Innovation Networks and Digital Innovation: How Organizations Use Innovation Networks in a Digitized Environment

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Abstract. The digital transformation dramatically lowered the costs for communication and coordination, thus, enabling new forms of cooperation. Companies seize this opportunity by creating new types of innovation networks. Until now, we know little about which types of innovation networks are currently prevalent and why organizations use them. In this paper, we build upon a recent study dealing with categorization of innovation networks and present the results of an exploratory series of case studies conducted with 27 high-level executives from 11 organizations in various industries. Our results indicate that companies are maintaining high-levels of centralized control over the innovation network, which is contrary to what the literature suggests. Furthermore, there is a strong trend towards more heterogeneous knowledge within a network. Additionally, we identify mechanisms that help companies to transition from one type of innovation network to another one and investigate why organizations use certain innovation networks.

Keywords: innovation network, digital innovation, digital transformation, case study research

1 Introduction

'Two heads are better than one' is a common proverb and the increasing reliance on innovation networks - instead of individual innovators - appears to confirm this assumption (e.g., [1],[2]). Innovation networks can be understood and defined as "a set of actors connected by a set of ties. The actors […] can be persons, teams, organizations, concepts, etc." [3]. For this paper, we have a focus on socio-technical networks formed between various actors and their respective tools in an increasingly digitized environment as described by Lyytinen et al. [1].

The increasing reliance on different forms of digitally enabled innovation networks is reflected in widespread practices such as open innovation [4], user innovation [5] and crowdsourcing [6]. These practices are enabled by the progressive digitization of our environment (e.g., [7],[8]) with costs for communication and computation at an unprecedented low level [9], which, enables companies to easily access knowledge from

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beyond their organizational boundaries [10], [11]. Hence, innovation networks are poised to become the backbone of successful innovation efforts in a digitized environment [1], [2], [12]. Accordingly, recent research addresses the topic of innovation networks. For example, striving for conceptual clarity Lyytinen et al. [1] built upon extant literature on innovation networks and put forward a framework to distinguish between different forms of innovation networks by categorizing them along the dimensions of (1) control over resources and (2) degree of heterogeneity.

However, even though we can observe the rise of innovation networks over single innovators (e.g., [4], [5], [10]), and know that different types of innovation networks lead to either incremental or radical innovation outcomes [1], we do not know which types of innovation networks are actually prevalent among incumbent companies since digitization became nearly ubiquitous. Furthermore, we do not know how companies can fluidly transition between different types of innovation networks. Moreover, we do not know why organizations decide to use a certain innovation network. Thus, as pointed out by Nambisan et al. [12] we cannot comprehend "how firms are able to successfully and fluidly mix, match, and integrate internal and external parties and various diverse communities in digital innovation". As innovation is the ultimate raison d'être for companies [13] it is paramount to further examine how the pervasive digitization of entire industries influences innovation networks and why organizations use specific network types. Thus, this paper investigates two research questions:

RQ1: Which types of innovation networks are currently prevalent and why do organizations use them?

RQ2: How can companies fluidly transition between different types of networks?

Striving to answer these questions, we conducted 27 interviews with high-level managers from 11 different companies in different industries and inquired about their approaches to organizing and innovating in a digitized environment. Theoretically, we rely on the framework by Lyytinen et al. [1] to clearly delineate and categorize different forms of innovation networks. This allows us to distinguish between common forms of innovation networks, categorize them within the framework and examine which types of innovation networks are currently prevalent and why companies use them. Additionally, it allows us to identify mechanisms that companies use to transition from one type of innovation network to another. In the following sections, we will review the literature on the influence of digitization on innovation networks and describe how we analyzed the case studies. Furthermore, we present our findings, discuss the implications of our findings and highlight potential limitations and promising avenues for future research.

