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How Digitalised Innovation Environments Impact Companies' Innovation Capability - a Review and research Agenda

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HOW DIGITALIZED INNOVATION ENVIRONMENTS IMPACT COMPANIES' INNOVATION CAPABILITIES - A REVIEW AND RESEARCH AGENDA

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Abstract

The aim of this paper is to structure the diverse investigations into various Digitalized Innovation Environments (DIE) such as FabLabs, Makerspaces, and Innovation Laboratories and to identify the resulting potential for companies. In private and academic contexts, DIEs are already established as environments for fostering innovation and knowledge transfer. Taking into account a wide range of disciplines and perspectives, a total of four functions were identified that DIEs can potentially assume in companies. Based on this, both direct and indirect impacts could be derived and resulting research gaps were identified. These blind spots are supplemented by research questions on the structural integration of DIEs in companies. Thus, the paper provides an overview of the current state of research and reveals relevant research gaps, which contribute to a future structured investigation of the research subject DIE.

Keywords: Digitalized Innovation Environments, Digitalization, Digital Transformation, Innovation Process, Innovation Capability, Research Agenda.

1 Introduction

Digital transformation (DT) has a significant influence on each part of our daily life and challenges the existing structures and processes (Vial 2019). For that reason, it is not remarkable that DT has become an essential phenomenon in scientific research (Bharadwaj et al. 2013, Piccinini et al. 2015) as well as in practice (Fitzgerald et al. 2014, Westerman et al. 2011). Because of the diversity and the fields of the impact the research has been spread over various use cases and is considered from different point of views.

In this paper, we examine the development of novel innovation spaces in more detail and place them in the context of companies. The aim is to identify initial potentials and starting points on the one hand, but also to uncover research questions that have not yet been examined in detail on the other hand. This is because innovation environments have also evolved in the course of ongoing digitization and generate a significant impact,

particularly in the private and university context (Garcia-Ruiz and Lena-Acebo 2018). In recent years, a whole movement has formed around these environments, the so-called Maker Movement, which is now a global initiative of digital Do-It-Yourself characters (Dougherty 2012). The use of digital production technologies has led to the development of various new types of innovation spaces such as FabLabs (Fabrication Laboratory), Makerspaces or Hackerspaces (Capdevila 2013), which enable a broader range of users to implement their own projects and ideas independently within a very short time (Cutcher-Gershenfeld et al. 2018). These Digitalized Innovation Environments (DIE) are distributed worldwide but the link to the innovation efforts is only partially established by individual companies. The majority of FabLabs and Makerspaces are privately organized or initiated by universities and libraries, although the development of innovation processes (IP) of companies has similar demands in the context of digital transformation (Dziallas and Blind 2019).

Further, new technologies and methods enable new innovation approaches such as digital innovation (Nambisan et al. 2017). Various definitions of digital innovation exist, but they have several points in common: The use of digital technology during the process of innovation is one core point in digital innovation (Iansiti and Lakhani 2014, Hui 2014). But also, the outcome provides an indicator for digital innovation if the result of the IP is entirely or at least partly of digital nature. This change transformed entire industries by enabling new ways of value creation and value appropriation by including all relevant stakeholders with various motivations and capabilities (Porter and Heppelmann 2014, Boudreau and Lakhani 2013, OECD 2016). This results in comprehensively updated IPs in which digital technologies and associated digitizing processes describe an essential part of the new product or service or its development (Nambisan et al. 2017, p. 224). Over the last decades, IPs have continuously accelerated and thus pose new challenges for companies to be successful in the long-term. The early model of Schumpeter of a single entrepreneur commercializing his ideas at the market (Schumpeter 1943) has been superseded by the perception of various actors working hand in hand in an iterative process until successful exploitation (Freeman 1983, Hippel 2007, Tidd and Bessant 2016). This connection of different innovation actors became possible through new digital communication technologies, which are one central aspect of DT.

