The DevOps Funnel: Introducing DevOps as an Antecedent for Digitalization in Large-Scale Organizations

Michael Hüttermann
University of Cologne
huettermann@wiso.uni-koeln.de

Christoph Rosenkranz
University of Cologne
rosenkranz@wiso.uni-koeln.de

Abstract

Business productivity and speed to market are among the top priorities of IS managers to stay successful. To achieve these goals, a change in business processes or models is often required, which is often linked to the phenomenon of digitalization. Enterprises have observed that a holistic approach to agile IS development is essential to enable this change, leading to the concept of "DevOps". While past studies have delivered first insights about DevOps, an understanding of which factors are important to introduce DevOps in organizations, and how DevOps relates to digitalization is still missing. To close this gap, we conducted a two-staged study of literature review and a multiple-case study. Our findings suggest that DevOps links success and practices for development and operations across actors of different organizational levels. We find that DevOps supports digitalization efforts, contribute to the understanding of the DevOps phenomenon, and identify worthwhile paths for further research.

Keywords: DevOps, Digitalization, Innovation, Agility, Fusion.

1. Introduction

Business productivity, cost reduction, and speed to market (Luftman & Zadeh, 2011) are among the top priorities of information systems (IS) managers to stay successful. However, the traditional division of labor in IS and its split into distinct organizational subunits often hinders organizations to successfully pursue these goals (Hemon-Hildgen, Rowe, et al., 2020). In industry, proponents of the recent *DevOps* phenomenon argue that it brings together team members from both, IT development (those that build IS) and IT operations (those that run and maintain IS) in order to implement IS development (ISD) in a comprehensive way (Qumer Gill et al., 2018; Wiedemann et al., 2020).

With DevOps, those two major IT-related enterprise functions increasingly apply shared goals and use shared practices across both functions (Conboy, 2009; Hüttermann, 2012; Sharp & Babb, 2018). Thus, DevOps appears as a logical extension of agile ISD (Hemon-Hildgen, Lyonnet, et al., 2020; Hemon-Hildgen, Rowe, et al., 2020; Wiedemann et al., 2020) and as such a means to scale application of agile ISD (AISD) across the organization (Hüttermann, 2021). Consequently, companies applying DevOps streamline their ISD and IS operations to overcome well-known barriers and friction points between those two often siloed IT functions (Wiedemann et al., 2020).

As part of the root metaphor for strategy in digital innovation (Nambisan et al., 2020), DevOps is a new and promising path to support business-IT alignment in order to enable *organizational agility* (Horlach et al., 2020). Enterprise-wide organizational agility (through sensing and responding) supports achieving management goals in turbulent environments, including strategic flexibility and market orientation (Overby et al., 2006). *Business-IT alignment* is an influencing factor for enabling organizational agility (Tallon, 2007), which in turn is an important antecedent for digital *innovation* (Osmundsen & Bygstad, 2021). Stemming from agile ISD, DevOps expands agility across IT functions; moreover, with business and IT roles being an explicit part of an autonomous DevOps team, it supposedly goes even beyond business-IT alignment, and may achieve the sought-for tight fusion of business and IT (Bharadwaj et al., 2013; Henry Lucas et al., 2013).

First studies in IS have examined the emerging DevOps phenomenon. For example, existing research has proposed a tripartite model of intra-IT alignment (Wiedemann et al., 2020), examined the orchestration of automation, sharing, and risk management in DevOps teams and their relationship to work conditions and job satisfaction (Hemon-Hildgen, Rowe, et al., 2020), or has studied which characteristics influence how DevOps is tailored in organizations (Hüttermann, 2021). While these studies offer very valuable preliminary insights about DevOps, their research questions are grounded on already implemented and existing DevOps implementations (Hemon-Hildgen, Rowe, et al., 2020; Hüttermann, 2021; Wiedemann et al., 2020), and focus on particular aspects such as how alignment in DevOps teams can be achieved (Hemon-Hildgen, Rowe, et al., 2020), or how DevOps affects job satisfaction (Hemon-

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Hildgen, Rowe, et al., 2020). However, we are still missing a foundational understanding of DevOps in general, how DevOps supports digitalization, and which factors are important to initially implement DevOps in organizations. Consequently, we ask the following research question: "*Which factors are important to initially introduce DevOps in organizations, and how does DevOps relate to digitalization?*".

