatives:

> *"There were no artifacts created for documentation purposes during this period." – Case F*

However, interviewees commented that little to 'no guidance' on this subject exists, but would be beneficial. The perceived decision effectiveness with regards to the configuration of the design selection is generally described negatively. It is furthermore the most negatively described decision attribute in comparison to the other attributes.

"Well, you search for a way to make this decision, but there are no really good best practices available. [...] So, I think there is a lack of guidelines for founders with an IT background to focus on the right aspects. These could save you time and ensure that you reduce uncertainties more quickly." – Case H

Involved Parties: As part of the initial technology design decision-making, a very limited number of individuals are involved. Typically, the technical co-founder, referred to as the Chief Technology Officer, steers the process alone or with the support of inexperienced IT staff (e.g., junior developer or interns), i.e., 'limited internal parties'. The involvement of 'external parties' is very limited too, due to a lack of sparring partners available to support the design process.

"I don't really remember any team discussions or that sort of thing." – Case E

"We didn't have any sparring partners at all, people with whom we could exchange ideas. We only had one intern who wasn't ready to discuss such topics yet." – Case B

Yet, in retrospect, the interviewees in our sample would have liked to have had external support. Involving very few parties in the design selection negatively influences the perceived decision effectiveness.

"In retrospect, I would describe our approach as somewhat unsystematic, especially how we got started. Some guidance in this area would have been helpful." – Case H

To summarize, as a result of the configuration of decision-making characteristics, the technology design choice made by our interviewees often did not lead to a satisfactory level of decision effectiveness. While some configurations are described positively with regards to perceived decision effectiveness, the overall result is quite negative. 17 out of 32 configurations of decision-making characteristics had been deemed to either negatively affect perceived decision effectiveness or to have no effect.

"We didn't do a deep [technology design] investigation, especially not whether the technologies chosen were the best alternative, it turned out they weren't." – Case C

"In retrospect, when I look at it, it's actually a problem that with our technology design it is not very easy to add new functionality or adjust functionality. So if I would choose to develop something like our product again, I would try to change many things about the design." – Case F

Discussion

Technology design decisions constitute a landmark decision for any digital startup on its way of growing into a viable business. A high level of decision effectiveness of the technology design decision is paramount for being able to develop innovative digital products and services, as the technology design defines and restricts the solution space, and several subsequent decisions rely on it. Up to this point, the literature has held the decision context responsible for low decision-effectiveness of technology design decisions in digital startups (Giardino et al. 2014; Klotins et al. 2018; Paternoster et al. 2014). The influence of design decision-making characteristics and their configuration has largely been neglected up to this point. This is surprising, as for other non-technology related entrepreneurial decisions, it was already shown that both aspects considerably influence decision-effectiveness (Dean and Sharfman 1996; Shepherd et al. 2015; Thywissen 2015). With our study, we aim to start closing this gap by providing first empirical insights into the decision-making characteristics and their configuration during technology design decisions in digital startups, as well as by providing an indication of the configurations that influence perceived decision effectiveness. We apply an exploratory research design using a multi-case study approach that allows us to collect primary data directly from the decision-makers about 'how' technology design decisions were made. Through semi-structured interviews we were able to collect in-depth descriptions about decision-making characteristics and to address each case in a flexible, responsive manner in order to derive insights.

Our contributions are fourfold. First, we identify that several decision-making characteristics are relevant and configured by digital startups during technology design decisions. Second, we find first indications for their influence on perceived decision effectiveness. Each of the decision-making characteristics is described in detail, closely related to the empirical data collected, and respective configurations are explained. With this, we provide empirical evidence that the decision-making characteristics for technology design decisions are of considerable importance for decision effectiveness. Third, we find that in retrospect, for a considerable number of the decision-making characteristics, the configuration is perceived as negatively influencing perceived decision effectiveness. For this reason, the digital startups in our sample would configure several decision-making characteristics differently if they had the possibility to do so. Fourth, through our study, we deliver a first indication that further research on the subject is required to identify configurations of decision-making characteristics that positively support decision effectiveness of technology design decisions in digital startups.

With regards to the identified usage of 'intuition', 'effectuation', and 'lean' as decision paradigms, we are in line with extant literature which presents intuition and effectuation as typical paradigms for early decisions by entrepreneurs (Cunha 2007; Sarasvathy 2001) and lean principles as common in digital startups (Unterkalmsteiner et al., 2016; Kraus et al., 2019). Sarasvathy (2001, p. 249) describes that entrepreneurs starting with "who they are" and "what they know" make decisions based on their means rather than focusing on particular ends. Cunha (2007) highlights that intuition is common among entrepreneurs, when complex decisions need to be made quickly. Also, entrepreneurs prefer to learn through iterations and continuously collecting feedback (Ries, 2011; Unterkalmsteiner et al., 2016).

