5-15-2019

KNOWLEDGE MANAGEMENT IN THE DIGITAL ERA: HOW DIGTIAL INNOVATION LABS FACILITATE KNOWLEDGE RECOMBINATION

Axel Hund
German Graduate School, axel.hund@uni-bamberg.de

Friedrich Holotiuk
Frankfurt School of Finance & Management, f.holotiuk@fs.de

Heinz-Theo Wagner
German Graduate School of Management and Law (GGS), heinz-theo.wagner@ggs.de

Daniel Beimborn
University of Bamberg, daniel.beimborn@uni-bamberg.de

KNOWLEDGE MANAGEMENT IN THE DIGITAL ERA: HOW DIGITAL INNOVATION LABS FACILITATE KNOWLEDGE RECOMBINATION

Research paper

Hund, Axel, German Graduate School for Management & Law, University of Bamberg, Bamberg, Germany, axel.hund@uni-bamberg.de

Holotiuk, Friedrich, Frankfurt School of Finance, Frankfurt, Germany, f.holotiuk@fs.de

Wagner, Heinz-Theo, German Graduate School for Management & Law, Heilbronn, Germany, heinz-theo.wagner@ggs.de

Beimborn, Daniel, University of Bamberg, Bamberg, Germany, daniel.beimborn@uni-bamberg.de

Abstract

Knowledge is widely regarded as a crucial organizational resource. In the pursuit of finding novel solutions to problems, organizations combine and re-combine knowledge and resources in different ways. This ultimately leads to innovation, which often is viewed as the ultimate reason d'être for organizations. While there exists a rich literature strand on knowledge management, the pervasive digitalization of entire industries creates new challenges. Different areas of knowledge are converging and organizations struggle with managing the rapidly increasing amount of heterogeneous knowledge. An increasingly popular approach to master the challenges of knowledge creation and recombination in the arena of digital innovation is the creation of Digital Innovation Labs (DIL). Although DILs provide a promising approach to the current challenges of innovating in a digital environment, we have only limited insights about DILs. To uncover how DILs facilitate knowledge management and recombination we conducted several case studies in different industries. Our results show how knowledge enters the DIL, how knowledge is applied and recombined and how knowledge is exchanged between units. Most importantly, we identify six key mechanisms that DILs use to master the challenge of knowledge management and innovation in a digital era.

Keywords: Knowledge, Recombination, Digital Innovation Lab, Case Study Research.

1 Introduction

Recombination of knowledge is the main driver behind the creation of innovation (Schumpeter, 1934). The notion that novel combinations of different forms of knowledge (e.g., concepts or components) lead to the creation of innovation is well established in multiple disciplines such as strategic management, innovation research and organizational research (e.g., Carnabuci and Operti, 2013; Karim and Kaul, 2015; Yoo et al., 2010). Hence, knowledge is commonly regarded as a crucial organizational resource, especially for successful innovation outcomes (Nonaka and Takeuchi, 1995; Alavi and Leidner, 2001; Trantopoulos et al., 2017).

During the last decade, the increasing digitalization led to new possibilities but also necessities to recombine knowledge. On the one hand, digitalization increases the possibility to tap into more heterogeneous sources of knowledge from outside the company (Majchrzak and Malhotra, 2013; Nambisan et al., 2017) due to a sharp drop in communication and coordination costs (Altman et al., 2015). This facilitates access to external knowledge and fosters the ability to combine internal and external

knowledge easily, creates, ceteris paribus, more opportunities for novel recombination and digital innovation (Saldanha et al., 2017; Trantopoulos et al., 2017). On the other hand, digitalization leads to an ever increasing pace of digital innovation (Yoo et al., 2012), which creates the necessity to acquire knowledge from various backgrounds (Saldanha et al., 2017) because digital innovation goes along with increasing knowledge heterogeneity (Nambisan, 2013). Furthermore, since digital innovation has already fundamentally transformed or even destroyed entire industries, organizations have a very strong incentive to find ways mastering the new challenges of creating new knowledge and innovating in a digitalized environment (Nambisan et al., 2017). An increasingly popular approach to master the challenges of knowledge creation and recombination in the arena of digital innovation is the creation of what we call Digital Innovation Labs (DIL). We define a DIL as an entity that is entrusted with the exploration of new digital technology and the development of digital products, services and business models (cf. Velten et al., 2016; Svahn et al., 2017). Independent from organizational subtleties, a DIL is designed to integrate knowledge from various backgrounds and produce digital innovations.

However, even though the rapid establishment of DILs is taking place in most industries (Velten et al., 2016) and the importance of knowledge as an organizational resource is irrefutable (Alavi and Leidner, 2001; Nonaka and Takeuchi, 1995; Trantopoulos et al., 2017), there is a dearth of literature on the relation between organizational entities such as DILs and knowledge recombination. Hence, we are not able to fully understand how organizational entities such as DILs facilitate the recombination of knowledge. In particular for DILs, there is limited empirical evidence for their success (Moultrie et al., 2007), although they provide a promising approach helping organizations to create innovation (Lewis and Moultrie, 2005). Thus, following a call for research to investigate how pervasive digitalization impacts knowledge and innovation from Yoo et al. (2012), this paper aims at shedding light on knowledge recombination in the context of DILs by answering the following research questions:

RQ: How do DILs facilitate knowledge recombination?

To answer the research questions, we apply the knowledge framework of Alavi and Leidner (2001) because it facilitates a more granular look on knowledge exchange and combination. We conducted four case studies with a total of 12 interviewees from various industries. In the following, we will provide an extensive overview about insights from extant literature. Subsequently, we explain how we structured and analyzed our case studies according to Yin (2018). In the next section, we present the results and lastly, we discuss the theoretical and practical implications of our findings.

2 Research Background

2.1 Knowledge and its Recombination in the Digital Age

Knowledge has long been established as a major organizational resource (Spender, 1996). The importance of knowledge is underscored by an entire literature strand that investigates organizational success from a knowledge-based view (e.g., Nonaka and Takeuchi, 1995; Carlo et al., 2012). Knowledge is especially valuable for organizations because innovation is created through the recombination of knowledge (e.g., Schumpeter, 1934; Yoo et al., 2010). Since innovation is the ultimate raison d´être of organizations (Drucker, 1955), there is a strong incentive for organizations to improve their ability to access, create and manage different areas of knowledge. Generally, innovation can be understood as anything that is novel by being different from existing things, thoughts and behaviors (Barnett, 1953). Digital innovation also has this aspect of novelty to it and additionally requires the usage of digital technology (Nambisan et al., 2017; Yoo et al., 2010).

