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A Solution in Search of a Problem: A Method for the Development of Blockchain Use

by

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Completed Research

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Abstract

Blockchain technology is a very recent and fast evolving phenomenon with the potential to disrupt various industries. Organizations are thus increasingly looking at blockchain technology and are forming multi-functional teams to evaluate the technology and its impact on their businesses. Researchers and practitioners, however, still lack a technology-driven, systematic approach to understand the potential of blockchain and to develop convincing use cases. We addressed this research gap by applying an action design research approach and situational method engineering to propose a method for the development of blockchain use cases. Following this approach, we iteratively evaluated and further developed the proposed method through application and testing in four distinct industries. We thus derive constructive knowledge at the cutting edge of digital transformation, innovation management, and utilization of emerging technologies. In addition, our research supports practitioners in systematically developing blockchain use cases.

Keywords

Blockchain, emerging technology, use case development, action design research, situational method engineering.

Introduction

Digitalization forces organizations to continuously evaluate and innovate their business model (Bharadwaj et al. 2013). Emerging digital technologies constantly push into the market, provoke changes, and reshape existing business practices and established structures (Gimpel et al. 2018; Legner et al. 2017). Blockchain is one of these emerging technologies and has drawn considerable attention from academia and practice alike (Fridgen et al. 2018; Glaser and Bezzenberger 2015). Originally invented as the technological backbone behind Bitcoin (Nakamoto 2008), it has purportedly become a multipurpose technology for a wide range of applications (Mattila 2016). Especially smart contracts, programs that can be run on a blockchain, have increased the potential to improve existing processes, foster disintermediation, and enable disruptive business models (Fridgen et al. 2018; Wright and Filippi 2015). Some projects even build blockchain organizations whose business logic is fully coded into smart contracts and executed autonomously (Forte et al. 2015).

Promising prototypes have also emerged in crowdfunding (Schweizer et al. 2017), initial coin offerings and fraud-resistant supply chain applications, workflow management systems (Fridgen et al. 2018), Internet of Things security and privacy (Dorri et al. 2017), and in the energy sector (Munsing et al. 2017). Still, some authors are skeptical that blockchain technology will live up to the expectations and thus call for further research on the technology and its application (Avital et al. 2016; Risius and Spohrer 2017). For example, Glaser (2017) describes the current blockchain phenomenon as innovative technology in search for use cases. In particular, he determines "a paucity of knowledge where and how blockchain technology is effectively applicable" (Risius and Spohrer 2017). Furthermore, research and practice lack effective approaches to evaluate the potential of blockchain and to develop innovative use cases in the first place (Glaser 2017). This is in small part due to the technology-driven and unpredictable nature of disruptive innovations (Bower and Christensen 1995). Moreover, popular innovation methods (e.g., Design Thinking) approach innovation from a customer needs perspective and are only of limited value for use case development of emerging technologies. Therefore, researchers and practitioners alike require a technology-driven, theoretically sound and practical approach to capitalize on emerging digital technologies, such as blockchain. To address this need, we state the following research question:

How can organizations and research systematically approach blockchain technology to understand its potential and to develop viable use cases?

To answer the proposed research question, we developed and evaluated a method both to understand blockchain technology and to identify suitable use cases. To develop our research artifact, we applied an action design research (ADR) approach (Sein et al. 2011). Following this approach, we directly and iteratively evaluated our results. In particular, we evaluated our blockchain use case development (BUD) method in four workshops in different industries to ensure the generalizability of our results. By reporting our results, we seek to make two important contributions. One, we strive to provide practitioners with a structured and theoretically sound method for the utilization of the blockchain technology. Second, we aim to create constructive knowledge in the fields of digitalization, innovation management, and emerging technologies.

The remainder of the paper is structured as follows: In Section 2, we introduce the foundations of this study and review related work on innovation and blockchain. In Section 3, we introduce the chosen research method, while in Section 4 we provide an overview of the research process. In Section 5, we discuss our results and derive recommendations for further research.

Foundation

To better understand the organizational problems motivating our research, and to derive suitable solution objectives, it is important to understand the underlying concepts and related research. We thus introduce digitalization, innovation, and blockchain in the following.