In this context, some large companies have already recognized the potential of special innovation environments and make them available to their innovation departments to validate ideas in short iteration cycles in a protected atmosphere (Lo 2014). Through the continuous use of digital tools and technologies, first prototypes can be produced in such environments without having to rely on external resources. In addition, it is possible for employees without extensive manual skills to produce physical products, allowing a larger group of employees to participate in an IP. Through digital communication technology, it is possible to innovate in interdisciplinary teams around the world without meeting face-to-face at all. This development challenges current core organizing axioms and may fundamentally change by the digital IPs (Benner and Tushman 2015). All these points indicate that the nature of innovation and the organizational scholarship is at a transition point and needs to be investigated comprehensively for an enlarged understanding of the risks and potentials of these ongoing change. It is necessary to integrate the complex organizational research in the broader context of digital technologies, innovation environments, infrastructure, and the complete ecosystem (Bharadwaj et al. 2013). In this context, there has already a lot of research gaps been identified (Tilson et al. 2010, Yoo et al. 2012, Yoo et al. 2010, Tiwana et al. 2010) but the linking of these new efforts with existing approaches such as the FabLabs and Makerspaces has been missed. Thus, we have the needs of companies with regard to their innovation capacity on the one hand and the already existing DIEs, which have already confirmed their potential to promote innovation in other contexts, on the other hand. Such DIEs are much more widespread and complex in private and academic contexts, so that entire movements and communities have been established here. A wide variety of environments has developed, which allow a very diverse user community to pursue their own innovation and realize individual ideas. At this point it is necessary to project the potentials known from the private and academic context also on small and medium enterprises (SME) and to identify the appropriate framework conditions. Against this background the following research questions arise:

1. *How can Digitalized Innovation Environments impact the Innovation Processes of companies - especially SME?*
   1.1. *Which innovation approaches are supported by DIE?*
   1.2. Which additional potentials arise for SME by cooperating with an DIE?

On this basis, this paper tries to generate a decisive contribution for the IS community by investigating points of contact and overlaps of innovation approaches within companies on the one hand and infrastructures of innovation environments from the private or academic context on the other hand, in order to be able to derive first insights regarding the potentials and, moreover, to set up a research agenda to reflect this topic in its complexity. In doing so, it is attempted to link the theoretical foundations of the innovation approaches and IPs with the practical insights of the innovation environments in order to also generate a contribution for practitioners which is currently underrepresented (Nambisan et al. 2017). This paper is therefore a first step and tries to provide a solid basis for further research on the topic of Digitalized Innovation Environments within companies as drivers of innovation.

2 Methodological Process

As identified in the introduction, there are currently two developments that are largely running independently of each other and in parallel. On the one hand, companies are under pressure to increase their innovation capacity and are trying to integrate new innovation approaches such as digital innovation or user/open innovation into their existing IPs. On the other hand, new DIEs are already successfully applying the same innovation approaches for other motives in other contexts. The individual research artifacts in themselves are already established research subjects in science, but there is a knowledge vacuum between these artifacts. Thus, the research gap is framed by the mentioned artifacts as visualized in Figure 1.

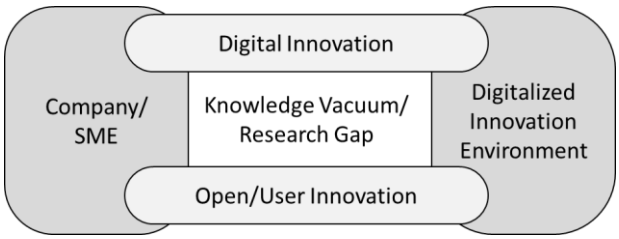

Figure 1: Visualization Research Gap Context

In order to be able to further specify the research gap and derive a research agenda from it, it is first necessary to investigate the state of the art of the individual artifacts. For this purpose, a comprehensive literature review of the respective overlapping topics (e.g. companies and open/user innovation) was implemented in order to define the boundaries of the knowledge vacuum. This literature review further forms the data basis for the

research gaps to be identified (Webster and Watson 2002). The next step is to identify overlaps between needs on the one hand and potentials on the other. In a mapping process, these symmetries are then summarized into dedicated research perspectives and initial impacts are derived. This is done in an iterative cycle with the matching of the research status in the individual artifacts. Overall, five different types of research gaps are identified and distinguished in the following: Structural Blind Spots [SBS]; Communication and Networking Platform [CNP]; Digitalized Fabrication Environment [DFE]; Digital Competency Incubator [DCI]; Market Research [MR]. In order to enable an assignment of later research gaps even in the presentation of the research status of the individual artifacts, we will anticipate the assignment in brackets in this paper. In a final step, these research gaps will be compiled into a structured research agenda and initial research questions will be derived based on this.