In regard to knowledge, an important insight is the differentiation between implicit and explicit knowledge. Implicit knowledge is personal and hard to transfer, whereas explicit knowledge is codified and easily transferred (Nonaka and Takeuchi, 1995). This distinction is becoming even more relevant since an increasing part of the organizational value creation takes place across different units and companies (Lee and Berente, 2012; Lyytinen et al., 2016). Thus, relevant knowledge about a product or service is oftentimes dispersed across various contributors from different backgrounds (Yoo et al., 2010;

Lyytinen et al., 2016). The increasing distribution of relevant knowledge creates the need for new approaches to transfer and integrate implicit and explicit knowledge (Leonardi, 2011). Furthermore, due to the dramatic drop in communication and coordination costs caused by digital technology, organizations can now easily tap into heterogeneous knowledge from beyond their organizational boundaries (Altman et al., 2015; Saldanha et al., 2017). There are numerous organizational mechanisms to access external knowledge such as open innovation (Chesbrough, 2003, 2006), user innovation (Hippel and Katz, 2002) or crowdsourcing (Majchrzak and Malhotra, 2013). All of these mechanisms help accessing and acquiring knowledge from beyond the organizational boundaries and in doing so, also increase the heterogeneity of the available knowledge. However, the competitive advantage of knowledge will only be realized if the knowledge is applied to a specific product or situation, rather than just be held (Grant, 1996). Thus, the convergence of knowledge from different fields leads to an increased complexity but only leads to a competitive advantage if organizations find a way to apply the knowledge (Alavi and Leidner, 2001; Grant, 1996; Yoo et al., 2012).

The knowledge framework by Alavi and Leidner (2001) takes a more granular look on the knowledge transfer among individuals and groups. Knowledge is thereby investigated on three different levels: First, on an individual level, individuals possess implicit knowledge. Implicit knowledge can be shared with other individuals through various mechanisms. It can be externalized through e.g., documenting it in an explicit manner (Nonaka and Takeuchi, 1995). Once knowledge is documented, other individuals can learn about it and internalize the knowledge. Explicit knowledge can also be combined with other explicit knowledge. Furthermore, individuals can also share implicit knowledge directly through socialization (Alavi and Leidner, 2001). These different mechanisms of sharing implicit and explicit knowledge through socialization, externalization, combination and internalization are central for innovation and are depicted in more detail in the SECI model by Nonaka and Takeuchi (1995). Second, on the group/unit level exists the group/unit knowledge, which is an aggregation of individual knowledge. Individuals can draw on this collective knowledge and apply it to a specific situation. Through the application of knowledge, individuals can learn and add novel knowledge to the entirety of the group knowledge (Alavi and Leidner, 2001). Finally, on an inter-unit level there is also knowledge exchange between unit knowledge. This usually happens, e.g., through sharing of best practices or using organization-wide systems. Thus, groups/units are able to learn from each other's insights and knowledge (Alavi and Leidner, 2001).

2.2 Conceptualizing Digital Innovation Labs

Digital Innovation Labs (DIL) are separate entities of an organization where lab stands for laboratory. Laboratories are defined as a room or building equipped for scientific experiments, research, or teaching[1]. Labs are physical places where experiments are carried out. In the case of DILs, experimentation is done with a particular focus on digital technologies to create digital innovations such as new processes, products, services and business models (Yoo et al., 2010). Velten et al. (2016) provide different approaches to set up DILs. These approaches can be classified into four different categories, whereby all categories have the common goal to create digital innovation (Velten et al., 2016). Whereas the first two approaches aim to invest in and accelerate already existing ideas, two other approaches aim to create entirely new ideas for digital innovation. First, an incubator supports startups with office space, business services, or mentoring, among other and aims to support few startups. Second, an accelerator has several investments for shorter time periods to many startups. Third, the company builder realizes business ideas as a spin-off or subsidiary because processes and structures of the mother company are not supportive for the new business. Lastly, innovation labs encompass entities in which all activities directed towards digital innovation are concentrated.

In DILs, internal employees of an organization cooperate across disciplines and functions to create and implement new products, services or business models (cf. Svahn et al., 2017). To transfer new ideas

[1] Oxford Dictionary definition: https://en.oxforddictionaries.com/definition/laboratory (accessed 20.11.2018)

about digital technologies into the existing range of products and services, it is crucial to ensure proper integration and communication between the DIL and the rest of the organization (cf. Velten et al., 2016). Hence, DILs are not designed as a spin-off but remain in the organization. DILs leverage the special position and disconnect from units dealing with exploitation, to be innovative and focus on exploration (Velten et al., 2016). Furthermore, DILs are designed to encourage creativity through an open and stimulating environment and provide crucial tools to conduct and assess the required experiments. Space, resources, and facilitation are important factors for the DIL, yet they only provide the framework for innovation (Velten et al., 2016). The outcomes of DILs rely heavily on the employees involved and their knowledge. Furthermore, outcome is depending on employees' collaboration and interrelations among each other and the rest of the organization (Magadley and Birdi, 2009).

3 Method

Our research examines *how* DILs help establish conditions that facilitate the recombination of knowledge in a digital environment. "Case studies are the preferred strategy when "how" or "why" questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context" (Yin, 2018, p. 1). Thus, due to the real-life context of our research and the essence of our research question ("how"), case studies are an ideal approach.

We followed an multiple case study design with multiple interviews per case as described by Yin (2018). We selected our case study partners by (1) identifying relevant units that fit the definition of digital innovation labs and (2) selected two rather structurally integrated DILs and two rather autonomous DILs. In total, we conducted 4 case studies with three, in-depth expert interviews each. The DILs were founded between 2005 and 2016, and have between six to 30 employees. Furthermore, we organized three different interview partners per case – one with the DIL leader, one with a project leader within the DIL and one from outside the DIL. This approach allows us to gain further insights since we can triangulate the same case from three different perspectives. Additionally, we used interview notes and official organization data to round off our understanding of each respective case study. The interviews were individually conducted onsite by the authors (a pair of two interviewers in each case) during 2018. Our interviews were guided by a semi-structured interview guideline, which allowed us to guide the interview towards our areas of interest but at the same time allowed enough flexibility to follow up on interesting leads. The main categories of our interview guideline are: First, a brief introduction of the interviewers, the interviewee and some general information about the interview procedure. Subsequently, we inquired about demographical aspects of the DIL (mission, number of members, location etc.) and then followed up by asking questions about the exchange between the DIL and other units. Afterwards, we inquired about different levels of re-integration such as how the results of the DIL are used in the rest of the organization or whether there is an exchange of employees between DIL and other units. Moreover, we asked about differences in projects and an example of a specific project. Finally, we concluded by asking about the outcome (e.g., what is the output of the DIL) and the outlook (future developments). In addition, we include the focus of a DIL and distinguish between the level of autonomy and the level of integration (Birkinshaw et al., 2002). Autonomy describes the amount of decisions a DIL can make by itself, whereas integration is about the extent of close collaboration with other units within the same organization. Since no DIL is entirely autonomous or integrated, these are only indications whether a DIL leans towards autonomy or rather towards integration.
All interviews were recorded and transcribed in order to code them in MaxQDA 2018. Table 1 provides an overview over the conducted case studies.