To answer our research question, we followed a two-stage approach. First, to identify dominant concepts of the DevOps phenomenon relevant for our study, influenced by Webster & Watson (2002), we conducted a literature review. The results served as a baseline from past studies of the IS community on DevOps (or covering or mentioning it in a relevant way) and to abstract provisional codes as input for the second stage of our study. Second, we conducted a multiple-case study of seven organizations implementing DevOps. Based on provisional codes of the first stage and analyses of the case data, we theorize what we call the "DevOps funnel", which orchestrates the three core concepts success, actors, and practices, and bridges success and practices across different organizational levels to implement DevOps and foster digitalization.

We contribute to the understanding of DevOps by shedding light on DevOps' implementation in organizations and the role of DevOps in digitalization. By drawing on existing concepts and suggesting the DevOps funnel as a new concept, we unpack the role of the emerging DevOps phenomenon in digitalization initiatives. Our results are of value to practitioners who want to start a DevOps initiative and might suffer from an unclear systematic knowledge of the role of DevOps and missing guidance of which factors are important to initially implement DevOps in organizations spanning multiple organizational levels.

Next, we discuss the related work of our study. Afterwards, we describe our research method and present our main findings. We summarize our contributions by suggesting two propositions. We conclude with avenues for future research.

2. Theoretical Background

2.1. Towards Studying Implementations of DevOps

DevOps can describe different things, including team structure, success criteria, concepts, or tooling (Qumer Gill et al., 2018). Since it suggests a relation to collaboration across functions, innovation and agility, we draw on the DevOps definition suggested by Hüttermann (2021) that emphasizes DevOps as way of collaborative work between functions to continuously deliver valuable outcome. This also poses a bridge to optimize overall IS success: DevOps aims to reconcile the plethora of different approaches trying to measure IS success and ISD success (Hüttermann, 2021). Adding to AISD, DevOps aims to include operational factors, the resulting IS product or its long-term operation and use (DeLone & McLean, 1992; Fitzgerald & Stol, 2017; Petter et al., 2013). With DevOps, siloed goals, for example, amount of functionality (Lee & Xia, 2010) as a developmental goal, or "mean time to restore" (Dekleva, 1992) as an operational goal, are becoming less important. Instead of these instrumental goals, holistic and humanistic goals, for example, rapid change (Lee & Xia, 2005) or customer satisfaction (DeLone & McLean, 2016; Petter et al., 2013), are often preferred.

While DevOps is a recent phenomenon, past studies so far have resulted in the proposition of three distinct theoretical models to explain various aspects related to DevOps. First, a theoretical model of job satisfaction suggests that the orchestration of automation, sharing and risk management is moderated by work conditions and positively impacts job satisfaction if AISD teams move towards DevOps (Hemon-Hildgen, Rowe, et al., 2020). Second, a model on intra-IT alignment extends operational alignment's focus on IT infrastructure and processes to alignment of development and operations functions (Wiedemann et al., 2020). Third, a model on environmental context of DevOps implementations suggests implementations to be gradual transitions in between the two extremes "detached" and "full coalescence" of integration of development and operations functions (Hüttermann, 2021).

Although these three models provide very valuable preliminary insights on DevOps and some of its probable characteristics, mechanics, and effects, they offer only a narrow focus on very specific effects (job satisfaction) and mechanisms (intra-IT alignment), and are based on a single case study (smaller software products such as online shops), or empirically center on environmental characteristics of DevOps implementations (Hüttermann, 2021), respectively. Moreover, these studies all have investigated effects of existing DevOps implementations (Hemon-Hildgen, Rowe, et al., 2020; Hüttermann, 2021; Wiedemann et al., 2020). While one study we know of has investigated barriers while adopting DevOps (in small to medium-sized enterprises) (Krey, 2022), the reasoning behind the initial introduction of DevOps in large-scale situations or an evaluation of its effects using empirical data is missing.

2.2. DevOps in the Digitalization Age

DevOps is part of the root metaphor for strategy in *digitalization* (Nambisan et al., 2020). While digital transformation is a "broad and complex phenomenon

that does not fit easily into a given theory" (Furr et al., 2022), challenging a "separation of disciplines" (Tilson et al., 2010), it can be disaggregated into concepts where *actors* across organizational teams and levels play an important part in (Furr et al., 2022; Nambisan et al., 2020; Osmundsen & Bygstad, 2021) to achieve *success* (Furr et al., 2022; Hüttermann, 2021) – similar to DevOps.