Digitalization and the Role of Innovation

Digitalization changes and reshapes entire industries, as innovative digital technologies enable novel functionalities and foster promising business opportunities (Aral et al. 2013; Bharadwaj et al. 2013; Downes and Nunes 2013). These technology-driven developments are caused by digitizing, the transfer of analog into digital data (Legner et al. 2017). They invoke digitalization, a sociotechnical process of "applying digitizing techniques to broader social and institutional contexts" (Tilson et al. 2010). The fundaments of digitalization are, in particular, widespread application and rapid development of information and communication technologies (Chen and Tsou 2006). The commoditization and accessibility of these technologies increases interconnections and accelerates innovation cycles (Gimpel et al. 2018). Meanwhile, the rise of embedded computers has enabled the creation of smart things (Yoo 2010) and fostered a wave of emerging technologies (e.g., blockchain) that could reshape organization and management theories (Matt et al. 2015). To benefit from these technologies, organizations must develop and utilize new ideas, processes, products, or services (Thompson 1965; Yoo 2010). Although innovation and its management are crucial for each organization's success (Drucker 1984; Teece 2010), many institutions fail to continuously change and innovate (Denner et al. 2017; Van de Ven 1986). In particular, incumbent firms that have been successful in the past often focus on current operations, and thus lack innovative capabilities (O'Connell 2011). In contrast, startup companies generally rely on agile structures, teams, and openness to change, leading to faster development cycles and higher innovation capabilities (Ansari and Krop 2012; Christensen 2013).

Blockchain Technology as Basis for Innovation

Blockchain uses cryptographic mechanisms to consistently and immutably store data in a fully distributed system (Risius and Spohrer 2017). While early blockchains primarily focused on the transfer of cryptocurrencies, more recent instantiations (e.g., Ethereum or Hyperledger) provide Turing-complete programming languages that allow for the implementation and execution of programs on the blockchain (Glaser 2017). These programs are known as smart contracts and allow for a wide range of blockchain-based applications (Szabo 1997). Based on these properties, blockchain is often labeled as highly disruptive and as having far-reaching impact on various industries and society (Niederman et al. 2017; Schweizer et al. 2017). In particular, blockchain technology is seen as an enabling infrastructure for novel processes, products, and businesses models with blockchain characteristics (Lauslahti et al. 2016). Research, however, addresses the blockchain phenomenon mainly from a technical perspective and excludes a business as well as a user perspectives (Walsh et al. 2016). Although several researchers apply design science research approaches to develop blockchain prototypes (Beck et al. 2016; Fridgen et al. 2018; Schweizer et al. 2017), academics and practitioners still search for cogent use cases. Thus, voices are being raised that blockchain might be an innovative technology searching for convincing use cases (Glaser 2017; Risius and Spohrer 2017). Especially practitioners are uncertain about the impact blockchain might have on their organizations and are asking for a structured approach to develop blockchain use cases (Iansiti and Lakhani 2017).

Research Method

To develop our BUD method, we followed an ADR approach (Sein et al. 2011) and applied situational method engineering (SME) (Braun et al. 2005). In general, ADR aims at solving organizational problems by creating innovative artifacts (e.g., methods or constructs) that serve a meaningful human purpose (Gregor and Hevner 2013; March and Smith 1995). Broadening design science research, ADR specifically seeks to involve practitioners (e.g., individuals with first-hand experience or end-users) in the alpha and beta research cycle (Figure 1). Thus, the resulting artifact is not only grounded in theory but also shaped by organizational and user perspectives (Sein et al. 2011), which is critically important in developing a method to address a new and potentially disruptive technology like blockchain.