Case	Industry	Goal/ *Focus*	ID	Interviewee Position and Background	Length
A	Logistics	Creation of new products and services as well as improvement of existing products / *Autonomous DIL*	IP01	… is head of the DIL and reports directly to the CEO and the executive board of the company. IP01 is in charge of three teams working on digital innovation with different topics.	90 min
			IP02	… has been working for the company for more than 10 years and has a strong background in logistics. IP02 heads a unit for process and system management in the organization. Some people of the unit are actually working in a team within the DIL.	55 min
			IP03	… has a background in physics and is a product manager inside the DIL and responsible for one team. Focus of the role is to motivate people and aligning the different knowledge domain to the project goal.	57 min
B	Credit Agency	Creation of new services aligned to the business / *Integrated DIL*	IP04	.. is the CTO of the organization and at the same time the head of the DIL. IP04 has a background in research and a PhD in data science and information management.	90 min
			IP05	… is a project manager in the DIL and earned a PhD in data analytics and predictive systems. IP05 work in the field of data management and heads a team for search algorithms and data quality insurance.	90 min
			IP06	… has previously worked in consulting, is now a product manager (outside the DIL) and was working on one project with the DIL. Product managers are at the intersection between business and IT.	70 min
C	Banking	Creation of new services and products / *Autonomous DIL*	IP07	… built the DIL with external consultants. Now IP07 is responsible for the DIL's products, the cooperation with FinTechs and start-ups and team management. IP07 has a background in business IT, creative methodology and worked as a consultant for digital products before.	74 min
			IP08	… works for the digital sales of the firm and in a role as coordinator or link of incumbent firm and DIL. IP08's responsibilities include sourcing ideas, connecting relevant employees and sourcing new members for temporary DIL programs. IP08 has a banking background with an apprenticeship in a banking branch and a degree in cooperate banking.	74 min
			IP09	… is responsible for coordinating and managing the DIL's teams and communicating with top management. IP09 has a degree in biology, an 11-year software project management and startup background. IP09 started to work for the incumbent firm as a project manager first and based on, inter alia, his recommendations the DIL was founded.	64 min
D	Banking	Improvement of existing services aligned to the business / *Integrated DIL*	IP10	… is responsible for coordinating the various innovation initiatives in the decentralized group. IP10 has a strong background in innovation management and is well connected in the group.	53 min
			IP11	… is responsible for innovation and digitalization for the corporate client business of the bank. IP11 has an eight-year background in rating and investor relations, was then a founding member of the digitalization unit, and helped build the initiative. IP11 therefore has a deep understanding of the DIL's structure and mission.	69 min
			IP12	… trades corporate and government bonds with a focus on e-commerce sales. After the DIL was launched in the organization IP12 joined the program to develop an idea to improve operation in trading.	61 min

Table 1. Case Study Overview

The coding process was conducted by two of the authors and followed the guidelines for deductive qualitative content analyses specified by Mayring and Fenzl (2014). We chose a deductive approach to better understand the established insights about knowledge management in the newly arising context of the digital revolution. The analysis started with explicitly determining a research question. For this paper, our focus clearly lays on understanding how knowledge is exchanged and recombined in an organizational and pervasively digitalized context. Afterwards, we reviewed extant literature to identify a

fitting framework, which we found in the framework of Alavi and Leidner (2001) as described in section 2. The framework takes a more granular look into how individuals exchange knowledge and how this knowledge can become part of a groups shared knowledge. Furthermore, it depicts how new knowledge can be created through the application of existing knowledge and lastly, it shows how group knowledge can be shared between different groups (Alavi and Leidner, 2001, p. 123). Thus, the framework helps structure the examination of knowledge exchange between individuals and units, between different units, and how knowledge can be applied and integrated. These insights informed the subsequent design of the deductive coding categories. Following this framework, the primary process of coding is guided by three questions:(1) How does knowledge enter a specific unit?, (2) How is knowledge integrated and recombined? and (3) How is knowledge exchanged between different units? All of these three considerations are depicted through the arrows in figure 1. The dashed arrows depict how knowledge (or employees with knowledge) enter or leave specific units. The circle-arrows in the middle depicts how knowledge is integrated and recombined. The drawn-through arrows between the business, IT and DIL unit depict how knowledge is exchanged between units.

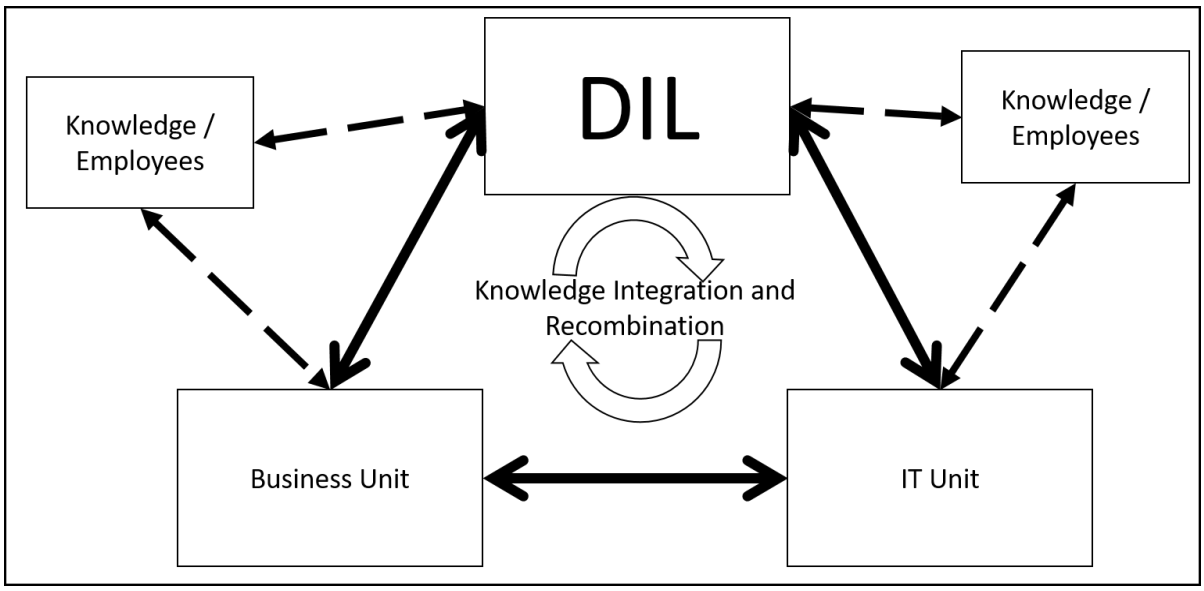

Figure 1. Framework based on Alavi and Leidner (2001)