Similarly, *digital innovation* (and, more broadly, digitalization) can be defined as the creation of and change in market offerings, business processes, or models that result from the use of digital technology (Nambisan et al., 2020). Innovation is encompassing and includes the process of developing and implementing new ideas (Van de Ven et al., 2008). In the digitalization age, innovation can be seen as a self-enforced mechanism that, based on a space of possibilities and assembly of components, may lead to new products and services in IS infrastructure, the installed base of organizations, systems and users (Bygstad et al., 2016). Generative innovation is based on a composition of technology and users and a lightweight IT that is well suited for a specific task and provides immediate value for the user (Bygstad, 2017).

The evolution of the composition of technology is the process by which managers initiate and implement changes in an organization for increasing the alignment between its IT resources and strategic imperatives (Henfridsson & Bygstad, 2013; Nambisan et al., 2020). It is a means to stay competitive in its decoupled structure of actions (Greenwood et al., 2020). AISD emphasizes agility on the team level (Horlach et al., 2020). However, to digitally innovate as an organization to continuously deliver valuable outcome to customers (Fowler & Highsmith, 2001) and to improve the speed of IS delivery (Bharadwaj et al., 2013), agility has to be perceived as an enterprise-wide concern (Horlach et al., 2020). The ability of enterprises to sense environmental change and respond readily is called *enterprise agility* (Overby et al., 2006). This ability across functions connects multiple actors: The effectiveness of an interconnected, historically grown IS is conditioned on an installed base of extant socio-technical arrangements (Henfridsson & Bygstad, 2013; Yoo, 2013), with innovation emerging from interactions of actors – either interaction of different IT specialists across roles or interactions of powerful users with IT product specialists (Bygstad, 2017).

Business-IT alignment (Gerow et al., 2014; Reynolds & Yetton, 2015) can be understood as an influencing factor for enabling this organizational agility (Horlach et al., 2020; Tallon, 2007). Business-IT alignment describes the orchestration of the separate entities of business and IT to have them work together towards a common goal (Luftman et al., 1999), as a convergence of strategies of business and IT (Bharadwaj et al., 2013; Overby et al., 2006).

Linking all of this to DevOps, the orchestration of ISD in contemporary digital systems is deeply impacted by alignment of its decoupled structure (Wiedemann et al., 2020), above all development and operations (Hüttermann, 2012), and the evolution of its environment (Hemon-Hildgen, Rowe, et al., 2020). The concept of DevOps is a promising path to contribute to business-IT alignment (Gerow et al., 2014) and to reconcile different alignments models (Reynolds & Yetton, 2015; Tallon & Pinsonneault, 2011). While expanding AISD toward DevOps, autonomy of teams is increased by having parts of the business (rooted in AISD) and operations within the team (Fitzgerald & Stol, 2017; Hüttermann, 2021). As digitalization (Sandberg et al., 2020) continues, companies therefore increasingly implement DevOps in order to become more agile (Hemon-Hildgen, Lyonnet, et al., 2020), to constantly innovate (Hüttermann, 2021), and to achieve better business-IT alignment, where alignment is ranged on a continuum including shared goals and practices between functions (Hüttermann, 2012), assisted DevOps, to full coalescence (Hüttermann, 2021), that, in its extreme, may lead to a fused relationship of business and IT (Bharadwaj et al., 2013; Henry Lucas et al., 2013). Due to the emergent role of DevOps and its relationship to business-IT alignment, there are increasing calls for studies on successes and failures of implementing DevOps, specifically in large-scale enterprises (Maruping & Matook, 2020). Considering the lack of research about DevOps in general, and the missing understanding of dominant factors while introducing DevOps in large-scale organizations, and how this relates to digitalization, our goal is to theorize which factors are important to initially introduce DevOps in organizations to shed light on the role of DevOps in digitalization efforts.