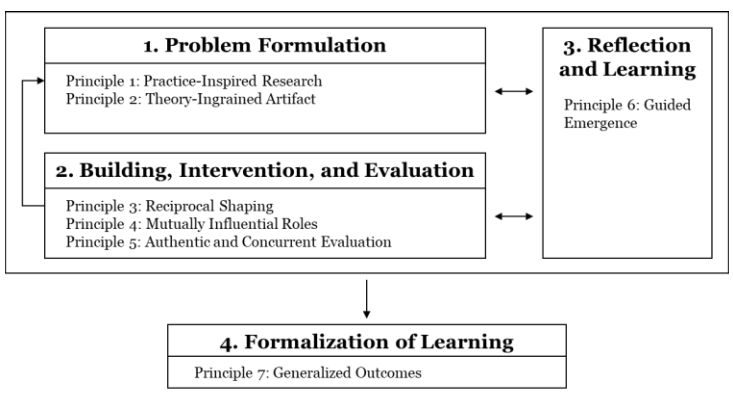

Figure 1. Action Design Research Approach

The ADR approach consists of four stages and seven underlying principles. Principle 1 of the problem formulation stage deals with a "problem perceived in practice or anticipated by researchers" (Sein et al. 2011). Principle 2 ("theory-ingrained artifact") states that ADR, by dealing with a problem from practice, aims to create knowledge that can be transferred to similar problems (Sein et al. 2011). Stage 2 ("building, intervention, and evaluation") involves continuous evaluation of the artifact during a joint development process (Sein et al. 2011). Stage 3 ("reflection and learning") aims to guide the application of learnings from one particular instance to "a broader class of problems" (Sein et al. 2011). Finally, stage 4 ("formalization of learning"), encompasses the establishment of generalizability (i.e., principle 7) (Sein et al. 2011).

Information systems (IS) research follows two objectives: contribute to theoretical knowledge and assist in current and future problems in practice (Benbasat and Zmud 1999; Iivari 2003; Rosemann and Vessey 2008; Sein et al. 2011). To meet this end, we integrated SME in our ADR process. SME provides a structured approach toward the creation of a method. This combined approach is in line with recent literature and has been successfully applied by several authors (e.g., Denner et al. 2017; Henderson-Sellers and Ralyté 2010; Morschheuser et al. 2017). We followed Braun et al. (2005) and defined a method as a systematic approach to conduct work steps to achieve specified objectives. To ensure that our method development integrates all important characteristics, we built upon research from Braun et al. (2005) who conducted a comprehensive literature review on method building and identified relevant method attributes (Table 1). SME differentiates method configuration and method composition (Bucher et al. 2007). Method configuration is the adaption of a generic method for a specific situation. In contrast, method composition picks pieces of existing methods that meet the specifics of the current. Our method places in the method composition part, also called assembly-based method engineering, as we assembled a blockchain use case development method from other existing approaches (Ralyté et al. 2003). The approach consists of three main steps: (1) specification of method requirements, (2) selection of method chunks, and (3) assembly of method chunks (Ralyté et al. 2003). Firstly, the method requirements must be specified in line with the method engineering goals. Secondly, method junks must be selected matching the requirements. Thirdly, the new method can be assembled (Ralyté et al. 2003).

	Name	Description
Fundamental attributes of a method	Goal orientation	Methods strive for achieving specific goals
	Systematic approach	Methods possess a specific structure
	Principles	Methods are bound to design principles or strategies
	Repeatability	Methods can be repeated in different contexts
Fundamental elements of a method	Activity / Procedure model	Task that creates a distinct (intermediate) output
	Role	Actor that executes or is involved in the execution of an activity
	Technique	Detailed instruction that supports the execution of an activity
	Tool	Tool (e.g., software) that supports the execution of an activity
	Defined Output	Specifies the outcome of each activity

Table 1. Method Attributes and Elements (Braun et al. 2005; Denner et al. 2017)

Development of a Blockchain Use Case Development Method

In this section, we provide a detailed overview on how we applied ADR and SME. In line with ADR, we established a joint development team of researchers and banking practitioners for the development of the alpha version of our method. To further evaluate and generalize our method, we conducted workshops with additional practitioners from four distinct industries (automotive, banking, construction, and insurance). The overall research process encompasses four stages and seven principles, which we used in an iterative manner. In the following, we shortly describe each stage and its underlying principles.

Stage 1: Problem Formulation

In the problem formulation stage, we defined the problem as *"lack of a systematic approach to understand blockchain technology, its potential and the development of viable use cases"*. In multiple discussions and semi-structured interviews with practitioners (from various departments such as innovation management, business development, and IT management) we verified and confirmed the need for a theoretically sound and practical method to engage with blockchain technology. In addition, a review of existing blockchain and innovation management literature confirmed that previous research has not yet developed such a method and a structured approach to benefit from blockchain technology is missing. Further, an evaluation of existing approaches related to blockchain use cases also indicated the lack of a comprehensive method. Existing approaches only focus on specific challenges like the evaluation of an blockchain use case (e.g., Wüst and Gervais 2017), but do not satisfy the fundamental attributes and elements of a method (Braun et al. 2005). Thus, we concluded from our problem analysis and evaluation that the identified problem is relevant for practice and represents a valid research gap (Principle 1). Further, we decided to apply SME in stage 2 of our ADR (Principle 2) due to its guiding structure especially developed for practice-inspired research (Henderson-Sellers and Ralyté 2010).