With this framework in mind, we started to deductively code the interviews in MaxQDA2018. In a first step, we went through the case studies and organized relevant statements within the categories of the framework. After categorizing we had a total of 46 statements in the first category (how knowledge enters the DIL), 98 statements in the second category (how knowledge is applied and recombined) and 191 statements in the third category (how knowledge is exchanged between units). Thus, the first step of filling the deductively established main categories was completed.

In a second step, we inductively coded for emerging subcategories within the main categories as recommended by Mayring and Fenzl (2014). This helps gain a better understanding over the topics that make up the main categories, thus, improving conceptual clarity. We present our findings in the next section.

4 Findings

We are now presenting the results of the deductive qualitative analysis (Mayring and Fenzl, 2014). The chapter is structured along the three levels from the knowledge framework of Alavi and Leidner (2001). First, we present insights on how knowledge enters the DIL. Second, we show how knowledge is applied and recombined in the DIL. Third, we present our results showing how knowledge is exchanged between units such as IT units, business units and the DIL. Furthermore, within each section, we present the main

subcategories that we uncovered during the inductive second stage of coding within each level as recommended by Mayring and Fenzl (2014).

4.1 How Knowledge Enters the DIL

In order to gain new knowledge, the DIL is integrating existing knowledge via transferring people from the rest of the organization to the DIL. In particular, this is true when it comes to the *head of the DIL*. In all the cases, the heads have been with the organization for quite some time and are fairly well-known in the organization. In that sense, the heads present the original base of knowledge inside the DIL.

People. Most importantly, the DIL is characterized by *cross-functional knowledge*. This knowledge is carried by the people joining the DIL. The majority of people working in the DIL comes from the rest of the organization. They provide different backgrounds and, hence, a diverse set of skills. Most importantly, they carry knowledge about current business of the company and can assess how digital innovation fits. The diverse knowledge enables that "all skills, required to achieve the goal, are in the team" (IP03) inside the DIL. Moreover, to ensure that always new knowledge is entering the DIL, *people rotation* is applied. It allows people from the rest of the organization to temporarily join the organization and contribute their knowledge. To join the DIL only *key personnel* from the rest of the organization is recruited. The goal is to leverage the diverse existing knowledge of the company and to staff the DIL with internal employees by selecting the best people. People selected for the DIL have to be *highly motivated* and willing to go the extra mile. Still often the internal knowledge inside the organization is insufficient for the DIL. Thus, the DIL *integrates external knowledge* to complement the internal knowledge. External knowledge is also needed to spark new ideas. In one case we observed that start-ups are invited to the DIL. Personnel of the DIL and start-ups work together in the same space. In particular, when it comes to developing and implementing the innovation, "external support in form of external IT resources" is used (IP04). External knowledge enables to *scale the ideas* of the DIL and to provide exactly what is needed.

Team. In order to ensure that the knowledge of the people inside the DIL is efficiently used and shared, teams in the DIL have a very *small team size*. The small size enables close collaboration and people have a good overview about what everybody is doing. We observed that not more than seven to ten people are in one team. Otherwise, "working effectively is no longer possible" (IP01) and the focus is lost. Small teams ensure the *aligned focus* on single domains to push innovation forward in a fast-paced manner. If teams are getting inflated they would lose their focus. Additionally, if new people enter the DIL they usually replace other people to maintain the fairly fixed team size and to keep the intimate character. Inside the DIL, a new *way of thinking* is established which allows employees to go beyond the previously existing boundaries. Still, this can be difficult "as people who have been in the organization (outside the DIL) for a long time, are difficult to be infused with a new of thinking" (IP02).

4.2 How Knowledge is Applied and Recombined

The teams inside the DILs are very diverse and they integrate heterogeneous knowledge. To make the work effective they all follow specific plans or working processes, which define their task. Interestingly, there is no standard or industry-wide solution for the process, but similarities and commonalities are noticeable. All work routines inside the DIL are designed to capture the entire phenomena or idea under investigation. The DIL is not just the initiator of new knowledge, the user of knowledge, or the distributor of knowledge. By focusing on the entire process, the DIL is able to greatly accelerate the process of developing digital innovation by recombining knowledge inside the DIL.

Innovation. The goal of the process inside the DIL is to *accelerate ideas*. The knowledge among the employees in the DIL is leveraged to quickly test ideas. By doing so, the DIL supports the innovation process of the company by providing a concrete prototype, which can be used to discuss the idea further. The team can decide if "the prototype is good or not" (IP12) and if is worth to proceed the idea. Thus, knowledge is quickly build up and used to evaluate the idea. To organize the different steps of the innovation process DILs apply a *structured innovation process*. This process often covers the following

layers: "First, an idea enters our innovation lab, next is the prototyping phase, testing the idea over a certain time frame, then a proof of concept, to develop a minimal viable product or something similar, and subsequently the realization phase" (IP10). The different steps are aligned in the DIL to build up knowledge and the "methods are used to develop ideas further" (IP12). Projects start with an ideation or discovery phase where new ideas are explored and possible collaboration with start-ups, among other, is considered. "The screening of the market identifies ideas from the different corners" (IP09) of the environment to raise awareness for different trends. Subsequently, the ideas are evaluated with user feedback and interviews. Next, a "prototype is developed, which is tested with users" (IP09) and later also presented to the wider organization. The innovation process is very intense; hence, not more than three to four projects are running simultaneously. In one case, the focus is even just on two projects.

