

# LEVERAGING INDUSTRIAL IOT PLATFORM ECOSYSTEMS: INSIGHTS FROM THE COMPLEMENTORS' PERSPECTIVE

*Research paper*

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## Abstract

*To create value from the increasing amount of data produced by the Industrial Internet of Things (IIoT), many firms establish platforms to collect data and make it available to third parties. Thus, IIoT platforms rely on a diverse ecosystem of complementors for value creation. While platform ecosystems have received considerable attention in research, most studies focus on the platform owner and domains such as video game or mobile platforms. In this article, we conducted a case study to shed light on why complementors choose specific IIoT platforms and how they leverage IIoT platform ecosystems for their benefit. To this end, we collected interview data from 15 firms that provide complementary offerings to an IIoT platform. We identified platform owner relationship, platform owner background, customer decision, platform market position, and platform features as vital criteria for platform choice. Additionally, our findings show that complementors leverage IIoT platforms primarily as a technological basis for individual solutions but not as a marketplace for generic applications. Our study extends research on platform ecosystems by illuminating the complementors' perspective and adding insights from the IIoT domain. Additionally, our findings provide guidance for platform owners on how to design IIoT platform business models and facilitate leverage.*

*Keywords: Industrial Internet of Things, Platform, Ecosystem, Complementor, Leverage.*

## 1 Introduction

As exemplified by Amazon, Microsoft or Apple, platforms constitute a significant trajectory of digital innovation (Yoo et al., 2012). In recent years, industrial firms have started to move towards platform business models as well. Fueled by the increasing prevalence of the Industrial Internet of Things (IIoT), the created platforms ease the collection and processing of data from various industrial assets and facilitate data-driven services (Hodapp et al., 2019b). The success of platforms is based on the concept of leverage, i.e. “*generating an impact that is disproportionately larger than the input required*” (Thomas et al., 2014, p. 206). This refers to their characteristic of acting as a technological basis for complementary solutions and their role as a market intermediary between different groups of actors (Gawer, 2014).

While suppliers enable the production of a good, complementors enable its use (Adner and Kapoor, 2010). In the case of IIoT platform ecosystems, for example, these actors provide software applications (apps) to analyze and use the generated data. As a result, digital platform business models depend heavily on an ecosystem of complementors (Teece, 2018; Parker et al., 2017). In the case of IIoT platforms, the ecosystem becomes even more relevant as the technical complexity of the IIoT, as well as the business-to-business (B2B) context, require a more diverse set of actors for value creation (Schermuly et al., 2019; Hein et al., 2019c). With the growing number of IIoT platforms, the key differentiating factor will

be the ecosystem of complementors emerging around them (Wortmann and Flüchter, 2015). Despite the importance of peripheral actors for a platform, prior work has primarily focused on the role of the platform owner or orchestrator (Schrieck et al., 2016). Thus, while there exists a lot of research on how platform owners leverage platform ecosystems to their advantage, insights from the complementors' perspective are scarce (Schrieck et al., 2016; Selander et al., 2013; Hein et al., 2019a).

To shed light on IIoT platform ecosystems from the complementors' perspective, we conducted an exploratory case study at a large, multinational technology firm that has recently established an IIoT platform. Our research questions are as follows: “*What are the criteria that determine complementors' IIoT platform choice?*” and “*How do complementors leverage IIoT platform ecosystems?*” To answer these research questions, we conducted semi-structured interviews with 15 partners of the platform that were subsequently coded following Glaser and Strauss (1967). We found five primary factors that influence platform ecosystem choice: platform owner relationship, platform owner background, customer decision, platform market position, and platform features. Furthermore, our results show that complementors use IIoT platforms primarily as a technological basis to deliver individual customer solutions, but not as a marketplace for generic applications.