Stage 2: Building, Intervention, and Evaluation

In stage 2 of our ADR and in line with Sein et al. (2011), we followed the generic scheme for organization-dominant development of artifacts (Figure 2). This approach guided the cyclic design and development (e.g., alpha and beta development cycles) of our method and included multiple evaluation cycles against the assumptions, expectations, and knowledge of practitioners (Principle 3 and 4). To integrate existing methods in our research process, we used the method composition part of SME. By doing so, we first specified the method requirements based on recent method development literature and case-specific characteristics. Thus, we used the method requirements from Braun et al. (2005) and Denner et al. (2017), depicted in Table 1. Secondly, we identified and selected existing method pieces from literature, such as benchmarking (Camp 1989) or lean startup (Ries 2011) that contribute to the intended method Thirdly, we used these method pieces to assemble our new BUD method (explanations of used method pieces can be found in the detailed descriptions of our method stages hereinafter).

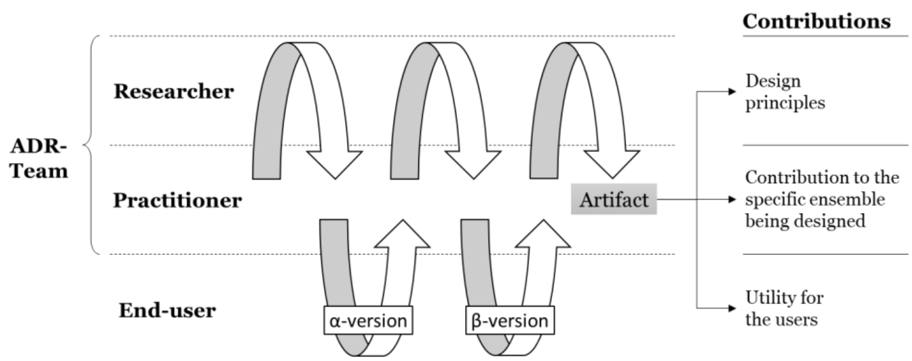

Figure 2. ADR Stage 2: Building, Intervention, and Evaluation (Sein et al. 2011)

Since we followed an iterative ADR process, we conducted these three method composition steps multiple times, and interwove the evaluation with decisions about method components, design, and reshaping activities (Principle 5). Overall, we shaped our BUD method through the application and evaluation in one-day and two-day workshops with organizations of four distinct industries (Table 2).

Evaluation	Participants	Organization
1-day workshop	• Involved departments: Business development, several business units, and IT and process management • Number of participants: 11	• Industry: Banking • Size: ca 6.300 employees
1-day workshop	• Involved departments: IT and process management, system and application architecture, and software engineering • Number of participants: 17	• Industry: Insurance • Size: ca 4.200 employees
1-day workshop	• Involved departments: IT and process management, several business units, and system and application architecture • Number of participants: 5	• Industry: Construction • Size: ca 25.000 employees
2-day workshop	• Involved departments: Emerging technologies and disruptive business, several business units, and software engineering • Number of participants: 7	• Industry: Automotive • Size: ca 18.000 employees

Table 2. Evaluation Cycles of the Blockchain Use Case Development Method

Our final BUD method has six stages that we explain hereinafter, and illustrate in Figure 3 and Table 3.

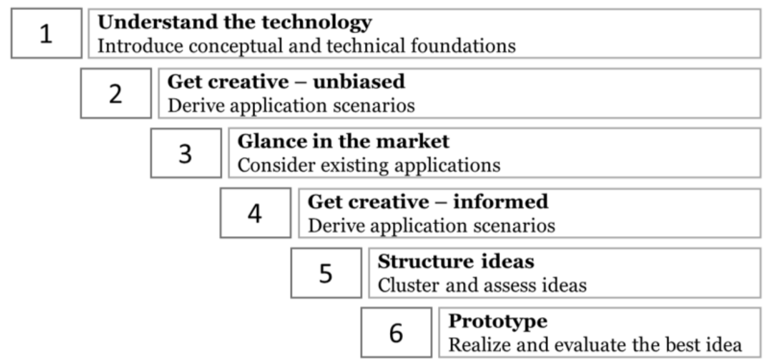

Figure 3. Blockchain Use Case Development Method

1) Understand the technology

Often, organizations have little knowledge of blockchain technology, its main characteristics, and its organizational implications. A thorough understanding of these aspects, however, is necessary to assess, while avoiding exaggerated expectations, the technologies' potential to improve processes and to disrupt the organizations' businesses. This step must not be rushed as it builds the basis for all subsequent stages. In this stage, our research achieved the most satisfying results, when using existing methods like structured lecture notes, hands-on workshop, and prototype presentation.