Work Practice. The DIL adopts many work routines from the *agile work practices*. A lot of meetings and procedures are adopted from the well-known scrum framework. In all cases, the planning of tasks is scrum-based. Tasks are divided into sprints and stand-ups, additionally retrospectives are held. Still, existing frameworks are not used without adaption and most of the work routines are customized and mixed with other practices. The work practice is referred to as "informal scrum" (IP05). Often this is led by the head of the DIL who is experienced in innovation management. The adaptations are targeted to make knowledge faster accessible. Still, the overall structure in of sprints is maintained and there are a lot of scrum-based stand-ups and planning meetings. To reflect on the new gained knowledge in the DIL, work practices include various *forms of feedback*. One of the most important one is the scrum-based retrospective to identify "how we can get better" (IP09)? The feedback is not only coming from outside the DIL (e.g. internal (business or IT) or external (start-ups)) but also from inside the DIL. There is a number of events, which stimulates exchange and feedback to critically reflect the ideas. These events also occur outside the regular working hours. To receive feedback quickly and early, the work practices focus on *developing prototypes*. Prototypes stand between the initial idea and the minimum viable product, which is often considered as the end of the structured innovation process in DILs. The scope of the prototype ranges from fully developed applications, over interfaces to test the integration of a solution provided by a Fintech, to click dummies based on a GUI. A prototype is suited as boundary object where people discuss the application of new knowledge and how it can be used to transform a product or process. People are motivated to contribute their ideas to new prototypes and to do their daily work based on what they consider to be most important in close alignment with the team. *Intrinsic motivation* is used to trigger everybody to contribute what they can do best. It is evident that people are willing "offer their help" (IP09) and develop ideas further. People inside the DIL have a fairly good overview of the ongoing projects, due to the small size of the DIL and the teams they are able to identify where knowledge is missing and where their knowledge might be of help. Due to the iterative nature, new knowledge is often pushed directly into the teams by other team members. This goes along with "people going crazy, instead of just following one goal" (IP07). People feel highly motivated to contribute their ideas and knowledge, hence, there is no need to track time or define working hours.

Collaboration. Ideas and knowledge inside the DIL is spread through *intensive collaboration*. Collaboration is encouraged and even supported by a new physical office structure in most cases (three out of four cases). People sit at one desk as a team instead of being separated by walls between the different offices. Due to the new facilities the office space "is more communicative" (IP09) and triggers more collaboration. The collaboration allows people to "coach each other" (IP09) and build up knowledge internally. Generally speaking, the work inside the DIL is characterized by very *little friction* among people and collaboration and exchange inside the teams stretch to even outside the working hours. There is physical room inside the DIL to exchange ideas.

Communication. The way how a DIL works is often compared to a *hub*. A hub offers many different tasks and services to other units of the organization. At the same time, a hub is used a central point for of contact for new ideas and innovative project. These two features allow the DIL to align its work. On the one hand, the DIL integrates a lot of knowledge in itself to further accelerate idea generation. On the other hand, through its central role, people working in the DIL can make sure their knowledge spread out in the organization and does not only stay in the DIL. Knowledge is spread out through into the

organization via *transparent communication*. Transparent communication is important to ensure the constant backing and support of the projects. The DIL is "continuously showing what is coming out in form of ideas and solutions" (IP11), which will in turn increase the acceptance. Presenting the outcome let people in the organization believe in the effectiveness of the DIL and builds trust. Hence, DILs can clearly differentiate themselves from any external consultancy or agency, which often lacks the needed transparent communication. To provide further transparency, DILs use internal communication platforms (like Slack) to display ideas and track the progress of the projects. Platforms also allow employees to submit new ideas, provide feedback to existing projects, and inform themselves about new technologies (and their potential impact).

Teams. The teams inside the DIL and the DIL itself are *independently organized*. Working inside the teams is connected with getting a lot of freedom and the autonomy to define an own agenda. The DIL can "with regard to decision-making decide autonomous" (IP09). At the same time, this is also designed as a self-defense mechanism to protect the DIL from internal politics. The DIL can harvest the knowledge of the organization, but remains distant to avoid any organizational drawbacks. The knowledge inside the DIL is shared among team members based on intrinsic motivation and equal contribution. There are *flat hierarchies* and people are contributing their best knowledge and offer their expertise.

4.3 How Knowledge is Exchanged Between Units

During the analysis, three subcategories emerged that are central for the understanding of how the exchange of knowledge between the DIL and other units or functions.

Cooperation. The most prevalent topic that emerged during the analysis of how knowledge is shared between units concerns the different aspects of cooperation. We found insights about it in every single interview. In the following, we present the most important ones. First, the *challenges of cooperation* can be found in every case study. When cooperating beyond the boundaries of a unit there is the challenge of aligning different sets of vocabulary (IP02, IP06), different mind-sets (IP02), and different workflows (IP07). Oftentimes, different units use different sets of vocabulary, which can lead to communication breakdowns. For example, IP06 states that one of the main problems in the "(…) collaboration with colleagues from the Innovation Lab is that there are always linguistic problems between them and the legal department in particular (…)". Thus, different units oftentimes struggle to align their mind-sets and workflows because both sides have different interpretations of what is going on. Another challenge is the management of overlapping responsibilities. Since DILs are established as a new unit within the ecosystem of already existing business and IT units a partial overlap is inevitable. Especially since DILs commonly deal with overarching interface tasks. In case B for example, IP05 states that: "(…) we have the highest overlap in IT direction (…)". In order to facilitate cooperation, the specification of clear targets and responsibilities was mentioned to be particularly important (IP03, IP04). The clarification of explicit targets and responsibilities was mentioned to help with cooperation. IP04 puts it as follows: "(…) there are different departments and each department tries to perform as good as possible on its own tasks and tries to secure itself. Thus, there is also little consideration for what the other needs when, so to speak. Instead, (the departments or units) take their time (when it is a task from another department or unit)". Here, a clear formulation of responsibilities and tasks helps avoid bottlenecks since there is clarity about what has to be done and what not. Furthermore, common goals lead to common motivation and thus improve cooperation (IP04). Moreover, one interviewee (IP01) pointed out that part of the inherent challenge for DILs is that their focus mostly is on interface topics, which require the cooperation between vastly different units. Despite these hurdles, IP01 stated the reason why it is important to establish DILs: "I have optimized all the topics that I could optimize in my functions over the past 15 years so there is not much to win anymore. The topics that are relevant now are cross-functional; (cultivating these topics) is only possible when I cultivate good cooperation. Of course, I can try to work between three silos, but that is doomed to failure. I have to try to pull the topics out (of these units)".