2 Related Literature

New types of innovation networks are emerging as traditional approaches struggle to efficiently coordinate the increasing amount of connected actors and integrate the vastly heterogeneous knowledge available [1]. There are entire literature strands that take a more granular look on different types of innovation networks such as network-centric innovation [2], open innovation [4], [14], distributed innovation [15], user innovation [5], [16] and crowdsourcing [6], [17]. All of those literature strands have in common

that they accentuate an external focus for innovation. This makes perfect sense when considering that "[…] in any given sphere of activity most of the pertinent knowledge will reside outside the boundaries of any one organization, and the central challenge for those charged with the innovation mission is to find ways to access that knowledge" [15]. Thus, organizations experience an increasing blurring of their external boundaries and leverage digital technology to enable new cooperation's [12]. All of the beforehand mentioned articles focus on different aspects of external cooperation. For example, user innovation focuses on the involvement of the user in the development process to better understand user needs [5]. Crowdsourcing on the other hand is about outsourcing tasks to an undefined crowd through tournament-style or collaboration-style open calls [6]. In addition, digital technology also plays a vital role for more traditional approaches such as merger and acquisitions (M&A), as digital technology-related M&As can make or break the efforts of a company to master the digital transformation [18], [19]. In general, research on networks has grown exponentially and can be categorized on basis of the respective focal point such as for example social capital, embeddedness or organizational networks [3]. Another typology put forward by Mentzas et al. [20] delineates inter-organizational knowledge networks along the nature of exchange (sharing / trading) and the nature of community (closed / open). However, since our research focuses on *innovation* networks in a digitized environment, we chose to build upon the theoretical framework put forward by Lyytinen et al. [1] as it was designed to do exactly that. The framework helps delineate between different types of innovation networks along two dimensions. These two dimensions embody the effect of ubiquitous digital technology, which leads to:

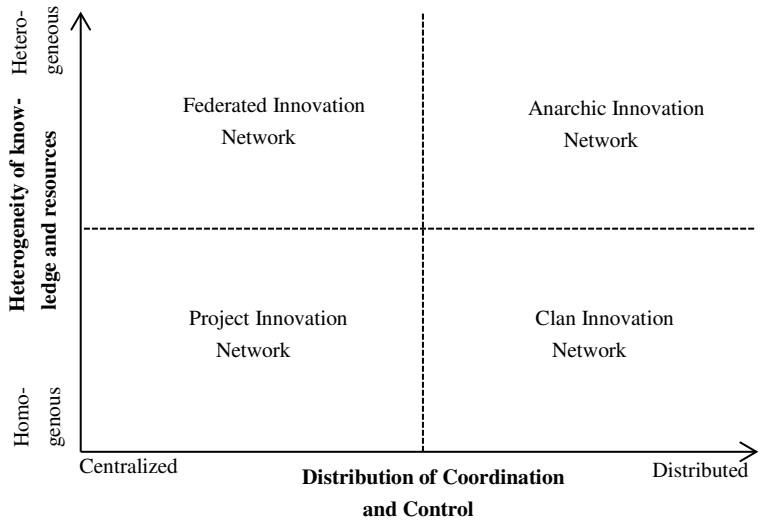
(1) **Distribution of coordination and control:** Vanishing costs for communication allow connecting, coordinating and controlling innovation network contributors and resources independently of time and location. In the past, business models and innovation networks were limited by the high cost of communicating and processing information [21]. However, with the rise of ubiquitous digitization these costs have diminished to the brink of almost vanishing [9]. Plummeting costs for communication make it possible to connect and coordinate previously unconnected actors and, thus, enabled the creation of new types of innovation networks (e.g., [4], [6]).

(2) **Heterogeneity of knowledge and resources:** Combining the expertise of previously separated knowledge communities increases the heterogeneity of resources and knowledge within the innovation network. When a formerly static product or process is digitized it is endowed with an unprecedented level of flexibility and openness [8], [22]. Increased openness and flexibility enables previously separated knowledge communities to combine their distinct areas of expertise as demonstrated in the "quadruple-play" – the combination of phone functionalities with TV-services, broadband internet and mobile internet apps [1], [8]. The convergence of heterogeneous knowledge enabled the creation of a groundbreaking digital innovation - the smartphone [1], [8]. As different knowledge communities are more interconnected and form innovation networks, the heterogeneity of knowledge available within these innovation network increases [1]. Moreover, due to the higher flexibility, contributors can frequently enter and exit the innovation network when the focus of an innovation network changes or

requires different forms of knowledge [23]. This dynamism increases the heterogeneity even further as the contributors in innovation network constantly change [12].