3 Digitalized Innovation Environments

Environments in which innovations are implemented in a targeted manner and which support the IP through their equipment and infrastructure are well-known instruments in private, academic, and commercial contexts. For example, cocreation rooms, coworking areas and workshops with various conventional tools for rapid prototyping or design creation are established instruments (Cabral and van Winden 2016). New are the digital components and tools which are increasingly used in such creative spaces and thus enable new ways of innovation. For example, 3D printers and CNC milling machines enable the rapid creation of prototypes without the need for manual skills, thus enabling new groups of people to participate in IPs [DFE, CNP] (Cutcher-Gershenfeld et al. 2018). However, these have so far mainly been found in the private or academic environment. In the following, the landscape of DIEs will be outlined to identify characteristics and potentials that are relevant to the business context.

3.1 Definition and Characterization

"Digitalized Innovation Environment" is an umbrella term for a wide range of physical innovation spaces that make use of digital tools and technologies to promote innovation. At this point, the differentiation between digitization and digitalization is very crucial. These environments are physical spaces that make use of a wide range of digital technologies but are not digital themselves. They are therefore Digitalized Innovation

Environments and not digitized innovation environments such as virtual reality environments, which convert analogue material into a digital format. Through the term "environment", in contrast to "space", the structure, organization, atmosphere and community should also be taken into account. Since such environments have developed in the past in various contexts and for various motives, the following sections will define and characterize them in more detail in order to derive potentials for commercial contexts and in particular SMEs.

The basic idea to create a place for innovation and to complement it with various digital technologies has developed in different environments. Therefore, there are several different approaches and forms, each with different objectives, user groups and levels of professionalization. Each innovation environment is designed for a specific use case and is therefore unique. Thus, basic classifications and differentiations are difficult to make, since the boundaries are fluid and innovation environments are constantly evolving. For this reason, a large number of names have been developed for comparable approaches such as Fabrication Laboratory/FabLab, Makerspace, Hackerspace, Innovation Laboratory, Design Laboratory, Coworking/Collaboration space or Living Laboratory, making it difficult to classify them. Efforts have already been made to structure and classify these parallel approaches, but attempts have been made to identify differences by name, which is not a promising approach due to the widely varying interpretation of the names of the operators of these DIEs (Capdevila 2014a). Furthermore, these efforts remain on a very abstract level and neglect the digital aspect (Capdevila 2017), which is why separate criteria are to be defined for this investigation.

The most obvious common denominator of these innovation environments is the claim and goal that all approaches pursue: They intend to create a physical environment that provides all the tools for independent use to enable the user to realize more or less specific ideas [CNP, DFE]. For example, the expression "How to make almost anything" has been defined as the motto of the original initiator of the FabLab movement, Neil Gershenfeld (Gershenfeld 2012). In general, all innovation environments address a user group with similar characteristics and have evolved in response to the development of the Maker movement [CNP] (Dougherty 2012). Makers are people who critically question their surroundings and are motivated to optimize them through their own developments or adapt them to specific needs. Digital technologies are used specifically

to implement individual ideas, which is why the Maker movement can also be interpreted as a digitalized further development of the DIY movement (Hartmann et al. 2016). In addition to individualized development, the focus is also on sharing knowledge and resources, which makes the movement a kind of counterpart to established mass production [CNP, DCI] (Böhmer et al. 2015).

Although this makers' movement is intrinsically motivated and therefore has its origins in the private context, other institutions such as universities and libraries have also recognized the potential of this movement and are trying to offer a platform through suitable physical spaces [CNP, SBS] (Konopek et al. 2018). Due to the different initiators and the associated framework conditions such as financial possibilities, different concepts have also developed, which are united by the following points (Capdevila 2013): Firstly, they are all freely accessible to the general public, even if individual institutions finance themselves with membership fees [SBS]. Second, they all have a defined focus and goal, which is collectively agreed by their users [CNP], and third, they share information and tools among the members, and they encourage the free sharing of knowledge [CNP, DCI]. These characteristics enable a creative environment which supports the innovation capability of each user. In spite of their similarities, the individual settings can be assigned focal points even if the boundaries are not strict but fluid.