Second, in order to facilitate cooperation between units, specific *methods of cooperation* are discussed

in every case. Generally, DILs appear to have a strong focus keeping communication channels to other units open. As a tool of choice, many interviewees mentioned regular meetings (IP02, IP04, IP06, IP08, IP09), open door policies (IP10-12), and workshops (IP04, IP12). All of these methods aim at facilitating regular exchange and realignment of ideas, workflows and tasks. Additionally, in every case there were specific mentions of persons that function as connectors between different units. Those people are described as being well-connected key-players with the ability to spark action as well as mediate between different parties. Such persons were described to bridge different units and groups by bringing together the right people. Generally, the strong focus on meetings and workshops may be explained by the perception of the DIL within the organization and the need for open, inter-unit communication. Since DILs are fairly new, they have to deal with skepticism from other units and, thus, focus on clearly communicating their role and value. Or as IP04 stated: "Absolutely, in the beginning we often got questioned. (Many people asked why we) need such a new unit here?" Staying transparent and communicating regularly was mentioned to be an effective remedy (e.g., IP12).

Autonomy. Within the cases A, C and D, a total of six different interviewees (IP01, IP02, IP07, IP09, IP10, IP12) discussed the level of autonomy in regard to how the DIL interacts and cooperates with other units. Oftentimes, the level of autonomy a DIL has strongly influences how it interacts with other units and how it´s eventual ability to apply and recombines knowledge. Depending whether the focus of the DIL is on creating new ideas themselves or on realizing and improving ideas from other units, the level of autonomy was either high or low. This has several implications. First, if the DIL mainly focuses on *creating new knowledge and products,* high autonomy over the selection of topics was mentioned to be important. For example, IP07 stated that: "We do not have to prove anything here. There it goes. The hub itself, can completely decide for itself which topics it wants to deal with, and what it does." This gives the DIL the freedom to explore new areas of knowledge without interference from other units. On the other side of the spectrum, are DILs that do not create new ideas and knowledge themselves but rather *follow up on ideas from other units*. For example, IP10 stated that: "It is important to mention that the ideas and projects all come from the business unit. What my unit does not do is develop ideas by itself." Thus, the autonomy over the selection of topics is low but a close cooperation with other units is possible. Furthermore, there are implications for the geographic location of the DIL or as IP01 put it: "So when we have 'Make-Better' topics, we need the proximity to the headquarters. The moment we say we're doing 'Make-New' topics we do not actually need to be near the headquarters." Since the DIL of case A is pursuing both approaches simultaneously, there is an ongoing discussion about whether or not the DIL should move further away from the other business units. In comparison, the DIL of case D is focused on following up and realizing ideas from other business units, thus, proximity to the other units is important to ensure a high level of alignment and integration.

Handover. Several interviewees mentioned the handover of projects between units as important (IP01, IP07, IP09, IP10). DILs often develop projects through several stages up until the point when the key responsibility for a project is handed over to another unit. Generally, there seems to be the risk of projects being slowed down or even watered down once they are handed over to another unit. The interviewees mention various reasons such as different clock speeds within the established units (IP07), a missing vision in which direction the product should develop (IP09), or lacking handover processes (IP10). Important steps to mitigate the friction during handover are, for example, the involvement of a person from the unit that eventually takes over the project (IP09). Ideally, this person is involved in the entire process and has the opportunity to collaborate in the project. When the project is handed over, the person can manage the further development and clearly motivate why the project is relevant (IP09).

5 Discussion and Conclusion

This paper sets out to answer the question: "How do DILs facilitate knowledge recombination?" During the analysis, we uncover several, specific mechanisms that DILs employ to facilitate knowledge recombination. In the following, we present the respective mechanisms and discuss their implications for knowledge recombination along the three different levels of how knowledge enters the DIL, how knowledge is applied and recombined and how knowledge is exchanged between units as adapted from

Alavi and Leidner (2001). The key mechanisms are liaison employees, workshops, aggregation of cross-functional knowledge, small teams, rotations and exploration. We uncover these key mechanisms by analyzing the results presented in section 4 and evaluating their impact on each of the three levels.

Liaison Employee. The concept of liaison employees emerged as an important mechanism. Liaison employees are well connected and have the ability to spark action as well as mediate between different parties. Through their capacity to find a common denominator between different areas of expertise, they are able to enable knowledge transfer and recombination on all three levels. First, they help knowledge entering a unit by sharing the cross-functional knowledge they possess themselves with the unit. Furthermore, they have the ability to identify (and access) valuable knowledge in different areas. Second, they enable integration and recombination of knowledge by translating between different knowledge domains, thus, avoiding communication breakdowns and misunderstandings. Additionally, liaison employees are described as being able to understand customer pain points and enrich the accessible knowledge base within a DIL with an 'outward' perspective. Lastly, liaison employees facilitate the knowledge exchange between units by having an overview over several areas of knowledge and understanding the bigger picture. Thus, they can connect the right units to enable projects. At the same time, they can estimate the probability of realization for a given project.

Workshops. Workshops emerged as a valuable mechanism to communicate knowledge and synchronize objectives and expectations across different individuals and units (Svahn et al., 2017). First, workshops help knowledge entering a unit by communicating knowledge from a unit directly to members of other units. Thus, the participants of the workshop are able to access cross-functional knowledge. Second, a scheduled workshop requires the organizing unit to prepare the knowledge that is going to be shared and communicated. In order to be shared, implicit knowledge has to be converted into explicit knowledge, which then enables the combination with different knowledge (e.g., Nonaka and Takeuchi, 1995). Hence, workshops enable the integration and recombination of knowledge. Finally, workshops help communicate knowledge across unit boundaries. Furthermore, workshops prove insights into the work and objectives of the organizing unit, thus, synchronizing the expectations towards the unit from other departments.

Aggregation of Cross-Functional Knowledge (CFK). A rather informal mechanism emerged from the case studies, which is the objective to aggregate CFK. A focus on aggregating CFK helps knowledge recombination on every level (Yoo et al., 2012). First, employees are encouraged and empowered to engage with knowledge from other areas. Thus, they are able to learn about new topics and subsequently bring new insights into their unit. This might be especially powerful to overcome silo-mentalities. Second, a positive attitude towards the value of aggregating knowledge from different areas facilitates the recombination of knowledge. Lastly, units have a strong incentive to collaborate with units in other areas of expertise, thus, enabling access to new knowledge sources.

Small Teams. Small teams allow for a high density of knowledge. Although, teams are staffed with people from different domains and functions they are placed in one team and in the same location. These often share a large table where everybody sits together to enable knowledge recombination. First, people bring in the knowledge based on their background and education and share it with the other team members. Second, through the small team size the can be easily shared in stand-up meetings and everybody has an overview of all tasks and newly generated knowledge. Third, due to the concentrated teams and the good connection to the rest of the organization, the new knowledge remains manageable and can be easily reflected back to the organization.