Lyytinen et al. [1] conceptualize along those two dimensions four canonical archetypes of innovation networks which can be intra-organizational or inter-organizational. The first archetype is *project innovation networks* which is characterized by homogenous contributors coming from the same discipline and, therefore, have the same knowledge background. Project innovation networks rely (mostly) on hierarchically integrated structures as given within an organization, thus, allowing for tight control of resources and the goal of the innovation efforts [1]. The second archetype is *clan innovation networks,* which also comprises a homogenous group of contributors that have the same – or at least very similar – knowledge background. However, in a clan innovation network the contributors are not controlled by a hierarchical structure and can freely determine which innovation outcome they pursue. A typical example of a clan innovation networks are open-source communities [1]. The third archetype is *federated innovation networks,* which are characterized by contributors from different disciplines and heterogeneous knowledge. Even though they come from different backgrounds, resources and the eventual innovation outcome are tightly controlled by hierarchically integrating the contributors. Classic examples of a federated innovation network are automotive manufacturers, which rely on numerous knowledge communities ranging from logistics over engineering to design. Contributors from different departments or even different companies work together beyond the classic company or discipline-boundaries. Nonetheless, the final outcome of innovation efforts is tightly controlled by the manufacturer [1], [24]. Lastly, there are *anarchic innovation networks,* which are characterized by contributors from different disciplines with heterogeneous knowledge backgrounds and no hierarchical control. Hence, anarchic innovation networks introduce an unprecedented level of complexity and dynamism as vastly heterogeneous knowledge communities' work together in absence of any formalized form of control over the innovation outcome, the innovation process or even the structure of the network. An example for an anarchic innovation network was the Gehry project in Bilbao in which numerous independent companies from diverse backgrounds took part [25]. Figure 1. depicts the four types of innovation networks along two dimensions:

Figure 1. Four Types of Innovation Networks



3 Method

“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” [26]. Due to the nature of our research, we neither have control over the events nor the context, and are fundamentally guided by “how” and “why” research questions. Thus, case study research is a perfect match [26]. For the sampling procedure, we focused on companies that currently conduct digitalization projects and aimed a minimum of three senior managers per company to ensure multi-facetted insights into the project. However, depending on company size, sometimes one person was in charge of every critical area of interest. In total, we interviewed 27 senior managers from 11 different companies in various industries as listed in table 1:

Table 1. Case Study Overview: Industry, ID, Interviewee Position and Length

Case	Industry	ID	Interviewee Position	Length
A	Mechanical Engineering	IP 01	Innovation Manager	59 min
B	Banking	IP 02	Innovation Manager	68 min
		IP 03	Head of Product Management	66 min
		IP 04	Chief Technical Officer	57 min
C	Online Publishing	IP 05	Head of Business Development	72 min
		IP 06	Deputy General Manager	70 min
		IP 07	Chief Technical Officer	66 min
D	Private Bank	IP 08	Marketing Manager	72 min
		IP 09	Head of IT & Organization	83 min
		IP 10	Chief Executive Officer	45 min
E	Plant Construction	IP 11	Product Group Manager	91 min
		IP 12	Head of Automation and Controls	121 min
		IP 13	Director Technology Management	54 min
F	Banking	IP 14	Chief Digital Officer	57 min
G	Banking	IP 15	Chief Executive Officer	65 min
H	Building Industry Supplier	IP 16	Chief Digital Marketing Manager	53 min
		IP 17	Chief Financial Officer	46 min
		IP 18	Chief Marketing Manager	53 min
		IP 19	Chief Executive Officer	45 min
I	Banking	IP 20	Chief Digital Officer	60 min
J	Automotive and Aircraft Supplier	IP 21	Vice President (VP) Sales	63 min
		IP 22	Product Manager	33 min
		IP 23	Team Lead Electronics	109 min
K	Automotive Manufacturer	IP 24	VP Systems Development	70 min
		IP 25	VP IT Solutions	60 min
		IP 26	Director Corporate Strategy	35 min
		IP 27	Director Product Management	45 min