While FabLabs with its digital tools and equipment are perfect environments to channel collective creativity by using methods and techniques like rapid prototyping [DFE] (Wolf et al. 2014), Hackerspace and Makerspaces are focused on enabling user innovation [CNP, MR] (Franke et al. 2006). Frequently FabLabs are additional environments of larger institutions such as universities and libraries and therefore have basic funding, where Makerspaces are mostly privately organized and financed [SBS]. This also determines the focus of the individual innovation environments: While Makerspaces and Hackerspaces usually form smaller units in which private individuals implement their ideas in a result-oriented manner [CNP, DFE], the focus of university FabLabs is usually on the acquisition of competencies during the implementation of an idea [DFE, DCI]. Due to the frequent basic financing, FabLabs are usually more professionally equipped and partly have their own staff, whereas in Makerspaces and Hackerspaces these tasks are mostly taken over by volunteers [SBS]. The individual

facilities also differ greatly in the extent to which digital technologies are used. While the FabLab movement has defined at least some, albeit very vague, framework conditions in the Fab charter, there are no specifications for Makerspaces and Hackerspaces [SBS]. The use of technologies is therefore usually based on individual projects and user groups [SBS].

As another concept, Coworking spaces with a social focus have been identified as a starting point for social innovation (Spinuzzi 2012), while Living Labs are the most widely used environment for companies to support open innovation approaches [CNP, MR] (Chesbrough 2003, Almirall and Wareham 2010, Schuurman et al. 2016). These two concepts are already in the commercial environment, since coworking spaces are usually operated by third parties and the sharing of workspaces and equipment creates a financial advantage for users [SBS, CNP], and Living Labs is often used by companies for market research purposes [MR]. The degree to which digital technologies are used varies greatly depending on the orientation and focus. Over all, all mentioned innovation environments are not a general new phenomenon, and there exist various types with different approaches (Capdevila 2017, van Holm 2014), but the increasing use of digital technologies for the implementation of the efforts reveals completely new potentials.

Capdevila (2013) collected the above concepts all under the term localized spaces of collaborative innovation (LSCI), but missed to address the aspect of technology deployment in its differentiation. For this reason, a new terminology including definition is to be introduced based on the aspects mentioned, in order to be able to examine the phenomenon of these innovation environments also from the perspective of the IS Community more precisely. In summary, the following definition of Digitalized Innovation Environments will apply:

Digitalized Innovation Environments are physical spaces that provide both traditional and digital tools and technologies to support collaborative and interdisciplinary innovation and knowledge transfer.

3.2 Digitalized Innovation Environments in Context of Enterprises

Some companies have already recognized the potential of collaborating with DIEs and have made various efforts to integrate them into their business [SBS] (Zakoth and Mauroner 2020). However, this collaboration is mostly limited to supporting the

research and development departments of large enterprises [SBS] (Lo 2014). The empirical data for this topic area are still very limited and take very different perspectives and often move on a meta-level, which does not allow any conclusions to be drawn for concrete application-oriented business models [SBS] (Ruberto 2015, Suire 2018).

Capdevila differentiated four different subtypes of digitized innovation environments that support companies at different levels (Capdevila 2014b) : FabLabs, Maker- and Hackerspaces, Coworking spaces and Living Labs. All these environments correspond to the definition given above and are integrated differently by companies into their existing structures. While FabLabs with its digital tools and equipment are perfect environments to channel collective creativity by using methods and techniques like rapid prototyping [DFE] (Wolf et al. 2014), Hacker- and Makerspaces are focused on enabling user innovation [CNP, MR]. Coworking spaces with a social focus have been identified as a starting point for social innovation [CNP] (Spinuzzi 2012), while Living Labs are the most widely used environment for companies to support open innovation approaches and market research [MR] (Schuurman et al. 2016, Almirall and Wareham 2010, Capdevila 2014b).

As mentioned above, these new innovation environments are used in companies to support or trigger different innovation approaches and thus significantly influence the IPs (Zakoth and Mauroner 2020). Companies thus seem to have an idea of the influence and the resulting opportunities, but there is a lack of precise and proven insights that enable a theory-driven implementation in practice [SBS]. There is a precise concept of use, instruction, communication, and networking necessary [SBS] (Bergner 2017).

4 Innovation Processes and Approaches

After having examined the DIEs in detail and identified their connecting points in companies, the context in which a linkage can take place will be presented in the following and thus the boundaries of the knowledge vacuum will be defined.