These decision paradigms also considerably influence the considered set of 'design elements', often resulting in "previously chosen alternatives disproportionally [being selected] more often" (Shepherd et al., 2015, p.30). While the technology design decisions indicated considerable usage of effectuation logic, a majority of interviewees would have preferred to have used it less in retrospect. More causation logic (Sarasvathy 2001), i.e., considering design elements beyond those known and used before, would have positively affected decision effectiveness. While other studies describe that digital startups could benefit from the use of existing design elements, we found that, at least for our sample, digital startups tend to rely on existing design elements only to a limited extent as part of their technology design and prefer to develop design elements themselves. Usage of self-developed design elements in digital startups is reflected critically by Unterkalmsteiner et al. (2018, p. 8), who state that the quality of these self-developed design elements can be "significantly lower [...] regarding functionality, performance, and maintainability". Furthermore, it is reported that "leveraging on established, well-known technologies to create new and innovative products" (Klotins et al. 2019, p. 18) is recommended in order to save development time. Existing design elements, such as frameworks and components, can also reinforce the architectural structure of a product and reduce maintenance efforts (Paternoster et al. 2014).

With regards to the 'design requirements', we found that the design pursues very special goals such as bringing a first product to market quickly, enabling fast development speed, and allowing customer feedback collection. These are very much in line with Lean Startup principles (Ries 2011), a methodology that became famous for supporting digital startups in developing products despite the uncertainties they face. Similar to our findings, time-to-market was also described by literature as a key strategic objective of design decisions (Paternoster et al. 2014). Yet, we were surprised to find that early technology designs are not meant to be revised once feedback has been collected. Especially the Lean Startup concept of a Minimum-Viable-Product by Ries (2011), suggests to carefully revise design decisions once an understanding of customer needs is generated.

For the 'design alternatives', a limited phase for alternative identification and the avoidance of over-analyzing them is in line with Lean Startup principles, i.e., especially with regards to not creating waste (Ries 2011). However, generating design alternatives as part of a thought process, without any visualization or documentation artifacts, is not recommended in the literature. As described by van der Ven et al. (2011, p. 329) technology designs often "reside in the minds of the designers and are therefore easily lost". This complicates the tracing of design decisions and rationale at later points, including information about evaluated alternatives and related trade-offs (van der Ven et al. 2011). As suggested by Tyree and Akerman (2005), we also believe that it would be recommended to back up the choice and the rationale with some basic documentation, as well as to revise the design choice with the goals to be attained at later points in time (Alexeeva et al. 2016). As the value of a good technology design is often not externally visible (van Gurp and Bosch 2002), it is tempting to postpone necessary design work. If initially considered insufficiently, resource-intensive redesigns might be required eventually, as a result of the interrelation between technology design elements and the software design. However, many of the risks associated with technology designs can be mitigated by some degree of explicit conceptualization (Abrahamsson et al. 2010). Yet, we observe that technology designs in our sample tend to be insufficiently conceptualized, suffering from a fear of over-analyzing the technology design.

The decision-making characteristics for the review of design alternatives consists of the 'review approach' and 'review criteria' (Tyree and Akerman 2005). Both of these in our sample were arranged to create little effort, i.e., in the form of desk research, quick prototyping, combined with limited review criteria. While the literature suggests to ask whether the design "decision affect[s] one or more system qualities (performance, availability, modifiability, security, and so on)" (Tyree and Akerman 2005, p. 20) and to identify externally visible properties, the digital startups in our sample largely neglected these recommendations. We only observed a strong focus on agnosticism towards the design. We believe that neglecting common system quality criteria is a result of digital startups following Lean Startup principles (Ries 2011).