3. Research Method

3.1. Literature Review

First, we conducted a review on IS literature to identify dominant concepts derived from past studies with relevance to our research question. Influenced by Webster & Watson (2002), literature was selected to identify concepts, and provide provisional codes as input for data analysis of the second stage of our study in form of a multiple-case study. The literature review is split into four phases: screening, filtering, testing, and packaging the final basket of literature. Screening included determining useful databases, identifying the search term, and developing the search strategy (vom Brocke et al., 2015). A recent literature review in IS

research (Sharp & Babb, 2018) ends with presenting an inventory of current publications. To focus on publications that combine high level of scientific rigor in IS research with strong practical relevance in the IS domain, we build upon the existing study (Sharp & Babb, 2018). This way, we accumulated a "relatively complete census of relevant literature" (Webster & Watson, 2002) of the IS domain aligned with our research design. The initial, complete background literature review also included other publications, for example, those of the software engineering domain and industry. Since the IS literature references these types of publications as well and to focus on the IS research stream (cf. Sharp & Babb (2018)), we focused our literature review of stage one on high-quality IS publications to extract relevant literature and the provisional codes for stage two (vom Brocke et al., 2015).

The initial background literature review unveiled that, although growing, the number of articles about the emerging DevOps phenomenon is relatively scant. For this reason, the search term was "DevOps" while we targeted peer reviewed papers, that were written in English (vom Brocke et al., 2015). Via AIS eLibrary (cf. Sharp & Babb (2018)), we searched in proceedings of AIS conferences plus the highly ranked, affiliated HICSS conference, to identify recent work of IS research covering the emerging DevOps phenomenon. Via EBSCOhost, we added relevant journal articles of the IS community. As part of the filtering phase, we fully read the resulting set of publications, checked how the subject domain was covered, and analyzed for relevance (Bandara et al., 2015). Analysis entailed identifying importance of the information being presented in respect of our research question (Bandara et al., 2015). This testing for applicability led to 23 articles in proceedings and 8 articles in journal outlets.

In the last phase, a forward/backward search uncovered four more yet undiscovered papers (according to our quality criteria), leading to a final list of 35 publications. Once all articles went through all of the above phases, the publications were streamed into our concept matrix (Webster & Watson, 2002) which emerged successively. Closing the last phase, we reordered lines and columns. The initial review of the background literature (the body of knowledge on DevOps, and digitalization) as well as the literature review (identifying the provisional codes for the second stage) were executed by one researcher and multiple student assistants. A graphical summary of the literature review and the concept matrix with all selected publications are available as Online Appendix A and B[1].

[1] The location of all online appendices is: https://osf.io/bkrhz/?view_only=84493d8e2b8743be97754abd2717ee93

3.2. Multiple-case Study and Data Collection

To achieve our goal to further unpuzzle the emerging DevOps phenomenon and its relationship to digitalization, the concept matrix from stage one identified dominant, relevant concepts as provisional starting codes for stage two. For stage two and as part of an overarching multiple-case study, we sampled a set of seven cases.

A multiple-case study is considered an appropriate method to build and extend concepts and theory (Dubé & Paré, 2003; Yin, 2018). Our cases are spread across industry segments including online entertainment, manufacturing, software, and finance. Cases are large-sized, international organizations. We expected them to go through a thorough decision-making process in complex organizational setups before they introduced DevOps. We started our study with the organization being the unit of analysis. As inside organizations several different DevOps implementations may be in place, the unit of analysis transitioned to teams developing and delivering IS products.

The main data source was interviews. Participants of the semi-structured interviews were highly knowledgeable informants spanning roles of developers/engineers, architects, and decision makers, see Table 1 for an overview of the demographics (names of organizations are anonymized for confidentially reasons). We followed a predetermined interview guideline emphasizing the narrative character of the open-ended interviews, and remained open for emerging themes (Brinkmann & Kvale, 2014). Case writeups were a complementary vehicle for theorizing and to triangulate evidence across participants and cases (Dubé & Paré, 2003; Yin, 2018).

Table 1. Multiple-case study: demographics.