Rotation. People join the DIL for some time and rotate between being part of a team in the DIL and their actual position/role in the organization. This is certainly not true for all people in the DIL, but a number of people rotate between DIL and the rest of the organization to increase the knowledge inside the DIL. First, through rotation people build up specialist knowledge in their actual position and bring this knowledge then in the DIL. Second, people are encouraged to connect, network, and collaborate with other people while being inside the DIL. This allows a connection of knowledge of people who are currently in the DIL (Holotiuk and Beimborn, 2018). Third, by going back into their actual position people can report about the DIL's project and bring new gained knowledge back into the organization.

Exploration. The DIL presents the organizational vanguard in the digitalization space of the company. It includes the relevant skills, knowledge domains, and tools needed to tackle the challenges of knowledge recombination (Henfridsson et al., 2018). By exploring the digitalization domain with experiments and testing new technologies, the DIL creates company-fitting knowledge about digitalization. First, the DIL depends on the diverse knowledge of different employees to understand implications of digitalization for the current business. Second, people work together on new technologies and advance digital technologies by combining them (e.g. Blockchain and IoT). Third, the frontier knowledge about digital technologies allows exploring further domains and generating new ideas inside the organization.

Mechanism	**Level of Influence: How is knowledge…**		
	…entering the DIL?	**…applied and recombined?**	**… exchanged between units?**
Liaison Employee	Can share cross-functional knowledge. Is able to identify necessary knowledge elsewhere.	Translates between different knowledge domains. Is able to understand/identify customer pain points.	Has an overview and can connect the right units. Understands the big picture and the potential of successful realizations.
Workshops	Cross-functional knowledge is communicated to other unit members.	Process of preparing knowledge for workshops, requires making it explicit and accessible for cross-boundary communication.	Helps communicate knowledge across unit boundaries. Provides insights into work of the unit.
Aggregating CFK	Empowers employees to acquire knowledge from other areas of expertise.	Creates an incentive to combine available knowledge with new and different knowledge.	Creates an incentive for units to cooperate with units from outside their own area of expertise.
Small Teams	Employees are handpicked for the DIL and bring in their diverse knowledge.	Everyone sits at "one" table to allow an efficient sharing of knowledge.	Agile working practices to share knowledge beyond the boundaries of the team.
Rotation	Employees bring their knowledge and experiences from their actual position into the DIL.	People are encouraged to connect, network, and collaborate with other people.	People go back to their actual position and can report about the DIL's project.
Exploration	The diverse knowledge is leveraged to explore the opportunities created by digital technologies.	Advance the knowledge on digital technologies by combining them.	Transfer the frontier knowledge of some domains to further domains.

Table 2. Mechanisms and their Influence

Although our research yields important implication on knowledge recombination, we have to recognize some limitations. First, our research is qualitative and thus limited to produce statistically generalizable results. Rather, it aims at understanding *how* a defined phenomenon functions in order to uncover fruitful avenues for future (confirmatory) research. Furthermore, while our chosen sample of four case studies with a total of 12 interviews can be considered a great representation of DILs, it is restricted to three industries and thus might exclude valuable insights from other industries. Moreover, it is important that our results are only applicable in the context of digital innovation labs. Additionally, our deductive coding framework focuses on organization internal knowledge exchange and recombination. It is possible that external factors also play a role, however, this is beyond the scope of this study. Lastly, human errors in the process of coding might be possible. However, we followed established frameworks in extant literature (Mayring and Fenzl, 2014; Yin, 2018) to mitigate any risk as far as possible.

Our research comes with a number of implications for future research. First, we were able to uncover mechanisms that DILs use to facilitate knowledge recombination. We further demonstrated how these mechanisms influence knowledge transfer and recombination on an individual and unit level (adapted from Alavi and Leidner, 2001). In future research it would be interesting to investigate how each mechanism is related to specific (digital) innovation outcomes. Furthermore, we do not distinguish between different types of knowledge. Extant literature already established valuable insights about different forms of knowledge such as temporal distant vs. temporal proximate knowledge (Massis et al., 2016) or

technology vs. market knowledge (Siegel and Renko, 2012), which would be interesting to investigate in a DIL context. Moreover, we identified some different types of DILs - some have a stronger focus on creating new knowledge whereas others rather follow up on insights from other units. In our sample, these differences are connected to differing levels of autonomy from the rest of the organization. From an organizational point of view it would be interesting to study what set up is actually ideal for which purpose. Another aspect, which would be interesting to examine is the question of how to define and quantify the success of a DIL. There are various ways of defining the goals of a digital innovation lab, thus, there is an opportunity for further investigation. For practitioners that are currently setting up DILs our results provide suggestions for mechanisms, which can be implemented to overcome typical hurdles such as miscommunication and a general misunderstanding of the objectives of the DIL. Moreover, our results show that there is an increasing need for cross-functional knowledge and cross-functional thinking. This insight is underscored by extant literature that describes the increasing convergence of formerly unconnected areas of expertise (e.g., Yoo et al., 2012) and the importance interfaces between different units (O'Connor and DeMartino, 2006). Furthermore, we summarized the most important mechanisms and their respective influence in table 2.

In conclusion, this paper takes a first step towards investigating the recombination of knowledge in the digital era by taking a granular look on DILs in three different industries. We derive our findings by building upon the insights from the literature on knowledge management and on digital innovation. Our results suggest that the pervasive digitalization causes new challenges. Different areas of knowledge are converging and organizations struggle with managing the rapidly increasing amount of heterogeneous knowledge. This necessitates a stronger focus on cross-functional knowledge and thinking, which has various implication for governance, knowledge, organization, and innovation research.

We have presented six mechanisms that are paramount for knowledge recombination within DILs. All mechanisms have in common that they enable how knowledge enters the DIL, how knowledge is applied and recombined and how knowledge is shared across organizational units. Our results show that if companies apply these mechanisms, DILs allow to master the challenges of pervasive digitalization and that companies can gain a competitive advantage by superior recombination of vast amounts of highly heterogeneous knowledge.

References

Alavi, M. and D. Leidner (2001). "Review: Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues" *Management Information Systems Quarterly* 25 (1).

Altman, E. J., F. Nagle and M. Tushman (2015). *Innovating Without Information Constraints*. *Organizations, Communities, and Innovation When Information Costs Approach Zero.* Oxford: The Oxford Handbook of Creativity, Innovation, and Entrepreneurship.

Barnett, H. G. (1953). *Innovation*. *The Basis of Cultural Change:* McGraw; Pencil Underlining edition.

Birkinshaw, J., R. Nobel and J. Ridderstråle (2002). "Knowledge as a Contingency Variable. Do the Characteristics of Knowledge Predict Organization Structure?" *Organization Science* 13 (3), 274–289.