2) Get creative – unbiased

Once participants established a fundamental understanding, they are asked to approach potential use cases in an unbiased and creative way. Thus, our BUD method incorporates existing creativity techniques like brainstorming and thinking outside the box. During this step, two situations may occur: One, the participants do not yet have knowledge about blockchain use cases. Two, the participants already acquired knowledge about possible use cases prior to the workshop. In the latter case, we urge participants to approach potential use cases that go beyond or even exclude what they already know as exemplary use cases. In doing so, we prevent participants from solely replicating ideas that already exist. Common guiding questions are: Which intermediary is most disturbing to your organization/business unit? Which of your data is most susceptible to manipulations? Which process involves (too) many process participants?

3) Glance in the market

In step (3), the BUD method proposes to introduce existing ideas or use cases – ideally following a two-step approach. At-first, existing blockchain solutions within the participants' industry are presented as a reference point. Afterwards, the participants discuss blockchain initiatives in industries with comparable characteristics, structures, and challenges. This two-step approach fosters development of a more detailed understanding and provides a broader perspective on the topic of blockchain. Moreover, it allows benchmarking the generated ideas with existing blockchain cases. This step informs participants of necessary conditions for successful application of blockchain technology and builds upon established market research methods and technology classification tools (e.g., Gartner Hype Cycle).

4) Get creative – informed

Based on the knowledge acquired in steps (1) and (2), our method proposes to readdress the question how the participant's organization might use blockchain. This reconsideration leads to additional or more detailed use cases. In addition, the input in step (3) enables to assess ideas more broadly by integrating external knowledge. Existing group creativity techniques (e.g., brainwriting) are import parts of this joint use case ideation.

5) Structure ideas

Once the participants developed ideas for blockchain use cases, our research results recommend clustering, prioritizing, and assessing them. First, our findings indicate to cluster the ideas depending on their area of application. For instance, the participants can cluster all ideas concerning a specific type of process or a specific product category into the same category. Second, we recommend prioritizing the clusters. Usually, such a prioritization comes naturally and originates from discussion with the participants. However, we propose to conduct a voting: each participant must choose a favorite use case cluster. For larger groups in particular, the voting provides opportunity to prioritize ideas in a structured but simple way. Third, our findings suggest defining a minimal viable product (MVP) for each cluster. The participants thoroughly use and analyze the MVP of clusters with a high priority in stage 6.

6) Prototype

We base the prototyping phase on the results from step (5). Our findings suggest a detailed process and product analysis of the selected MVP based on well-recognized approaches like BPMN. Thus, before the development team starts in an agile manner (e.g., Scrum), our results suggest to first model and analyze the process underlying the blockchain solution, and decide on a prototype case. To follow a lean innovation approach during the blockchain prototype development, our findings suggest building upon tools and test environments, such as truffle and ganache.

Activity	Role	Technique	Tool	Output
(1) Understand the technology	• Lecturer (blockchain expert) • Selected participants from departments like business development, IT and innovative business units	• Explain fundamentals of blockchain • Introduce key characteristics • Discuss advantages and disadvantages of blockchain	• Structured lecture notes • Interactive and hands-on workshop • Simple blockchain prototype for presentation purposes	• Informed participants • Participants being able to conceptually apply blockchain in various fields
(2) Get creative – unbiased	• Moderator (blockchain expert) • Participants from activity 1 (split into groups when > 20 participants)	• Identify potential blockchain use cases • Discuss all ideas anonymously	• Creativity techniques (e.g., brainstorming and thinking outside the box)	• First range of potential blockchain use cases
(3) Glance in the market	• Lecturer (blockchain expert) • Participants from activity 1 and 2	• Outline current trends in blockchain development • Introduce recent blockchain use cases • Discuss similarities and differences to the audiences' industry	• Structured overview on the evolution of blockchain (e.g., Gartner Hype Cycle) • Market analysis of blockchain use cases	• Informed participants • Participants knowing how others use blockchain
(4) Get creative - informed	• Moderator (blockchain expert) • Participants from activity 1-3 (split into groups in case of more than 20 participants)	• Identify additional blockchain use cases • Particularly integrate the insights from activity 3 • Focus on joint use case ideation and discussion	• Group creativity techniques (e.g., brainstorming or brainwriting 6-3-5)	• Additional, market-inspired blockchain use cases
(5) Structure ideas	• Moderator (blockchain expert) • Participants from activity 1-4	• Cluster ideas • Discuss the common features of each cluster • Prioritize the clusters • Define a MVP for each cluster	• Clustering technique (e.g., mind map) • Prioritization technique (e.g., simple voting) • Business model development techniques (e.g., business model canvas)	• Structured and prioritized blockchain use case clusters • Number of MVPs suitable for the prototype activity
(6) Prototype	• Project sponsor • Project manager • Process owner and/or product manager • Blockchain expert • Blockchain software engineer	• Conduct detailed process and product analyses of the MVPs • Decide for one MVP • Implement the MVP • Evaluate the implementation	• Process modelling language (e.g., BPMN) • Decision matrix analysis • Agile software engineering (e.g. Scrum) • Blockchain development and test environments	• Blockchain prototype • Decision-making basis for blockchain strategy