Organization	Segment	Interviews
EntertainCorp	Online products	3 Platform engineers
StampCorp	Manufacturing	1 Manager, 1 Platform engineer
CashCorp	Insurance	1 Chief digital transformation officer, 1 Application domain officer
SoftwareCorp	Software	2 DevOps engineers, 3 Product owners, 1 manager
ManuCorp	Manufacturing	3 DevOps leads, 1 manager

LiquiCorp	Banking	3 Manager, 1 Dev engineer, 1 Product owner
InsureCorp	Insurance	1 Digital transformation manager, 1 IT manager, 1 Project manager, 1 Coach

3.3. Data Analysis

Following Saldaña (2016), we applied different coding strategies, see the coding process with illustrations (excerpt) in Online Appendix C. First, as part of stage one, we executed our literature review influenced by Webster & Watson (2002). It was assisted by applying open coding (Miles et al., 2020) to identify the dominant concepts of each publication relevant for our study. Second, we applied theoretical coding (Glaser, 1978; Saldaña, 2016) as a second cycle coding method to model the integration of codes. We integrated the codes with concepts from the background literature. The resulting concept matrix in turn served as provisional starting codes for the second stage.

In the second stage, we applied provisional coding (Saldaña, 2016) as an exploratory coding method to build theory from case studies. Our predetermined list of provisional codes was extended, augmented, and integrated with new, emergent codes if needed. The analysis of the qualitative data was further inspired by the coding family "process" (Glaser, 1978; Saldaña, 2016). We found that family helpful to theorize about dominant factors to introduce DevOps in large organizations (Van de Ven & Poole, 1990). A "process" is a way to group together sequencing steps to a phenomenon. If one factor is more dominant than other factors, or is part of a sequence, this offers hints for introducing DevOps.

The concepts were the basis for our theory building (Sarker et al., 2013) as a "thought trial" (Weick, 1989). Informed by our DevOps definition and the integration with background literature (see Table 2), this led to our primary concept of the "DevOps funnel". Its representation draws on work of Osmundsen & Bygstad (2021) who identified interaction cycles between management and employees. We asserted our emerging new concept and triangulated evidence across cases (Yin, 2018).

4. Findings

Our analysis reveals "success" and "practices" as most dominant to introduce DevOps in organizations. In its orchestration, these concepts act as a funnel to link success and practices across organizational levels, see Table 2. Online Appendix D provides further details on how the studied teams implement the funnel. We find that DevOps is an antecedent to achieve organizational goals such as "digitalization".

The first dominant factor is "*Success*", which we define as the goal or the measure an actor aims to achieve. Our study reveals that a team may have success criteria originally rooted in the team itself ("bottom-up"), for example, that value has to be delivered to customers in high frequency to increase customer satisfaction ("continuous delivery"). If defined "top-down", success is articulated to the team as a criterion, requirement, or as part of rules and norms given by the organization and its management, for example "digitalization", cultural change transformation, or shared economics to support teams to find the next most valuable thing to work on.

The second dominant factor is "*Actors*". Actors can be internal producers or consumers of an IS product, or producers of products or services needed by the team, or other parties inside the organization defining rules and norms that influence how the team produces their IS product. Actors span different organizational levels (management, employees) and functions (business, IS development and IS operations). At the organizational level, the upper management consists of actors who initialize practices and define success (e.g., digitalization). On a team level, with its roots in AISD (including development and the business), DevOps adds the operations function.

The third dominant concept is "*Practices*". Practices concerns the methods defined or used by actors to develop as well as deliver IS products. Practices are either rooted in the team ("bottom-up"), for example "automation" and "continuous delivery", or methods or initiatives originated by management ("top-down"), for example "sharing" across functions. As part of practices, teams utilize digital technology, see Online Appendix E for details per case. The three concepts "Success", "Actors", "Practices" are intertwined. The concepts Success and Practices are funneled top-down and bottom-up across organizational levels. We define this orchestration as the "DevOps funnel", see Figure 1. The "top-down" and "bottom-up" directions of the funnel visualize that functions not only align with each other, but rather "fuse" to autonomous DevOps teams. As part of DevOps, besides developmental and operational roles, the team also contains business roles. In its extreme, this leads to a fusion of business and IT, horizontally (fusion on the team level) and vertically (fusion across organizational levels).

In these cases, for providing value to customers in short cycles, IT and business are deeply integrated.

Table 2. The Concepts of the DevOps Funnel.