This study entails several contributions. First, while studies on platform ecosystems to date have mainly focused on domains such as mobile platforms and video game platforms (e.g. Basole and Karla, 2011; Cennamo et al., 2018; Cennamo and Santalo, 2013; Ghazawneh and Henfridsson, 2013), we extend the literature by adding insights from the increasingly relevant IIoT domain. This allows us to derive first implications as to how the rules of the game in IIoT platform ecosystems are different from what we know from other domains. Second, we add to the yet scarce research on how complementors leverage platform ecosystems. Third, despite our focus on the complementors, our results offer guidance to platform owners on how to effectively design successful IIoT platform business models.

The paper is structured as follows. In the next section, we provide the theoretical background on IIoT platform ecosystems and the concept of leverage. Afterwards, we explain the method of our case study before presenting our findings. Subsequently, we discuss our insights, illustrating peculiarities of IIoT platform ecosystems and the implications for research and practice. In the last section, we provide concluding thoughts as well as avenues for future research besides addressing the limitations of our study.

## 2 Theoretical Background

### 2.1 Industrial Internet of Things Platforms

Technological advances in areas such as microprocessors, connectivity and memory in recent years paved the way for the emergence of the Internet of Things (IoT), referring to the increasing connection of physical things via communication technologies (Yoo, 2010; Wortmann and Flüchter, 2015; International Telecommunication Union, 2012). The terms IoT and IIoT are occasionally used synonymously in the context of B2B settings in literature (e.g. Xu et al., 2014). Nevertheless, to highlight the unique characteristics of industrial application scenarios, we argue for differentiating both concepts. Sisinni et al. (2018, p. 4725) describe the Industrial Internet of Things (IIoT) as being “*about connecting all the industrial assets, including machines and control systems, with the information systems and the business processes. As a consequence, the large amount of data collected can feed analytic solutions and lead to optimal industrial operations*”.

The IIoT leads to a paradigm shift towards smart factories, in which smart machines equipped with sensors, actuators, data storage and processing capabilities, as well as connectivity facilitate the emergence of smart services and new business models (Endres et al., 2019; Beverungen et al., 2017). Subsequently, to harness the generated data, many firms establish IIoT platforms that are often cloud-based, allow for the collection and processing of data from various kinds of industrial assets and are open to third parties to develop complementary applications (Hodapp et al., 2019b). In contrast to business-to-

consumer (B2C) platforms, IIoT platforms operate in a B2B context, facing significantly different market structures, relationships between actors, and high technological complexity, e.g. because of the necessity of integration into customers' existing information technology (IT) infrastructure (Schermuly et al., 2019; Hodapp et al., 2019a).

While the facilitation of application development by third parties is one of the most frequently mentioned capabilities of IIoT platforms, application developers are not the only complementors needed for value creation (Hein et al., 2019c; Papert and Pflaum, 2017). Typically, the IIoT platform itself performs the role of an "integration middleware" (Guth et al., p. 2), acting as a bridge between devices and applications (Wortmann and Flüchter, 2015). This includes the provision of computing resources such as cloud infrastructure with data storage and processing capabilities as well as an operating system to run applications for data analysis (Hodapp et al., 2019b). To facilitate the collection of data, additional actors such as providers of connectivity solutions and system integrators are required. This creates an ecosystem of complementors that is more diverse than in most B2C platforms or B2B domains studied to date, resulting in various "sides" in the sense of groups of actors (Hein et al., 2019c; Papert and Pflaum, 2017).

The creation of IIoT platforms by industrial firms entails potential changes in the business models of all actors on all these sides. Providers of sensors and connectivity solutions, for example, that previously relied on a product sales based business model might now offer own applications to customers to analyze the sensor data. Machine manufacturers might switch to performance based service business models because of increased usage transparency. Software developers might just use the platform as a new sales channel for applications. Additionally, all actors need to reevaluate how they capture value in this new setting characterized by horizontal relationships with less or sometimes even no hierarchical control as opposed to previous vertical supplier-customer relationships (Jacobides et al., 2018; Parker et al., 2016).