Digitalized Innovation Environments seem to have a significant impact on innovation processes and approaches, which is why they will be examined in more detail below in order to identify the resulting potential and possible blind spots. In recent decades, various innovation streams have developed that are continuously spreading and

influencing each other. Some of these have already been identified as the focus of individual DIE types. In principle, it can be seen that the digital transformation also has an impact on these innovation approaches and enables entirely new ones such as digital innovation (Kohli and Melville 2019, Ciriello et al. 2018). For example, it is well known that digital technologies such as big data analysis have an impact on companies' ability to innovate (Mikalef and Krogstie 2020).

All these innovation logics have in common that the innovator of these processes is not a single person but a larger group, network, or community [CNP] (Laursen and Salter 2006). The early model of Schumpeter of a single entrepreneur commercializing his ideas at the market (Schumpeter 1943) has been superseded by the perception of various actors working hand in hand in an iterative process until successful exploitation [CNP] (Freeman 1983, Hippel 2007, Tidd and Bessant 2016). This connection of different innovation actors became possible through new digital communication technologies, which are one central aspect of DT [CNP]. The emerging approach of integrating external knowledge and opening up the IP is still one of the biggest challenges for enterprises, even though it is one of the most promising drivers for innovation capacity [SBS, CNP] (Hofmeister 2015). Even this fundamental change in innovation logic, it has not been comprehensively integrated into current innovation process models [SBS]. This "Open innovation" as a phrase was coined by Chesbrough 2003 (Chesbrough 2003) and can be considered as utilizer-driven activities (Leminen 2013) focused on developing or improving third-party commercial products or services (Capdevila 2014b). The business focus and the use of external sources as innovation-driver is a typical characteristic of open innovation [CNP] (Chesbrough et al. 2014, Laursen and Salter 2006). In this view, open innovation is the opposite of closed innovation, taking place in the cage of R&D departments or research labs without any external influence. As a related innovation approach, "user innovation" has also developed, which can be described as user-driven innovation activities (Franke et al. 2006). The user of a product or service is intrinsically motivated in optimizing the product or service and initiate or support the development of new solutions [CNP, MR] (Hippel 2010). User innovation is, therefore, a classic bottom-up innovation logic. The aim of these activities is the improvement or development of new products or services for the lead user (Capdevila 2014b). Users often innovate in user communities, which is beneficial for their

processes of prototyping, developing, and diffusing solutions to their needs [CNP, DFE].

These integrative innovation approaches are based on new methods and techniques to promote collective creativity. Well-known examples of this are creative problem solving (Parnes 1967) and design thinking (Brown 2008). These are additionally supported by the complementary use of digital technologies, which also constitute the second aspect that inspires integrative innovation approaches [CNP]. Through technologies such as social media or big data, users and external experts can be integrated into the IP and this can also be done across locations through the use of digital communication channels [SBS]. But the use of digitized production processes such as 3D printing can also accelerate the early phases of an IP in particular [DFE] (Kelley 2001). Basically, it was determined that the digital transformation with its new tools and technologies moderates all activities within an IP (Hellwig et al. 2020).

The efforts of companies toward collaborative and integrative IPs described above coincide in some aspects with the characteristics of DIEs, which is why the resulting potentials will be discussed and presented below.

5 Mapping DIE and Innovation Processes

After the analysis of the DIEs and the new innovation approaches within companies, the following section will identify points of contact. For this purpose, the identified functions of DIEs in other contexts were compared with the aspirations of companies and SMEs, which show up in the form of new innovation approaches, and resulting potentials of linkage were derived.

One of the main points identified in the previous review is the shift to more open IPs. The integration of external stimuli during the IP, especially in the ideation phase, is identified as a key factor for long-term competitiveness [SBS, CNP](Gassmann 2006, Hofmeister 2015, West and Bogers 2017, Tidd 2014), which is addressed by DIEs. In a digitized world, it is not enough to maintain a single innovation department and leave the entire idea generation and development of new products and services to it. Some enterprises noticed this circumstance already and integrating various external environments in their IP (Garnier 2017, Lô and Fatien Diochon 2018, Ruberto 2015, Osunyomi et al. 2016) and using them as a platform to get in touch with external competencies and knowledges [CNP, DCI] (Zakoth and Mauroner 2020). DIE have the

potential to specifically address the methods of new innovation approaches such as Open Innovation and User Innovation and to support them [CNP, MR]. Even though initial findings have already been obtained in this regard, the integration processes and forms of cooperation have still not been empirically investigated, making it difficult to transfer them into practice [SBS].