Concepts	References from background literature	Short descriptions	Short descriptions Funnel perspective	Exemplary quotes from case study
Success	(DeLone & McLean, 1992; Hüttermann, 2021; Petter et al., 2013)	A goal and its measurement.	Top-down: DevOps is a means to achieve organizational goals, e.g. sharing or digitalization.	*"Once you have established DevOps, it is definitely an accelerator for digital transformations." (CashCorp, Chief digital transformation officer)*
			Bottom-up: Goal, and its measurement, the team aims to achieve.	*"Cause it's the intention of the way of working that you deploy, that you add, that you constantly provide business value. […] Having short cycles, small portions, and adding business value every time, it really helps in customer satisfaction." (LiquiCorp, Product owner)*
Organi-zational actors	(Greenwood et al., 2020; Hemon-Hildgen, Lyonnet, et al., 2020; Osmundsen & Bygstad, 2021)	Human individuals (or a group of) as a source of action, and as such an entity that interacts with other actors, and the IS. Either on the team level (employee) or part of top management.	Top-down: Upper management, who initialize practices, define success, or their "buy-in" to those.	*"Digital transformation is innovation, automation and education. […] It is pushed by upper management. Our COO is an IT person. He wants to rebuild our IS. The teams always wanted it, but without having someone in the top management, it will not work." (CashCorp, Chief Transformation Officer)*
			Bottom-up: Actors at team level, who use and/or initialize practices, and act with others, while striving for goals.	*"With DevOps, we want to have collaboration between all the teams and all the different roles." (StampCorp, Platform engineer)*
Practices	(Hemon-Hildgen, Rowe, et al., 2020; Hüttermann, 2021; Wiedemann et al., 2020)	Rules and practices that define the relationship and organization among actors and the IS.	Top-down: Practices defined or initialized by upper management.	*"We have programs initialized by C-Level executives. One past program run a cultural change transformation, and DevOps was part of it." (SoftwareCorp, DevOps engineer)*
			Bottom-up: Practices initialized and applied by the team.	*"Within minutes, that new code can be taking customer traffic, its's typically hours before that new code is servicing all of customer traffic." (EntertainCorp, Platform engineer)*

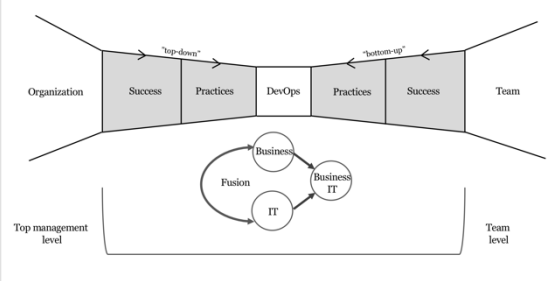

Figure 1. Representation of the DevOps funnel.

A manager explains the necessity of short iterations to stay innovative, with many actors included across functions and organizational levels:

> *"You have to keep innovating. Before, projects took years. Why can't I do that in small steps? So, give the customer something a little bit every time. And the good thing about that is that you get the feedback from users immediately, […] sometimes you only need to deliver 20% of the features and the twenty percent delivers 80% of the value. […] before we had the business department, with their own CEO. And they were delivering the business and they were telling us what to, but we skipped that. Now the business is part of the team." (LiquiCorp, Manager)*

This leads to teams of IT and business who are fully responsible for their product.

> *"Now the teams are fully responsible for everything. We do not have a segregated responsibility for production or another team is responsible for the product. They are together fully responsible. So, it is a collaboration not a segregation model." (LiquiCorp, Manager)*

If the goal of an actor is to deliver valuable outcome to customers, related actors must be identified to reach that success criterion (the customer and other internal teams), and practices have to be employed that enable the team to reach its goal (e.g., continuous delivery IS products). For example, if the team's success criterion is to support organization's digitalization efforts (given by upper management decision), actors and practices are identified and

employed accordingly. A DevOps lead explains the role of DevOps with regards to supporting digitalization efforts to stay competitive:

> *"We have to hit market windows of opportunity. Competition makes these windows increasingly shorter. It is an important program for our company to get closer to the customer, to react more agile to their demands. […] Digitalization is driving the entire company. We continuously collect user feedback. We work in short iterations with learning and improving and removing things if they don't work. […] Digitalization is pushed by the top management. They don't define the How. You need a good How in order to deliver the right products. With DevOps, we want to gather feedback what is the right product. And for that, it is of benefit to span the driver digitalization around everything." (ManuCorp, DevOps lead)*

With digitalization as on organizational goal given by management (the "what"), DevOps is considered to be the implementation (the "how"). DevOps reportedly serves as an enabler for digitalization efforts of the organization.