## 2.2 Leveraging Platform Ecosystems

Platforms and ecosystems are concepts often mentioned in the same breath as the former are often the trigger for the latter (Kapoor, 2018). Platforms create ecosystems in two ways (Gawer, 2014): by acting as a technological foundation, and by acting as a market intermediary. First, viewed from an architectural perspective, platforms provide a basis for the development of complementary products and services (Gawer and Cusumano, 2014). This notion of a platform originated in the literature on (internal) product families as collections of derivative products all based on the same core (Baldwin and Woodard, 2009; Wheelwright and Clark, 1992). It has since moved on to a more external view, defining platforms as "products, services, or technologies that [...] provide the foundation upon which outside firms [...] can develop their own complementary products, technologies, or services" (Gawer and Cusumano, 2014, p. 418). Consequently, platforms attract complementors who create complementary solutions, e.g. app developers on iOS. Second, platforms act as an intermediary between two or more groups (Rochet and Tirole, 2003). This notion of platforms as two-sided or multi-sided markets is based on the idea that platforms can connect buyers and sellers of specific products or services and enable or facilitate transactions between them (Eisenmann et al., 2006). The resulting ecosystem consists of the members of the different parties. These two roles of platforms are not exclusive, as most of the platforms display aspects of both (Schrieck et al., 2016). As a result, platforms facilitate the emergence of ecosystems around them, consisting of complementors and customers or users.

The success of platform ecosystems is based on the concept of leverage, i.e. "generating an impact that is disproportionately larger than the input required" (Thomas et al., 2014, p. 206). Platform ecosystems display three types of leverage: production leverage, innovation leverage, and transaction leverage (Thomas et al., 2014). The notion of production leverage, i. e. the reuse of components to achieve economies of scale, is deeply rooted in the literature on product families as the origin of platform ecosystems discussed above (Thomas et al., 2014). Car manufacturers, for example, often use a common platform for different models to realize efficiency gains. In the context of digital platforms, production leverage is facilitated by boundary resources such as application programming interfaces (API) and software development kits (SDK), which enable complementors to tap into data provided by users on the platform

and create offerings with less effort than would have been required for development from scratch (Ghazawneh and Henfridsson, 2013).

In digital platform ecosystems, innovation and transaction are the prevalent types of leverage (Hein et al., 2019a). Similar to production leverage, innovation leverage is based on the role of platforms as a technological foundation for complementary modules. Platform owners benefit by creating a greater set of offerings, not just in terms of quantity, but diversity as well, than would be possible by their own capabilities and efforts (Boudreau, 2012). Additionally, complementors often provide an impetus for innovations that are subsequently adopted by the platform owner (Hein et al., 2019a; Schrieck et al., 2017). Innovation leverage is therefore closely linked to the concept of generativity as a “*technology’s overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences*” (Zittrain, 2006, p. 1980). In the case of digital platforms, generativity describes a platform’s ability to trigger a variety of complementary innovations by third parties. Naturally, complementors benefit from this by being able to create innovative solutions that might not have been feasible without the platform’s technical capabilities.

Complementors also benefit from transaction leverage in platform ecosystems. Based on their role as market intermediaries, platforms reduce the effort of different parties interested in transactions to find each other and perform the transactions (Tiwana, 2014; Thomas et al., 2014). An application developed for iOS can address a vast customer base with each customer being able to download and install the app with just a few taps. At the same time, the value of iOS for customers increases as the number of offerings in the form of apps grows because of network effects (Parker and van Alstyne, 2005; Katz and Shapiro, 1985). The platform owners benefit by charging for membership in the ecosystem, retaining a fee for every transaction, or revenue sharing with complementors (Rochet and Tirole, 2006; Oh et al., 2015; Hagiu, 2006).

Insights on leverage and platform ecosystems in general have so far mainly been collected in domains such as mobile and video game platforms, nested in a B2C context (e.g. Basole and Karla, 2011; Ghazawneh and Henfridsson, 2013; Cennamo et al., 2018; Cennamo and Santalo, 2013). Based on the technological aspects and different market structures and relationships inherent to the B2B setting, it stands to reason that IIoT platforms display differences to other domains (Schermuly et al., 2019; Hein et al., 2019c). Additionally, prior work has mainly focused on the platform owner (Schrieck et al., 2016; Selander et al., 2013). Thus, in this study we want to shed light on how peripheral actors in the form of complementors leverage the IIoT platform ecosystem.