In addition to integrating external competencies into the IP, DIEs also allow barrier-free exchange across departmental boundaries [CNP, DCI]. Their claim to eliminate access restrictions and hierarchies makes them suitable as a communication platform for a wide variety of players [CNP]. In a company context, innovation is no longer reserved for the R&D department, but all areas can provide important impulses and discuss at eye level. Thus, competence silos can be reduced and a new inter- and trans disciplinarity can be achieved [CNP, DCI]. The environments are also suitable for market research purposes in which products can be validated in a playful manner [MR]. Through the use of digital communication technologies, this can even be done independent of location. In addition, DIEs form a link to the Maker Movement, which can also contribute significant impulses for internal company innovation through its members [CNP]. The potential of the Maker Movement - the implementation of product ideas from private individuals - is often cited as a promising approach (Allen 2016, Capdevila 2014a, Cutcher-Gershenfeld et al. 2018). Here structures and environments already exist which can be integrated as impulse source into standing Ips [SBS]. Also, this movement is characterized by a high degree of creativity and motivation (Dougherty 2012, van Holm 2014). The established institutions for implementing ideas in the maker scene also have great potential for established companies.

Against the backdrop of digital innovation, the DIEs also have the potential to develop into a digital competency incubator within a company. By making a wide variety of digital technologies and tools available, employees can familiarize themselves with them in a non-bureaucratic and hands-on manner and acquire relevant skills in dealing with them [DCI]. On the one hand, this can lead to a more extensive integration of the digital innovation approach, which in turn has the potential to innovate processes as well as products and services [DFE], and on the other hand can contribute to a direct improvement of the existing IP [SBS]. If this DIE integration succeeds, Bergner already mentions the following potentials (2017): First, maker tools and technologies enable

faster and easier prototyping and testing, which will increase the innovation speed [DFE]. Second, DIEs provide access to state-of-the-art technologies also for small and middle-size enterprises [DFE, DCI]. This also supports the ideation as well as the prototyping phase of IPs. Next, there is the potential that innovation and agility increase through open source and open innovation approaches [CNP]. Also, networking with talents and experts has been identified as a potential impact factor [CNP] (Zakoth and Mauroner 2020) and may lead to employee acquisition. Furthermore, the integration of DIEs in IP can increase working satisfaction and creativity through higher employee participation, which can be interpreted as an indirect impact on the innovation capability.