The interviewed senior managers held positions in various departments such as IT, innovation, and R&D. Most interviews were conducted during 2016 and onsite and were guided by the following guidelines: First, we asked the interviewees to briefly summarize their background and to describe their position in the company. Subsequently, we asked how they personally define digitization and whether they could talk about a recent digital initiative. Following up, we asked in detail about the company's internal structures and decision hierarchies. Furthermore, we asked about innovation processes, innovation co-operations and resource allocations. Additionally, we included questions concerning the personal opinions of the interviewed senior managers to gain a better understanding of critical success factors. The interviews were recorded and subsequently transcribed. The qualitative data analysis was conducted deductively following the guidelines of Mayring and Fenzl [27]. We started by defining clear research questions and, henceforth, selected and prepared the appropriate material as described above. We then searched the literature for frameworks that help determine categories which are firmly grounded in theory – in our case Lyytinen et al. [1] provided an ideal place to start as the framework specifically focuses on innovation networks in a digitized environment. Subsequently, guided by existing best practices in the literature (e.g., [27], [28]) we deductively coded the interviews in accordance with our established coding guideline as depicted in table 2:

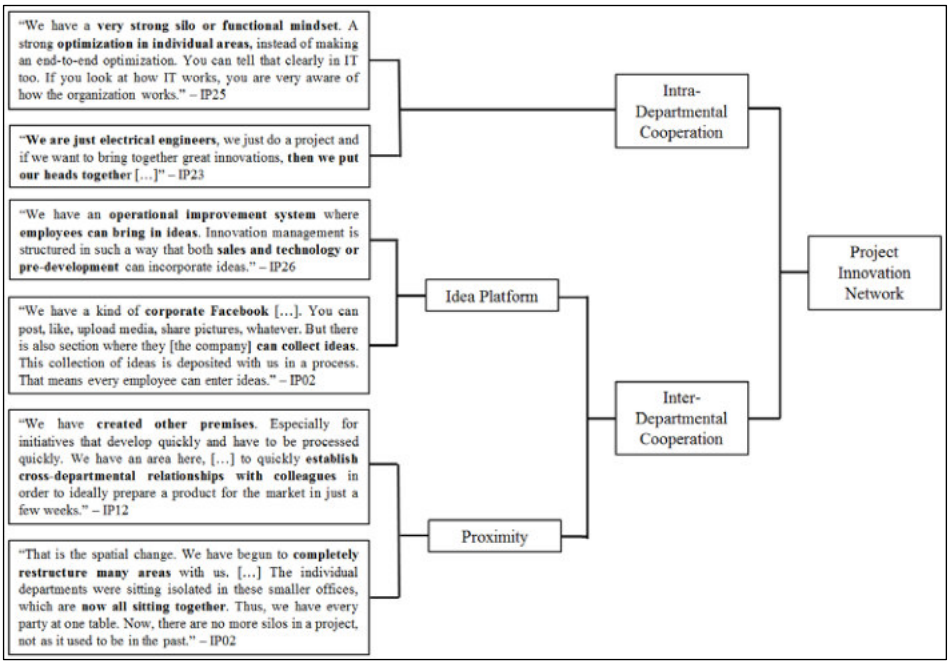
Table 2. Coding Guidelines based on Lyytinen et al. [1]

Type	Network Characteristics	Coding Rules
Project	**I.** Homogeneous actors / tools, readily identified and mobilized **II.** Hierarchically integrated control, mostly within a single company	There are clearly identifiable control structures for resources and outcomes. Actors within the network must have homogeneous knowledge and are easily identifiable.
Clan	**I.** Homogeneous pool of dynamic actors driven by common interest and well-defined set of tools; readily identified & mobilized **II.** No centralized hierarchical control	No clearly identifiable control structure. Outcome control is not existent or distributed. Actors within the network must be easily identifiable and have homogeneous knowledge.
Federated	**I.** Heterogeneous pool of actors, that need to be identified **II.** Hierarchically integrated control structure, within and beyond company boundaries	There must be a clearly identifiable control structure, which controls resources as well as the outcome. Actors within the network come from different knowledge communities; knowledge is heterogeneous.
Anarchic	**I.** Heterogeneous & dynamic pool of actors / tools, that need to be dynamically identified & mobilized **II.** No centralized hierarchical control	No identifiable control structure. Outcome control is not existent. Actors within the network come from different knowledge communities; highly heterogeneous knowledge.