Table 3. Overview of the Blockchain Use Case Development Method

Stage 3: Reflection and Learning

Stage 3 continuously accompanied stages 1 and 2 during the ADR process and allowed us to move from solving a specific problem in a single industry to solving a general problem in a variety of industries (i.e., broader class of problems). Continuous reflection and learning enabled us to reflect on the design and reshaping of our method and to test against the ADR principles and method requirement. We were able to better understand and analyze the changes to the research process as well as their consequences on the artifact. A vital part of the ongoing reflection and learning represented our workshops with practice (Table 2). Through these workshops, we received direct feedback, and gathered and evaluated qualitative data about the quality of our method as well as about its output. The reflection and learning stage allowed us to observe the overall nature of our method and to recognize mutually derived changes to initial assumptions about the BUD method (Principle 6).

Stage 4: Formalization of Learning

Since we combined ADR with SME in stage 2, we developed a structured method. We formalized our learnings through the incorporation and communication of the proposed BUD method. Our method is not restricted to particular industries albeit we developed it within the aforementioned four industries. The six steps also satisfy ADR's principle of generalizability. The BUD method represents a contribution to design science that is highly applicable due to the ADR approach we took (Principle 7).

Discussion and Conclusion

Blockchain technology is a very recent and fast evolving phenomenon with potentially disruptive effects on various industries (Fridgen et al. 2018; Wright and Filippi 2015). Although considerable efforts have been made by academia and practice to evaluate the technology and its impact on existing business, researchers and practitioners still lack a systematic approach to understand blockchain, its potential, and the development of convincing use cases (Glaser 2017). We addressed this research gap by applying an ADR approach and SME to develop a blockchain use case development method. Our proposed artifact fulfills the fundamental attributes and elements of a method, introduced in Table 1. *Goal orientation* is given, as our method aims to develop blockchain use cases. Applying the proposed BUD method, practitioners and researchers follow a *systematic approach* that encompasses six steps. What is more, by applying ADR and SME our BUD method follows concrete *principles* (i.e., construction guidelines). Additionally, we tested the *repeatability* of our method through the application in different organizations and industries. Further, our BUD method comes with concrete guidelines for *activities*, *roles*, *techniques*, *tools*, and *output* of each step (Table 3). Consequentially, we propose a method for the development of blockchain use cases that is, due to its comprehensive and structured nature, superior to existing approaches.

Before stating our contributions to research and managerial recommendations, we acknowledge some limitations. First, our method yet needs to prove applicability to other emerging technologies and second, blockchain technology is still in its infancy and, in the future, might show new characteristics that can influence the stages of our current BUD method.

By answering the derived research question, we make three theoretical contributions. First, we provide for incumbent organizations constructive knowledge on how to utilize an emerging technology (i.e., blockchain) to address the challenge of generating innovation in the digital era. Second, we expand the current body of knowledge in the fields of blockchain and method development research by proposing a theoretically sound and practical blockchain use case development method. Third, we support further research that focuses on analyzing the applicability of blockchain in other organizations and industries. Besides its theoretical contributions, our research has three important practical implications. First, we provide a structured method that serves as a guideline for the identification and evaluation of blockchain use cases. Second, we deliver an overview of required roles, suitable techniques and tools, as well as desired outcomes for each of the six stages. Third, our method helps practitioners to exclude ill-suited blockchain use cases prior to the prototyping stage and thus to invest only in promising projects.

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