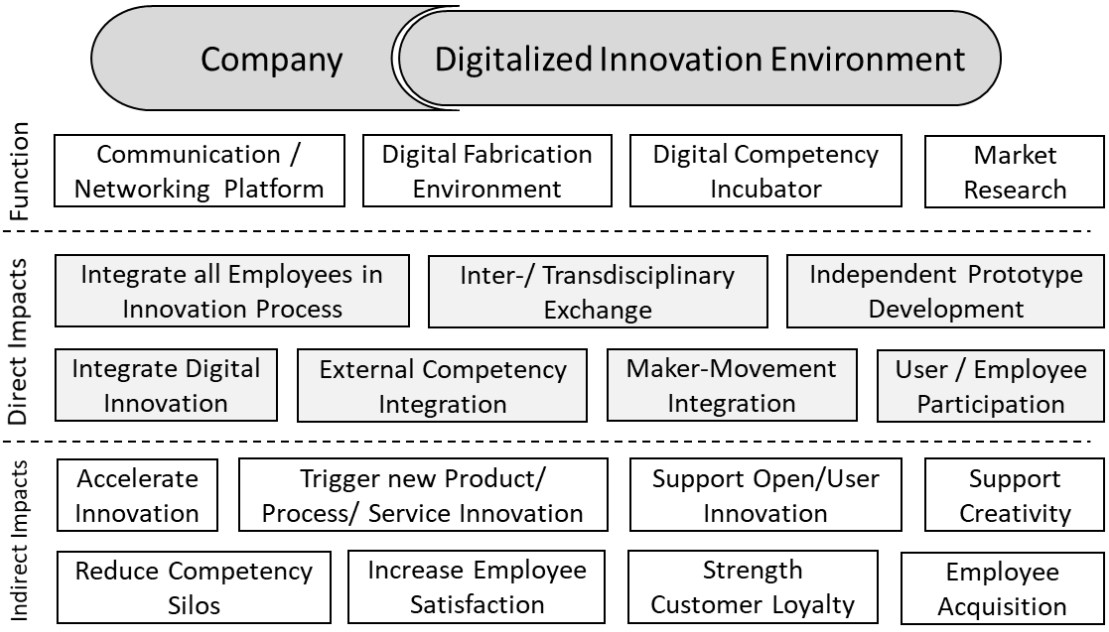

Figure 2. Direct and Indirect Impacts by Integrating a DIE in a Company

Figure 2 illustrates both the functions that a digitized innovation environment can assume within a company and the resulting direct and indirect impacts. Direct impacts inevitably result from the activities that arise from the different functions. The indirect impacts are to be regarded as optional, which may arise additionally without being specifically addressed. The identified Impacts and Potentials are mostly deductively derived and result from the comparison of characteristics of the DIE on the one hand and the requirements of companies resulting from the increased pressure of innovation capability on the other hand. So far, empirical findings on DIEs in companies are only partially available and consider only one of the identified functions. In order to be able

to research this complex topic in a structured way in the future, in the following a research agenda based on the previous findings will be developed.

6 Research Agenda

As the research so far has indicated, the integration of DIEs into business structures has the potential to have an impact on different levels and must therefore be viewed from different perspectives. In the following, these perspectives must be structured in a meaningful way in order to gain a holistic understanding of the effects. A differentiated view of the subject matter in terms of its function is considered to be a suitable approach here. This need for research is supplemented by structural questions.

6.1 Structural Blind Spots [SBS]

Due to the diversity of DIEs, there is still insufficient knowledge about how they can be embedded in existing company structures in a targeted manner in order to make use of their potential. So far, this has only been done partially and with very different demands and approaches. The spectrum ranges from superficial cooperation with an external DIE to the construction of an own internal DIE. The latter approach, however, is mostly reserved for large corporations, as they have the necessary financial strength. At this point, it is necessary to develop both theory-based approaches to integration and a comprehensive empirical investigation of existing structures. This is the only way to derive models for various application scenarios and thus to make an important contribution to their application in practice. Based on this claim, the following possible questions arise on the basis of the current state of research:

Q1: Which forms of cooperation can be derived on the basis of theoretical models?

Q2: Which forms of cooperation between DIE and companies have empirically proven to be functional?

Q3: Which prerequisites and framework conditions must be met for successful integration?

6.2 Communication and Networking Platform [CNP]

DIEs function in academic and private contexts as a platform for the exchange and networking of users on new technologies and tools and for mutual support in the implementation of novel products and solution approaches (Capdevila 2013). These potentials have also already been recognized by industry (Zakoth and Mauroner 2020),

but have not yet been comprehensively empirically proven. At this point, the function of DIEs as a communication and network platform must be examined in more detail with regard to its user groups in companies and the actual impacts validated. This leads to the following research approaches:

Q4: Which user groups/competencies can be linked in DIEs within companies?

Q5: Which contributions can individual user groups make in terms of the company's innovation capability?

Q6: Under what conditions can cooperation with external actors also be effective?

6.3 Digitalized Fabrication Environment [DFE]

DIEs are characterized by the provision of digital tools and technologies for the implementation of physical products and prototypes. In the private context, it has already been possible to examine a significant impact on the innovative capacity of users (Gershenfeld 2007). However, the extent to which this potential can also be transferred to the commercial sector needs to be investigated. This question focuses on the technological progress that can be realized with the integration of DIEs and can be outlined by the following research questions:

Q7: Does access to digital fabrication tools accelerate innovation cycles of companies?

Q8: Which activities within the innovation process are changed by the use of digital tools?

Q9: Which technologies influence the innovation capacity of companies and to what extent?