Table 1 summarizes our theoretical understanding of leverage in platform ecosystems. This understanding serves as a basis and guideline for our case study and allows us to extend existing theory by building on it (Walsham, 1995; Ketokivi and Choi, 2014). The architectural perspective is linked to innovation and production leverage, as complementors use the platform to build solutions more efficiently or create innovative solutions. As such, the focus of leverage from the complementors’ perspective is on the platform. The market perspective, viewing platforms as an intermediary between different groups or sides, is linked to transaction leverage as it facilitates interaction between actors. Complementors can draw on the platform’s potentially large customer base or cooperate with other actors. Consequently, the focus of transaction leverage from the complementors’ perspective is on the ecosystem.

<i>Perspective</i>	<i>Definition</i>	<i>Type of Leverage</i>	<i>Focus of Leverage</i>
Architecture	Platform as a technological basis for third parties to develop complementary offerings.	Production Leverage Innovation Leverage	Platform
Market	Platform as a market intermediary between two or more groups of actors or sides.	Transaction Leverage	Ecosystem

Table 1. Platform perspectives and focus of leverage

### 3 Method

#### 3.1 Case Description

As the field of IIoT platform ecosystems has not been studied extensively so far, we conducted an exploratory case study to create an understanding of this relatively new domain (Klein and Myers, 1999; Walsham, 1993; Yin, 2018). Case selection and analysis followed a theoretical sampling approach (Glaser and Strauss, 1967). While we are guided by the concept of leveraging as proposed by Thomas et al. (2014) on a high-level, we theorize in a grounded, inductive approach on a micro-level (Birks et al., 2013). To meet our research objective, the case needed to be an IIoT platform that was open to actors outside the owner-firm, had already attracted a certain number of complementors and had been in operation for some amount of time to allow for the collection of complementors' experiences. As a result, we chose the *Connect* Platform provided by *Industry Inc.* as a suitable case<sup>1</sup>.

Industry Inc. is a large, multinational technology firm providing, among other things, products and services for factory automation. In 2017, Industry Inc. established its platform *Connect*. The intention was to exploit the vast amount of data created by machines. Therefore, *Connect*'s features allow for the collection of data from various machines and sensors, the transfer of data to the cloud as well as the processing of data in the cloud or edge. Additionally, Industry Inc. provides boundary resources such as APIs and SDKs as well as an app store to offer third parties the possibility to access the data, create, and sell own applications on the platform.

To date, *Connect* has attracted over 500 actors that provide complementary offerings. The most popular and characteristic complementor role is app development. Similar to B2C platforms such as iOS, app developers can comfortably develop and offer their software on the platform with the given tools and specifications. Consultants support customers with evaluating their needs, providing them with use cases and showing them the return on investment regarding specific solutions. System integrators ensure the data's access on the shop floor and connected information systems. Connectivity partners provide hardware and software to connect the customers' industrial assets to the platform. Technology partners ensure the platform's operability and enhance its capabilities by providing infrastructure but also knowledge and services to the ecosystem regarding technologies and topics like artificial intelligence (AI), blockchain or security. In practice, most complementors perform several roles.

#	Complementor	Employees	Role(s)	Interviewee(s)	Duration
1	A	< 500	AD, CO	Head of Partnerships	37 min
2	B	< 500	CO, CP	Key Account Sales Director	29 min
3 - 4	C	< 5000	AD, CO, SI	Key Account Manager + IoT Project Consultant	26 min
5	D	< 500	AD, CO, SI	Member of Executive Board	37 min
6	E	> 100 000	AD, CO, SI	Head of Sales	49 min
7	F	< 50 000	AD, CO, SI	Executive VP for Sales/ Business Development	21 min
8	G	< 100	AD, CO, SI	Partner Manager	30 min
9	H	< 100	AD, CO, SI	CEO and Co-Founder	29 min
10	I	< 10	AD, CO	Managing Director	21 min
11	J	< 100	CP	Partner Manager	43 min
12	K	< 100	AD, TP	Founder and General Manager	45 min
13	L	< 500	AD, CO, TP	Manager Data Analytics Projects	35 min
14	M	< 500	AD, CO, CP	Managing Director / Key Account Manager	38 min
15	N	< 50 000	AD, CO, SI, CP	Key Account Manager	42 min
16	O	< 100	AD, CO, SI, CP	Founder and General Manager	43 min
	AD	CO	SI	CP	TP
	App development	Consulting	System integration	Connectivity	Technology