Carlo, J. L., K. Lyytinen and G. M. Rose (2012). "A Knowledge-Based Model of Radical Innovation in Small Software Firms" *MIS Quarterly* 36 (3), 865–895.

Carnabuci, G. and E. Operti (2013). "Where do firms' recombinant capabilities come from? Intraorganizational networks, knowledge, and firms' ability to innovate through technological recombination" *Strategic Management Journal* 34 (13), 1591–1613.

Chesbrough, H. W. (2003). *Open Innovation*. *The New Imperative for Creating and Profiting From Technology*. Cambridge, MA: Harvard Business School Press.

Chesbrough, H. W. (2006). *Open Business Models*. *How to Thrive in the New Innovation Landscape.* Boston, Mass.: Harvard Business School Press.

Drucker, P. F. (1955). *The Practice of Management.* New York, NY: Harper & Brothers Publishers.

Grant, R. M. (1996). "Toward a knowledge-based theory of the firm" *Strategic Management Journal* 17 (S2), 109–122.

Henfridsson, O., J. Nandhakumar, H. Scarbrough and N. Panourgias (2018). "Recombination in the open-ended value landscape of digital innovation" *Information and Organization* 28 (2), 89–100.

Hippel, E. A. von and R. Katz (2002). "Shifting Innovation to Users Via Toolkits" *Management Science* 49 (7), 821–833.

Holotiuk, F. and D. Beimborn (2018). "Organizational Ambidexterity for Digital Innovation. The Approach of Digital Innovation Labs" *Proceedings of the AOM Specialized Conference: Big Data and Managing in a Digital Economy* Surrey, UK.

Karim, S. and A. Kaul (2015). "Structural Recombination and Innovation. Unlocking Intraorganizational Knowledge Synergy Through Structural Change" *Organization Science* 26 (2), 439–455.

Lee, J. and N. Berente (2012). "Digital Innovation and the Division of Innovative Labor. Digital Controls in the Automotive Industry" *Organization Science* 23 (5), 1428–1447.

Leonardi, P. M. (2011). "When Flexible Routines Meet Flexible Technologies. Affordance, Constraint, and the Imbrication of Human and Material Agencies" *MIS Quarterly* 35 (1), 147.

Lewis, M. and J. Moultrie (2005). "The Organizational Innovation Laboratory" *Creativity and Innovation Management* 14 (1), 73–83.

Lyytinen, K., Y. Yoo and R. J. Boland Jr. (2016). "Digital Product Innovation Within Four Classes of Innovation Networks" *Information Systems Journal* 26 (1), 47–75.

Magadley, W. and K. Birdi (2009). "Innovation Labs: An Examination into the Use of Physical Spaces to Enhance Organizational Creativity" *Creativity and Innovation Management* 18 (4), 315–325.

Majchrzak, A. and A. Malhotra (2013). "Towards an Information Systems Perspective and Research Agenda on Crowdsourcing for Innovation" *The Journal of Strategic Information Systems* 22 (4), 257–268.

Massis, A. de, F. Frattini, J. Kotlar, A. M. Petruzzelli and M. Wright (2016). "Innovation Through Tradition: Lessons From Innovative Family Businesses and Directions for Future Research" *Academy of Management Perspectives* 30 (1), 93–116.

Mayring, P. and T. Fenzl (2014). "Qualitative Inhaltsanalyse". In N. Baur and J. Blasius (eds.) *Handbuch Methoden der empirischen Sozialforschung*, pp. 543–556. Wiesbaden: Springer Fachmedien Wiesbaden.

Moultrie, J., M. Nilsson, M. Dissel, U.-E. Haner, S. Janssen and R. van der Lugt (2007). "Innovation Spaces: Towards a Framework for Understanding the Role of the Physical Environment in Innovation" *Creativity and Innovation Management* 16 (1), 53–65.

Nambisan, S. (2013). "Information Technology and Product/Service Innovation. A Brief Assessment and Some Suggestions for Future Research" *Journal of the Association for Information Systems* 14 (4), 216–225.

Nambisan, S., K. Lyytinen, A. Majchrzak and M. Song (2017). "Digital Innovation Management. Reinventing Innovation Management Research in a Digital World" *MIS Quarterly* 41 (1), 223–238.

Nonaka, I. and H. Takeuchi (1995). *The knowledge creating company*. *How Japanese companies create the dynamics of innovation.* New York: Oxford Univ. Press.

O'Connor, G. C. and R. DeMartino (2006). "Organizing for Radical Innovation: An Exploratory Study of the Structural Aspects of RI Management Systems in Large Established Firms" *Journal of Product Innovation Management* 23 (6), 475–497.

Saldanha, T. J. V., S. Mithas and M. S. Krishnan (2017). "Leveraging Customer Involvement for Fueling Innovation. The Role of Relational and Analytical Information Processing Capabilities" *MIS Quarterly* 41 (1), 367–396.

Schumpeter, J. A. (1934). *The Theory of Economic Development*. *An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle.* Cambridge, Mass: Harvard University Press.

Siegel, D. S. and M. Renko (2012). "The role of market and technological knowledge in recognizing entrepreneurial opportunities" *Management Decision* 50 (5), 797–816.

Spender, J.-C. (1996). "Organizational knowledge, learning and memory: three concepts in search of a theory" *Journal of Organizational Change Management* 9 (1), 63–78.

Svahn, F., L. Mathiassen and R. Lindgren (2017). "Embracing Digital Innovation in Incumbent Firms. How Volvo Cars Managed Competing Concerns" *MIS Quarterly* 41 (1), 239–253.

Trantopoulos, K., G. von Krogh, M. Wallin and M. Woerter (2017). "External Knowledge and Information Technology: Implications for Process Innovation Performance" *Management Information Systems Quarterly* 41 (1), 287–300.

Velten, C., J. Michel and A. Özdem (2016). *Digital Labs – How to build, how to run.* Crisp Research.

Yin, R. K. (2018). *Case Study Research and Applications*. *Design and Methods.* Sixth edition. Los Angeles, London, New Dehli, Singapore, Washington DC, Melbourne: SAGE.

Yoo, Y., R. J. Boland, K. Lyytinen and A. Majchrzak (2012). "Organizing for Innovation in the Digitized World" *Organization Science* 23 (5), 1398–1408.

Yoo, Y., O. Henfridsson and K. Lyytinen (2010). "The New Organizing Logic of Digital Innovation. An Agenda for Information Systems Research" *Information Systems Research* 21 (4), 724–735.