6.4 Digital Competency Incubator [DCI]

DIEs with their characteristics correspond to an environment for self-experience and support the try and error approach, which is considered in didactics as a potent approach to reduce fear of contact and to convey knowledge (Keders et al. 2020). In combination with the use of many new digital technologies, DIEs also have the potential to specifically address the digital competencies of employees and thus act as a digital competency incubator. In the academic context, DIEs are already being used to teach the use of digital technologies in an application-oriented manner. The extent to which these potentials can also be transferred to the commercial context must be investigated

in greater detail and empirically proven. The following research questions should be the focus here:

Q10: Which competencies can be imparted to employees of companies within DIEs?

Q11: What forms and strategies are suitable for instrumentalizing DIEs as competence forges within companies?

Q12: What added value results from the integration of DIEs in contrast to conventional forms and formats of teaching?

6.5 Market Research [MR]

DIEs are already being used in individual companies as a tool for market research. Even if this is not an original function of the underlying facilities such as Makerspaces, Fabrication Laboratories or Hackerspaces, they nevertheless have the potential to fulfil this function due to their equipment. For this reason, it is also important to scientifically examine the impact from this perspective and to address the following questions for a better understanding of the overall construct of DIE.

Q13: For which formats of market research are DIEs suitable within companies?

Q14: To what extent do findings from market research in conventional environments differ from those from DIEs?

6.6 Future Research Approach

Many of the fourteen identified research questions require an empirical data base for further insight. Since DIEs are still very rare in companies, it is important to use these cases as an explorative starting point for initial findings regarding the integration of DIEs in companies. By collecting further empirical data through initial cooperation formats, more precise statements can be made as research progresses. We are therefore at a very early stage in this topic and will initially have to deal with a very limited database or draw on findings from other related research fields. The identified functions that a DIE can assume in companies can already be a starting point for this. For example, research from the university context on the use of DIEs as competency incubators could be transferred to the business context and initial studies could be initiated solely on the acquisition of competencies by employees in DIEs. In this way, individual areas of the identified potentials could be successively researched before they are combined into a holistic design.

7 Conclusion and Outlook

The purpose of this paper was to compare the potential of DIEs already established in the private and academic context with the requirements of companies with regard to their innovation capabilities resulting from the ongoing digital transformation and to identify existing blind spots in research. For this purpose, it was necessary to structure the multitude of different approaches and to establish a uniform wording. Through the use of digital technologies and tools, DIEs serve as a platform for a complete maker movement, which uses the equipment of DIEs to realize its own ideas. The shift to open and integrative IPs by companies poses requirements comparable to those already represented in DIEs. The integration of DIEs into companies thus offers a wide range of potentials for innovative capability. All in all, based on the experiences from the academic and private environment as well as isolated findings from specialized cooperations, four possible functions could be identified which a DIE could fulfill within a company. They can continue to function as a platform for communication and networking both internally and externally, but at the same time, through the use of digital technologies, they can be used as a fabrication laboratory to test prototypes or products independently and in shorter iteration cycles. In addition, DIEs are valid centers for teaching digital skills, as they can be experienced here in a hands-on and practice-oriented manner. In addition, the potential to instrumentalize DIEs as an environment for market research could also be identified. Based on these four functions, specific blind spots were identified and initial research questions were formulated to support a targeted investigation of the complex instrument of DIEs. The functions are supplemented by structural questions, which are aimed at the formal integration of DIEs in companies. In addition to the direct impacts, indirect effects were identified which are not necessarily related to the innovative capacity of companies, but which can nevertheless have a positive influence on competitiveness.

Thus, this paper can make an important contribution to the IS landscape on various levels. On the one hand, the introduction of the umbrella term "Digitized Innovation Environment" offers to consolidate the diverse research approaches to individual context-specific institutions. In addition, the potentials for companies resulting from cooperation with a DIE could be systematically derived on the basis of four functions and resulting research questions could be formulated. Thus, the basis for a future

structured investigation of this complex construct of DIEs has been laid, which also takes into account the different perspectives and disciplines.

Due to the high dynamics within this research field as well as the consideration of the phenomenon from very different perspectives and disciplines, the findings determined must be regarded as an intermediate status and by no means as a final result. Thus, the functions and resulting research questions will have to evolve successively. Also, it cannot be guaranteed that all relevant research streams have actually been taken into account, since the focus was placed on the context of companies, and here the processual level in particular was considered. The change in perspective may give rise to additional research questions and functions that have not yet been identified. Here, it is necessary to go into further detail and to integrate findings from outside the IS landscape as well.

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