Table 2. Details on interview partners

<sup>1</sup> *Industry Inc.* and *Connect* are pseudonyms used for confidentiality reasons.

As we intended to generate insights from the complementors' perspective, we selected several partner firms for our interviews. The prerequisites were that the partners were active in the sense that they currently use the platform to provide solutions to customers, and that our sample displays diversity in terms of company size and roles. As a result, 15 firms were selected for our case study. Table 2 gives an overview of the firms, their size and role in the ecosystem, as well as the interviewees' positions.

### 3.2 Data Collection and Analysis

We collected data through a series of 15 semi-structured interviews with 16 interviewees conducted between July and August 2019. Each interview represented a partner company offering solutions via the Connect platform. As the Connect Platform has only been established in 2017, the experience of most interviewees with this specific platform varies from around half a year to a little over two years. The interviews lasted between 21 and 49 minutes, with the median being at 37 minutes and the average at 35 minutes. The interview guideline covered three categories of questions: the first regarding the firms' business model and how it fits to the platform, the second related to the offerings they have created so far through the platform, and the third pertaining to their interaction with other actors.

All interviews were recorded, transcribed and subsequently sent back to the interviewees for further amendments and corrections. Following the approach proposed by Glaser and Strauss (1967; 1998), the final transcripts were analyzed by two researchers in three subsequent coding cycles as depicted in Figure 1. Although multiple minds allow for the generation of new and richer codes and thus leads to a broader understanding of the phenomenon, one researcher has been assigned primary responsibility to ensure consistency and reliability (Saldaña, 2013). In the open coding cycle, the researchers independently analyzed and coded all 15 interview transcripts line-by-line with support of the qualitative data analysis software MAXQDA. New incidents while coding subsequent interviews were regularly crosschecked with incidents of previous interviews in line with the constant comparative method (Glaser and Strauss, 1967; Corbin and Strauss, 2015). In the next step, the codes were consolidated to a common code schema. Both researchers carried out this process jointly, iteratively discussing the codes and adapting them further until full consensus was reached (Harry et al., 2005). As comprehensive coverage of the material from different perspectives and group consensus were our goal, we did not establish a quantitative rating to measure intercoder agreement (Saldaña, 2013).