For the process of coding and displaying the results, we used MaxQDA Plus 12 and built upon on the recommendations of Mayring and Fenzl [27] to organize the statements made in the interview within the established framework.

In the next step, we carefully went through each established category and searched for emerging subcategories, which would point us towards trends within each type of innovation network. This helped distinguish between different forms of, for example, project innovation networks, thus, further structuring the results. An example of the process is depicted in figure 2:

Figure 2. Exemplary Process of Subcategory Coding



4 Results

In the following section, we present the results of the deductive qualitative analysis. During the analysis, a general, overarching theme emerged that underscored the importance of better understanding how pervasive digitization changes the way organizations cooperate and innovate. As IP 12 put it: "[Digitization] is already changing the world and is changing our world […]. Until now, we relied on creating value ourselves. This will not stay the case with digitization because we already believe that we cannot do it alone. But the question is: "Where do you differentiate yourself, where do you work together and where do you have the differentiation potential in the future?"

In the following subsections, we put the subcategories that emerged during the coding process in bold font at the beginning of each paragraph.

4.1 Project Innovation Network.

Overall, 16 out of 27 interview partners (IP) mentioned forms of cooperation that fit the established characteristics of project innovation networks. In the following, we list the subcategories we identified during analysis as depicted in figure 2.

Intra-departmental co-operation. Surprisingly, only 2 out of 16 interviewees (IP23, IP25) mentioned pure forms of project innovation networks in which all actors come from a specialized subdivision within the same company. It is characterized by a very homogeneous group of actors, which are working and specializing within one department, while avoiding external input. Furthermore, within the setting of an organization there is a clearly identifiable, high level of hierarchical control over resources and the expected outcome. For example, IP 25 stated: "We have a very strong silo or functional mindset - a strong optimization in individual areas, instead of making an end-to-end optimization."

Inter-departmental co-operation. Most interviewees (12 out of 16) pointed towards less clear-cut forms of project innovation networks as they involved inter-departmental cooperation. The networks still consist of actors from the same organization but cooperate beyond the boundaries of their respective department. Hence, the knowledge available in these inter-departmental settings is – while still being similar - less homogeneous than in the case of a silo mindset. IP06 described this trend by stating: "Departments used to be very well organized side by side – now everything is somehow dissolved a bit. It also produces much greater transparency. For better or worse." This trend of cooperating beyond the respective department boundaries manifests itself in the creation of idea platforms (IP02, IP26), increased proximity (IP03, IP04, IP12) and the formation of inter-departmental teams (IP01, IP02, IP05, IP11, IP16, IP20, IP21).

Idea platforms help generate new ideas and facilitate exchange between different departments and often take the form of corporate social media platforms. IP02 stated that: "We have a kind of corporate Facebook […]. You can post, like, upload media, share pictures, whatever. But there is also section where they [the company] can collect ideas […]. That means every employee can enter ideas". Furthermore, companies not only create virtual platforms to foster cooperation but also change the workspaces itself to increase the physical proximity between formerly separated departments. IP12 elaborated that: "We have created other premises. Especially, for initiatives that […] have to be processed quickly. We have an area here, […] to quickly establish cross-departmental relationships with colleagues in order to ideally prepare a product for the market in just a few weeks." The most common mechanism is the formation of inter-departmental project teams that pursue several goals such as entering new markets (IP01), quickly solving unexpected problems (IP11), strategy planning (IP16) and establishing new work processes (IP20). In order for such endeavors to be successful, numerous success factors were mentioned such as a good-will commitment of the executive board (IP01), the ability to focus 100% on the new task (IP01) and an open culture between different departments (IP05).