With regards to the 'design selection', we found that the technology design choice is selected by a single decision maker, who experiences pressure to conclude the decision-making within a short time frame. Consequently, the decisions to include or exclude a particular technology are made quickly and considerably faster than in the context of an established company. Tofan et al. (2013) found that in an established company context, such decisions can take over a month. One could argue that digital startups should be aware of the drawbacks that are associated with their chosen configuration. The interviewees in our sample confessed that they were not aware of the complications associated with their configuration of design decision-making characteristics. In retrospect, the interviewees stated that they would have preferred a different configuration. Overall, an increased awareness about the importance of design decision-making characteristics started to exist among our interviewees after their technology design had been implemented and complications had become visible. Guidance on how to make technology design decisions in an entrepreneurial context was desired, but had not (yet) been available. With regards to the 'involved parties', like the architects described in the literature who reported feeling isolated in established companies, we also found this to be the case for the technical co-founders of digital startups. Similarly to what van der Ven and Bosch (2013, p. 176) described, we also perceived technical co-founders to be the "only ones with a system-wide overview" that have limited or "no peers within the organization" to exchange thoughts and ideas. This means that technology design decisions are also often taken in isolation. Our interviewees further reflected that involving (external) sparring partners would have increased the design decision effectiveness, potentially resulting in more suitable designs, and fewer negative consequences. Tofan et al. (2013) found that in established companies, at least several employees are directly or indirectly involved in design decisions. We believe that the availability of sparring partners could lead to the reduction of several complications, e.g., feeling isolated, considering limited design alternatives, relying on self-developed design elements, or conceptualizing design alternatives.

To summarize, as a result of the chosen decision-making characteristics and their configurations, the technology design choice often did not lead to a satisfactory level of perceived decision effectiveness. An initially unfavorably defined design can result in negative consequences and have a huge impact on product development (Klotins et al. 2019; van der Ven et al. 2011). We suspect that this also represents a root cause for the occurrence of technology redesigns at later stages of digital startups (Bohn and Kundisch 2018).

Conclusion

We investigated the decision-making characteristics and their configurations for one of the most essential decisions for digital startups, i.e., the technology design decision. Technology design defines the foundation of the products and services that digital startups develop, and many subsequent decisions rely on it. However, technology design decisions are fraught with complications, such as, for example, time pressure, an incomplete understanding of the customer problem, or uncertainty about how the developed solution will be received by potential customer groups. Based upon data collected from nine case studies, we identified and described the decision-making characteristics and their configuration during technology design decisions, which we identified as three prevailing decision paradigms and seven decision attributes. We also provide insights on the influence of configurations of decision characteristics on perceived decision effectiveness.

Our findings carry important implications for theory and practice. With this study, we present indications that, similarly to other entrepreneurial decisions, decision-making characteristics and their configuration play an important role for decision effectiveness of technology design decisions in digital startups. Our insights pave the way for subsequent research on the subject. For practitioners, our research results have shown several configurations of design decision-making characteristics that digital startups considered unfavorable in retrospect. Also, the configurations were often not in line with the suggestions made by past research. We recommend to digital startups to explicitly and visually conceptualize technology design alternatives throughout their decision-making. The considered design alternatives should be flexible enough to account for the prevailing uncertainties, continuous customer feedback collection, and iterative product development. They should allow to make necessary technical adjustments easily once requirements were derived and build upon existing and well-known design elements that suit the purpose of the digital startup, and not only selected among those previously known to the Chief Technology Officer. The preferred technology design should be tested thoroughly towards common quality criteria. Sparring partners, such as technical experts or serial entrepreneurs should be included in the decision-making, thereby receiving support to enhance decision effectiveness. For startup coaches and venture capital investors, they should consider whether they themselves could serve as sparring partners.

Our research has certain limitations. We analyze the decision-making characteristics and their configuration during the technology design decisions ex-post. This means that there is a possibility that further characteristics exist, which were not remembered and described by the interviewees. Furthermore, we analyzed the decision-making characteristics by interviewing first-time entrepreneurs. While this provides a higher comparability of findings among the cases, experienced (i.e., serial) entrepreneurs who had prior experience of selecting technology designs for digital startups could potentially reveal additional decision-making characteristics and configurations, as well as bring valuable insights on their decision effectiveness.

Future research could extend our findings into at least four promising directions. First, knowing that digital startups, by their very nature, often undertake technology design decisions more than once (Unterkalmsteiner et al. 2016; van der Ven and Bosch 2013b), it would be worthwhile to analyze decision-making characteristics and their configurations beyond initial technology design decisions. Second, future research could further evaluate the interdependencies between the individual decision-making characteristics and their individual impact on decision effectiveness of technology design decisions in digital startups. As part of this, integrating the experiences of serial entrepreneurs might bring valuable insights. Third, future research could investigate the uniqueness and differences in the decision paradigms and decision attributes between digital startups and other types of startups, such as IT-mediated or IT-facilitated startups (Steininger 2019). A stronger focus on the identified lean decision paradigm might be worthwhile here. Finally, further exploratory and explanatory empirical research could allow more substantive statements about how to improve decision effectiveness of technology design decisions.

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