5. Discussion

Our research aimed to shed light on which factors are important for organizations to introduce DevOps, and how this relates to digitalization. Similar to enterprises who customize AISD (Fitzgerald & Stol, 2017), organizations tailor their respective DevOps implementations. Our findings show that the DevOps implementation of a specific team depends on success criteria, actors, and practices. Those three concepts dominantly influence DevOps' initial implementation in organizations. Depending on the defined success, actors are involved, and practices are employed, in order to fulfill the success criteria in the initial iteration of DevOps implementation. Since the concepts are interweaved (for example, new actors may result in new goals or practices), the team may later iteratively cycle between the steps, once the first DevOps implementation is in place as a foundation for further adaption (Dingsøyr et al., 2012; Lee & Xia, 2010).

With DevOps, success and practices are orchestrated across functions (business, IT development, IT operations) and organizational levels (management, employees). This finding supports previous studies which connect DevOps with the concept of measurement and sharing (Fitzgerald & Stol, 2017; Humble & Molesky, 2011; Hüttermann, 2012) across stakeholders (Hüttermann, 2021), and the importance of practices and actors for innovation and digitalization (Bygstad, 2017). We capture this orchestration of concepts through our first proposition:

> *Proposition 1: Through shared practices across actors from different organizational levels, DevOps positively impacts success.*

We unfold an important role of success in DevOps initiatives. Success can be conceptualized "bottom-up" and "top-down", fusioning teams across different actors and linking organizational levels (Burgelman, 1983; Greenwood et al., 2020; Osmundsen & Bygstad, 2021). Conceptualized bottom-up, holistic and humanistic success criteria are often preferred (see Online Appendix D), for example to increase customer satisfaction (DeLone & McLean, 2016; Petter et al., 2013) in competitive environments where power shifts to the customer can be observed (Horlach et al., 2020). As a holistic approach to development and operations of IS products, DevOps also intends to link to the "top-down" view: Success in DevOps initiatives conceptualized "top-down", as part of a digital innovation (Nambisan et al., 2020), evolves the installed base of extant socio-technical arrangements (Henfridsson & Bygstad, 2013), with a generative innovation as essential part of the development culture (Bygstad, 2017). Although intertwined, digitalization is typically an effort on the organizational level (Burgelman, 1983; Greenwood et al., 2020; Nambisan et al., 2020). The team (as the unit of analysis) with its actors introduce DevOps to achieve their goals, and organizational goals (for example digitalization). Supporting the findings of Osmundsen & Bygstad (2021), teams interact with the management by continuous back coupling through sensemaking and supporting ("top-down") and adopting and sense-giving ("bottom-up").

As evidence suggests, DevOps often leads to autonomous teams (Hüttermann, 2021). They are fully responsible for their respective IS product (Wiedemann et al., 2020), with continuous synchronization ("top-down", "bottom-up") between management and employees (Osmundsen & Bygstad, 2021). In DevOps implementations where teams also include developmental, operational and business roles, DevOps positively impacts business-IT alignment (Reynolds & Yetton, 2015). Because business and IT inherently share the same strategy and work together toward shared (business) goals around the customer value flow (Horlach et al., 2020), this goes even beyond a business-IT *alignment*, and may arguably achieve the sought-for tight *fusion* of business and IT (Bharadwaj et al., 2013; Henry Lucas et al., 2013). This fusion might suggest future paths to reconcile

different alignment models (Reynolds & Yetton, 2015; Tallon & Pinsonneault, 2011).

Across all studied cases, the DevOps funnel enables the organizations with its teams to continuously innovate (Alt et al., 2021; Osmundsen & Bygstad, 2021) to champion the continuous innovation (digitalization) of the organization (Osmundsen & Bygstad, 2021), by being able to quickly react in two ways: adaptively to disruptive changes in the environment and entrepreneurially to opportunities in market offerings (Chakravarty et al., 2013), by adapting business models and processes (Nambisan et al., 2020), to maintain or gain a competitive advantage (Bharadwaj et al., 2013). The suggested funnel contributes to scale agility to the entire organization. It is an antecedent for digitalization. Consequently, we posit:

> *Proposition 2: The DevOps funnel with its autonomous teams does positively contribute to digitalization efforts.*

While the funnel streamlines the organization with its teams, with their diverse goals, actors and practices (Davison & Martinsons, 2016; Hüttermann, 2021), our research indicates that its operationalization might look different across organizations in their diverse contexts (Davison & Martinsons, 2016; Hüttermann, 2021). It might be intuitive that the studied case of a market-leading provider of an online product (EntertainCorp) has a fusion of business and IT (actors in autonomous teams sharing success criteria and practices) (Bharadwaj et al., 2013; Henry Lucas et al., 2013), and thus inherently maximizes the level of alignment of functions (all functions are fused in one team).