4.2 Federated Innovation Networks

During our conversations, federated innovation networks emerged as the most prevalent type of innovation network overall. Here, organizations strive to engage with highly heterogeneous knowledge (mainly) from outside the company and even from other markets while still maintaining a high level of control over resources and expected outcomes. In total, 26 out of 27 interviewees explicitly mentioned some or multiple forms of federated innovation networks. The most prominently mentioned ones are: Partnerships and cooperation (IP05, IP11, IP12, IP20-IP22, IP26), cooperation with startups and fintechs (IP02, IP05, IP08, IP10, IP20, IP25, IP26), customer panels (IP02, IP07, IP11, IP12, IP20, IP21), outsourcing (IP09, IP11, IP12, IP15), creation of platforms (IP01, IP11, IP15, IP24), external consultants (IP05, IP13, IP16, IP17), spin-offs (IP01, IP08, IP15). The most important ones, which were mentioned by at least five different interviewees, are explained in more detail below:

Partnerships and Co-operation were mentioned by 7 of the 26 different interviewees. As products and services are becoming increasingly complex [25], companies rely on an increasing number of co-operations to access external, heterogeneous knowledge and skills to solve problems that are out of their area of expertise. Control over the outcome and scope of such partnerships is typically ensured through contracts and agreements. IP20 stated: "I need other disciplines, other specialized [areas of] knowledge, which do not necessarily exist in our classical background of the company. In turn ... I said it before, I have to invest much more than I am used to in partnerships." Oftentimes companies collaborate with other companies that have expertise in fields such as the development of new IT solutions (IP13) or design choices (IP10, IP22). These co-operations aim at increasing customer value (IP11), extending research capabilities (IP20) and acquiring additional knowledge (IP26). The interviewees named an open-mindset on both sides (IP07), accepting failures in order to be able to try new things (IP21) and the development of strong networks (IP22) as important factors for success.

Startups and Fintechs. Even though co-operations with startups and fintechs could also be listed under the subcategory "partnerships and co-operations", 7 out of 26 interviewees specifically highlighted them as a special case of co-operation. startups were mentioned 6 times (IP02, IP05, IP08, IP10, IP25, IP27) and fintechs 3 times (IP02, IP10, IP20). The startup and fintech co-operations have the purpose of creating new ideas (IP05) and generally to increase value for customers (IP20, IP25). Furthermore, such co-operations are viewed as "a kind of research and development extension from outside [the company]. Of course, we only engage with ideas which we do not have to get out of our way." Furthermore, while they are perceived as an easy way to expand one's network and engage with new ideas, several interviewees pointed out common pitfalls such as that startup cooperation are great to learn but oftentimes do not end up profitable (IP05). Furthermore, startups and fintechs frequently compete for direct customer contact, which could transform incumbents into mere suppliers (IP20).

Customer Panels were mentioned by 6 out of 26 interviewees. Organizations try to closely align their offerings with what the customers want by directly acquiring feedback from their customers. To achieve this, companies create platforms on which customers can share suggestions for improvements or general feedback (IP03) or they even create an advisory board of specific customers to test products and quickly acquire feedback (IP03, IP07). The aim here is always to acquire customer feedback. However, it is crucial to build up the necessary processing capacity as it is easy to be overwhelmed by the amount of suggestions. IP03 stated for example: "The problem is, we have 1200 employees and 2 million customers. And 500 employees in the customer interface. They also get a lot of ideas from the customer and carry them there. So there are umpteen suggestions a day. They have to be evaluated. There must be someone who has time to look at his day-to-day business."

4.3 Clan and Anarchic Innovation Networks

Interestingly, there were no statements that fulfilled the requirements for being classified as clan or anarchic innovation network. We will elaborate on this insight in the discussion section.

4.4 Mixed Forms of Project and Federated Innovation Networks

During the analysis, an additional mixed type of innovation network emerged. Such a mixed type of innovation network appears to help companies moving from one type of innovation network to another. Within this mixed innovation network type we distinguish between two subcategories: (1) transition mechanisms and (2) integration mechanisms.

Transition mechanisms are mechanisms that companies rely on to transition towards the north (more heterogeneous knowledge) or east (more distributed control). In total, we found 7 interviewees mentioning different examples such as: Creating new internal departments which become spin-offs (IP01, IP05), focusing on inter-departmental cooperation but involving some external actors (IP04, IP15, IP20, IP24, IP26) and creating internal startups (IP05). All of them are examples for the transition from project to federated innovation networks (i.e., north) or from project innovation networks towards a clan network (i.e., east).

An example for an east-transition is provided by IP01 who describes how the company went from full hierarchical control to a more distributed form of control by spinning off a project team and turning it into a more independent company: "It was a project team within Department 1 that […] has pushed this project forward […]. Until at some point – along with the market entry - the time was right to spin-off the project team into an independent sales GmbH. An independent business unit, which is one of our more successful business units to this day, because they have since made a very beautiful growth story." Whereas it is questionable that this already qualifies as a full-fledged clan or anarchic innovation network, it certainly is a step towards this direction.

In general, the interviewees stated that such mixed forms are used to experiment with new business models or markets (IP01, IP05), quickly acquiring expertise from outside the company and speeding up the process of innovation (IP24) and for transformation projects (IP24).

Integration mechanisms are mechanisms that help integrate external actors, over which a company has little or no control. Thus, integration mechanisms help to move innovation networks towards the west (i.e., more centralized control) or south (i.e., more homogenous knowledge). Altogether, six interviewees mentioned integration mechanisms. Examples are acquisition (IP05), permanently integrating freelancers into work processes and decision-making (IP15) and classic hiring of valuable individuals (IP02, IP03, IP05, IP13). For example, IP 15 described how freelancers are completely integrated in decision making processes and feel as part of the team: "I also do not make the decision myself […], but I say: "The external and internal guys have decided on the design". There too, no separation. Freelancers already integrated internally. They also feel like internals. Connect with the company. Which is important - otherwise they cannot work the same as an internal one if they do not feel that it is their baby as well." Over time, the integrated freelancers develop a shared knowledge base with the company, thus, leading to a more homogenous knowledge base. Such a development signifies a slow move towards a project rather than a federated innovation network. Generally, these mechanisms were mentioned to help acquire new expertise (IP03, IP05, IP08, IP13) and to foster "out-of-the-box-thinking" (IP02).

5 Discussion

Theoretical Implications. This paper set out to answer two research questions. The first question is: *Which types of innovation networks are currently prevalent and why do organizations use them?* The main insight is that incumbent companies appear to rely only on project and federated innovation networks but not on clan and anarchic innovation networks, thereby, always maintaining control over resources and the eventual outcome. Furthermore, we found that organizations use project and federated innovation networks for different purposes. Project innovation networks are mainly used to facilitate idea generation, and to allow for fast problem solving and experimentation. Federated innovation networks on the other side are mainly used to gain access to external expertise, and to increase customer knowledge and thus customer value. Investigating which types of innovation networks are currently prevalent and why organizations use them addresses the "need to examine to what extent organizations simultaneously engage in multiple different types of networks, and how the intensity and proportion of these engagements affects the level and nature of their innovation work" [1].

The second question is: *How can companies fluidly transition between different types of networks?* We found that companies gradually transition between project and federated innovation networks by using mixed forms of innovation networks, which we categorized as either transition or integration mechanism. These identified mixed forms help address the fact that the two dimensions of control and heterogeneity are not as

clear-cut in reality as they are theoretically [1]. By recognizing and categorizing mixed forms between different types of innovation network, we are able to take a more granular look and position the identified forms of innovation networks more precisely within the framework. Thereby, contributing to extant literature.