On the other hand, it is surprising that, according to informants of LiquiCorp, a classic bank successfully transformed itself to a "software house with a banking license", thus a fully digital business. In both cases, IT has become both fabric and fusion (Henry Lucas et al., 2013), with DevOps playing an essential part to share success and practices across actors, horizontally and vertically (Reynolds & Yetton, 2015). From another example, in the case of ManuCorp, the industrial sector is again different. As a global manufacturing organization with a diverse product portfolio including power plants and trains, DevOps is reportedly also an antecedent on their digitalization way, however, digitalization with existing long-term inventory is considered to be a challenge ("brownfield digitalization", in the voice of a DevOps lead of ManuCorp). As suggested by Yoo et al. (2010), incumbent firms may address this challenge while combining physical and digital elements when digitalizing by applying the practice of using a layered modular architecture, to achieve transformation goals specific for their firm with its actors (Furr et al., 2022).

To implement a modular architecture (and to implement digitalization in general), the installed base of digital infrastructure (Bygstad, 2017; Yoo, 2013) can be a barrier as well. As informants reported, DevOps is more difficult to introduce when older technology is used (see Online Appendix E). Data further indicates challenges for organizations to find the right balance between IT exploration and IT exploitation while implementing fused teams (Gregory & Keil, 2015), specific to teams' respective environments, to bridge effectiveness and efficiency (Hüttermann, 2021) .

In summary, DevOps links an organization's digitalization effort (the "what"), defined by management (Furr et al., 2022), to "the how", how the team is developing and delivering the IS product (Gall & Pigni, 2021). These fused teams are fully responsible for their IS product (Bharadwaj et al., 2013; Henry Lucas et al., 2013; Wiedemann et al., 2020), scale agility across functions (Hüttermann, 2021), and innovate by reacting quickly to changes and business opportunities (Luftman & Zadeh, 2011; Nambisan et al., 2020; Osmundsen & Bygstad, 2021). In its visual appearance, the representation of the suggested concept of the DevOps funnel looks like an enterprise sandglass, a funnel, that is rotated counterclockwise by 90 degrees.

Our study is not without limitations. First, provisional codes are based on selected contributions of past studies of the IS community. Other studies may employ other filter and applicability criteria, broaden the basket of literature and include other publications as well (e.g., local AIS conferences, or publications from other conferences, industry papers, and outlets).

Second, we identified the three dominant concepts success, actors, and practices as the main factors for introducing DevOps. After initially introduced, adaptions of DevOps might lead to other, more, or different concepts. DevOps implementations are dynamic and may evolve over time.

Third, according to our research question and design, we aimed to reconcile existing knowledge of the body of the IS research for theory building, and to empirically assert our findings. Future research might detail the suggested concept "DevOps funnel", for example, by executing an in-depth, longitudinal, single case study research, empirically exploring how the case site does initially introduce DevOps, to detail on the "how" of introducing DevOps (in the sense of change and adaption of methods), and to provide further details on how DevOps funnels the organization and its teams, in a specific context,

including small-scale organizations, with barriers and challenges, to implement digitalization.

6. Conclusion

Existing literature on DevOps is diverse, and the role of DevOps in digitalization lacks systematic knowledge. To reconcile the growing yet scant set of studies of DevOps, we aimed to review valuable insights of past studies of DevOps from the IS domain, to empirically theorize and assert the suggested concept of "DevOps funnel", and to relate DevOps to digitalization. We contributed to and linked the discourses of research streams on DevOps and digitalization. In spite of our what we think timely and relevant findings to explain the role of DevOps that was imperfectly understood beforehand, and hopefully the valuable guidance it might provide for practitioners, this is not the end. We pointed to possible avenues for future studies on DevOps in order to further investigate the emerging DevOps phenomenon and how it relates to digitalization.

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