In the following, we discuss the highlights of our results and point out avenues for future research. When we started to analyze the data, we expected to find examples for distributed forms of control over the innovation network, the actors and the eventual outcome. This would be in line with the prediction of Lyytinen et al. [1] which stated that due to the ever more prevalent digitization there would be a trend towards more distributed forms of coordination and control. However, as stated above, our results do not support the prediction that there is a trend towards more distributed forms of control. For future research, it would be a worthwhile endeavor to investigate why organizations currently choose not to use clan and anarchic networks. A possible explanation is that while products become increasingly complex [8], [22], incumbents must engage their entire supply chain in order to successfully innovate (e.g., [29]). Thus, certain actors within a network of suppliers specialize for specific components which are then assembled into the final product by the manufacturer [24]. For such a modular design to be successful, manufacturers on top of a supply chain must maintain tight, centralized control over the innovation network and ensure that the individual components are modular and fit together [24]. Nonetheless, as Lyytinen et al. [1] stated, we can already observe examples of distributed control such as in open-source communities (e.g., [16], [30]). Projects such as Linux prove that the creation and development of highly complex products is feasible without any formal hierarchy [1], [24]. Thus, even though the incumbents in our case studies are currently not experimenting with more distributed forms of control, this may only be due to the tried-and-tested ways traditional companies always conducted their business. Path dependence, i.e. continuing to do things the traditional way, has implications for any renewal or restructuring process (e.g., [31]). Henceforth, after the successful emergence of open-source networks in highly digitized industries such as software and electronics, we expect "other industries [to follow] this trend as they embrace digitization in their products and services – for example, through implementing Internet of Things, digital product libraries, 3D printing and big data" [1, p.69]. Future research is needed to fully understand the factors that favor or hinder distributed forms of control and the decision of organizations to not use certain innovation networks.

Our results do support the prediction of Lyytinen et al. [1] that there is a strong trend towards more heterogeneous types of innovation networks. This is displayed in two different ways. First, 16 out of 27 interviewees mentioned project innovation networks. However, intra-departmental co-operation (co-operation within the same department; very homogenous setup) was only mentioned twice, whereas the overwhelming majority (12 of 16) referred to inter-departmental cooperation (co-operation across various departments; less homogenous as different fields of expertise within the company are involved). Thus, even within project innovation networks appears to be a strong trend towards the north. Second, multiple forms of federated innovation networks were mentioned by 26 of 27 interviewees, hence, providing a strong indication that the involve-

ment of more heterogeneous knowledge is becoming increasingly important. This development provides many opportunities for further investigation as each form of cooperation has different advantages and disadvantages. Quantitative research might be able to further analyze these factors and relate them to innovation success or failure.

Limitations and Practical Implications. As for every research endeavor, it is important to understand and point out possible limitations. The chosen form of research design cannot claim to produce generalizable results but rather aims at conceptual clarity and identifying valuable areas of further inquiry. Furthermore, our sample of 27 interviews has a strong focus on the financial and manufacturing industry, which may results in biases. Furthermore, our case studies were conducted by exclusively interviewing high-level executives in incumbent companies. Thus, it would be interesting to contrast our findings with insights in upcoming, less established companies that might or might not rely on very different innovation networks including distributed forms of control. Hence, we welcome future studies to supplement our results with insights derived from qualitative or quantitative research.

The results of our research offer numerous implications for practitioners. First, our results indicate that different types of innovation networks are used for different purposes. Practitioners are well advised to focus on inter-departmental project innovation networks to facilitate idea generation, rapid experimenting and problem-solving if the knowledge necessary to address such issues already exists within the company. If there is the need to acquire additional expertise that does not exist within the company, practitioners can use several forms of federated innovation networks. Federated innovation networks were pointed out to be especially powerful to access external expertise. Furthermore, federated innovation networks can be utilized to directly get in touch with the customer and acquire real-time feedback, thus, providing ample opportunity to increase eventual customer value.

Second, even though there are successful examples of distributed control in some industries, the incumbents in our case studies appear to not actively experiment with distributed forms of control. Hence, here might lay new opportunities for innovative forms of collaboration and new business models.

Third, companies trying to slowly increase the heterogeneity of their resources and knowledge without disrupting their current processes can experiment with transition mechanisms. If there is a need to increase control and streamline heterogeneous knowledge resources into a more consistent, homogenous knowledge base practitioners can rely on integration mechanisms.

In conclusion, this paper produced new insights into how companies can move from one type of innovation network to another and which innovation networks are currently prevalent among incumbents. Most importantly, our results produce novel insights about why different types of innovation networks are used and point towards fruitful avenues for future research on innovation networks.

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