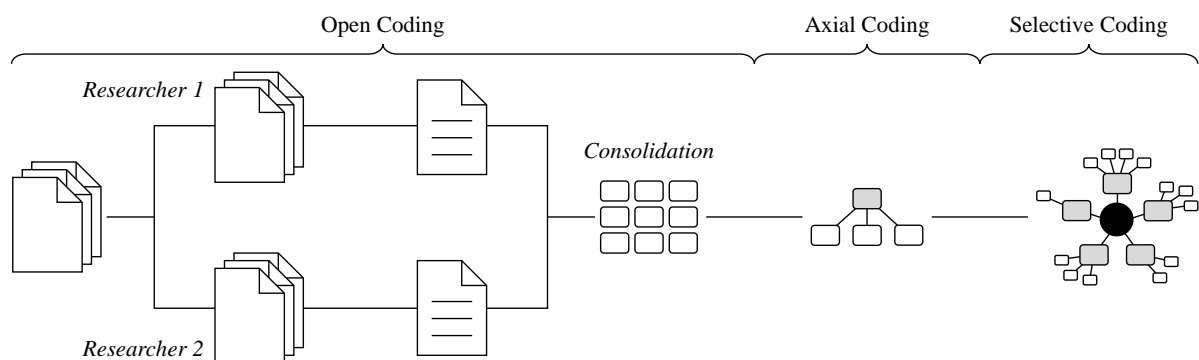


Figure 1. Overview of the coding process

In the second cycle, we applied axial coding. By comparing and identifying relationships between the codes, a deeper understanding of the fundamental phenomenon should be achieved (Corbin and Strauss, 2015). An alternating inductive and deductive reasoning pattern characterizes this phase. While we gained a better understanding with every iteration, we felt the need to return to interview material repeatedly to match and verify new findings. As the final step, selective coding was used to link the categories to our research question. The purpose was the identification of core categories to which the categories determined in axial coding were systematically connected (Corbin and Strauss, 2015). Table 3 shows a simplified illustration of our coding scheme.

<i>Transcript data</i>	<i>Open Codes</i>	<i>Axial Codes</i>	<i>Selective Codes</i>
<i>"We propose platforms and bring Connect into play, but if the customer chooses a different IoT platform, it is his decision. "</i>	Specific customer wishes regarding a platform	Decision authority of the customer	
<i>"Our customers are globally distributed. For each region, a specific platform is more accepted, e. g. in Europe and Japan, it is Connect."</i>	Regional differences in customer's platform acceptance		Reason for choosing a platform
<i>"Connect has the advantage that many Factories are equipped with Industry Inc. devices."</i>	Prevalence of the platform owner's products	Platform owner's background	
<i>"Industry Inc. as market leader in automation has a vast experience in the OT sector [...]"</i>	Domain knowledge of platform owner		

Table 3. Simplified illustration of the coding scheme

## 4 Results

### 4.1 Choosing an IIoT Platform Ecosystem

How IIoT platform ecosystems are leveraged is reflected early in the complementors' motivation and choice for a particular platform ecosystem. Our results indicate that five primary factors influence platform ecosystem choice: platform owner relationship, platform owner background, platform market position, platform features, and customer decision authority.

First, choosing a B2B platform can depend on the complementor's relationship with the platform owner. Complementors often choose to engage in a platform because of a preceding, long-lasting business relationship with the platform owner. The rationale is to intensify cooperation and increase dependencies with the platform owner. As one interviewee stated:

*"We selected Connect as an IoT platform because of the good business relationship between Industry Inc. and us in terms of a long-lasting supplier relationship until now." – Complementor M*

Another critical factor is the platform owner's background in terms of domain expertise and a large market footprint regarding relevant products and devices. Specifically, regarding IIoT, complementors appreciate prior knowledge in factory automation, connectivity and other technological fields. Some firms mention the importance of capabilities in the area of operational technology (OT) as a reason for their platform choice, others stressed Industry Inc.'s large number of automation devices already installed at their customers' sites. These specific capabilities and knowledge that go beyond mere IT capabilities often tip the scale in favor of specific platforms, as stated by two of the partners when asked about their decision for Connect:

*"A benefit of [Competitor 1]'s IoT platform is its larger ecosystem of companies, but we see more value in the OT background of Industry Inc." – Complementor G*

*"Other platforms like [Competitor 2] are more IT related and do not have the benefit of the OT background like Industry Inc.'s Connect. This is something unique." – Complementor E*

This credit of trust granted by the complementors is also visible in the third prevalent reason for platform choice: platform market position. Several partners expect a consolidation of the IIoT platform market in the coming years. As the development of solutions on a platform often entails significant investment, many complementors base their choice on the platform's current (regional) market penetration and its prospects of survival. As one interviewee stated:

*"We are sure Connect will be one of the remaining IoT platforms after market consolidation." – Complementor J*

Potential complementors also base their decision on the platform features. Frequently mentioned, the technical capabilities of a platform play a crucial role. Amongst others, the vertical and horizontal integration of hardware and software, data consistency throughout various systems and data security were frequently mentioned essential characteristics. More vague technical capabilities such as organisational openness for actors were also mentioned. A critical feature for more advanced applications is the platform's capability to not only integrate and consume data but also the possibility to control the embedded machines and products the other way around. For example, one interviewee expressed:

*“We do not have this solution [autonomous energy control solution; comment by the authors] available for Connect because at the moment, the edge agent between the control and Connect does only allow the consumption of data, but the “way back” is not possible with the current Connect solution.” – Complementor K*

Last, a considerable reason mentioned by several partners that is independent of the platform owner's or platform's characteristics was the decision authority of the customer. In many cases firms do not choose a platform to adapt their offerings to the platform's existing customer base or act as “platform evangelists” to their existing customers. Instead, the customer has individual requirements or preferences regarding platforms and the firms adapt and choose a platform accordingly. Many actors are also indifferent with respect to platform choice because of their business model or role in the ecosystem. E.g., one partner offering technologies to connect assets under various environmental conditions states:

*“We propose platforms and bring Connect into play, but if the customer chooses a different IoT platform, it is his decision. For sure, each platform has its specific advantages, but in the end the customer decides.” – Complementor E*

As indicated by our results, these criteria in many cases lead to an engagement on several IIoT platforms. The reasons for this are threefold. Some interviewees noted that the maturity of the platform market is currently too poor to commit oneself to a single provider already. Others mentioned that currently no platform could completely fulfill all desired characteristics. The third reason refers to the previously discussed approach of adapting the customer's wish for a specific platform.

## 4.2 Leveraging the Platform

We found evidence for production leverage in the sense that complementors use the platform to develop their solutions for customers. Complementors value the data collection capabilities offered by the platform as well as the easy access to data and its essential visualization solutions even if they do not intend to change their business model or provide innovative new solutions. While the firms were able to develop their offerings before joining the IIoT platform ecosystem, they benefit from significant efficiency gains, as one partner states:

*“Connect can help us because we can scale much easier because if we develop a product for a customer and this customer already uses Connect and the customers of our customer also rely on Connect, it is really easy to get the data available.” – Complementor H*

Several complementors leveraged the platform to provide innovative solutions in the form of new smart services. These range from real-time inventory control over predictive maintenance to AI based optimization of machine calibration. Most of these applications are very domain-specific and in many cases even customer-specific, as for example this solution developed by one of the complementors:

*“The customer has test stations to test the aging behavior of batteries to analyze the impacts of different load profiles on the batteries. For this, the company needs to determine the state of health in a very accurate way. We use AI-based algorithms to analyze critical sequences in the load profile. The analysis process could be shortened from 80 min to under 1 min with our application.”  
– Complementor H*



Although there are some examples of innovative applications, most of the complementors who create new offerings by leveraging the platform do so in a conservative manner. Our interviews show that a majority of the applications to date is restricted to monitoring and visualization functionality. One interviewee even criticized the exaggerations of other complementors regarding the features of their solutions:

*“At the moment, many companies advertise with the keywords predictive maintenance and AI, although their solution does not really contain AI-technology and predictive maintenance solutions.”*  
– Complementor O

Interestingly, although most of the complementors see a considerable advantage of a platform in selling generic apps instead of the usual project-based software development, only a small number of generic apps has been developed on the platform to date. Our results reveal several reasons for this scarcity of generic solutions. First, many firms have certain supplier restrictions that prevent them from purchasing apps from smaller or new suppliers. Before selling apps, complementors would first need to go through a certification process. A second obstacle mentioned by developers are high upfront investment costs coupled with uncertainty, whether many users will adopt the application or not.

*“The financial investment with application development can be a six-digit amount, the lead time for a project is approximately 12 months. This leads to high risk and thus, we develop an application only if we see that there's a real customer project.”* – Complementor D

The third impediment for sale and consequently the development of generic applications on IIoT platforms is the necessity for consulting. In line with the high development costs and the significant effort necessary for the implementation of a solution at a customer's site, business customers with professional purchasing departments will in most cases not simply purchase an application. Instead, several complementors stressed the importance of illustrating the (financial) benefits offered by an application and the support in terms of integration into the customer's operations. One interviewee clarified this difference between B2B and B2C platforms by stating:

*“We are quite critical of the current development of selling apps via a platform in the B2B sector because there is a huge difference to the B2C sector where a private customer is open to click & buy an application on the store. In the B2B sector, there is more consulting necessary. A typical customer will not buy the industrial application just via the store without any consulting.”*  
– Complementor M

The fourth reason for the dearth of generic solutions on IIoT platforms we identified in our case study are the high technological complexity and individuality of settings. Typically, IIoT solutions analyze large amounts of industrial asset data to monitor or optimize critical business processes. This does not only result in high demands in terms of reliability but also requires adaptation to the peculiarities of the customer's application scenario, making it hard to transfer a solution developed for one customer to another, as explained in an example by one of the interviewees:

*“One use case we already developed on Connect was [...] a maintenance prediction for train doors [...]. The solution was realized with a customized application [...]. In principle, the use case and application are transferable to other train operating companies as well, but the pattern recognition algorithm is proprietary which means the data access is different depending on the train manufacturer. This is the reason why we cannot provide a generic platform application, but only a manufacturer model-based or customized application.”* – Complementor L

### 4.3 Leveraging the Ecosystem

The most apparent form of transaction leverage in platform ecosystems from a complementor's perspective is the extension of the customer base. By offering solutions on a platform, it becomes available to

the potentially large number of platform users. We also found evidence for this in our interview data, as about half of the complementors stated that they had acquired new customers since joining the IIoT platform ecosystem. However, only few complementors leverage the market intermediary market character of platforms to the full extent by selling generic solutions via the app store because of the above-mentioned obstacles for creating such generic applications. Nevertheless, almost all complementors mentioned the opportunity of selling generic applications via the platform as the main potential change in their business model. Only occasionally interviewees mentioned that they had no interest in using this sales channel.

Another form of how complementors leverage the ecosystem emerging from our interviews was cooperation with other complementors. This cooperation is usually based on the initiating partner's lack of capabilities or resources to realize a particular solution for a customer. For many firms, IIoT is a diverse and highly sophisticated topic for which it is cumbersome to offer solutions on one's own. This is why companies welcome cooperation with third parties who cover unaddressed roles in the ecosystem and can provide missing resources and knowledge. This necessity of cooperation also shows the above-mentioned technological complexity inherent in the implementation of solutions on IIoT platforms:

*"[...] we collaborated with [Complementor B] because of their core competencies in a specific connectivity solution for a smart city project. We bring connectivity hardware like sensors and gateways into the solution, [Complementor B] brings the connectivity technology with a focus on near-field-communication. In addition, we contribute our competencies in application development [...]." – Complementor N*

Besides the compensation of missing capabilities, firms are also interested in aligning complementary offerings to increase customer demand and retention. Some also expect to gain access to new customers because of the cooperation. However, while cooperation with others is seen as critical, many complementors do not cooperate with new partners within the IIoT platform ecosystem but draw on their existing partner networks. This is especially true for large firms, while smaller firms tend to appreciate the opportunity of finding partners within the ecosystem. Only few interviewees state that the ecosystem is not of interest at all, as they are either only interested in the technical capabilities of the platform, have all necessary competencies available in house, or already maintain a partner network on their own. The remaining majority is at least open for future cooperation, albeit often in a passive position, as stated by one of the complementors:

*"Our focus is doing business – if we can provide a good solution, which meets the requirements of the customer, it does not really matter for us if we provide this with a joint solution or on our own." – Complementor B*

Interestingly, fear of competition does not seem to be an impeding factor for cooperation, at least for the majority of complementors. While actors focusing only on app development and consulting see themselves in a competitive situation, the system integrators, technology partners, and connectivity partners do not experience competition or threats. In their opinion, they have a unique setup of competencies and solutions, which is hard to imitate. This is, of course, also in line with the lack of generic solutions available on the platform at this point. However, one interviewee mentioned the aspect of competition with the platform owner:

*"One generic app was planned in the last months, but this did not happen because Industry Inc. wanted to develop this kind of application and sell it themselves." – Complementor M*

In general, complementors are eager to get more information about the ecosystem, regarding customers, potential cooperators and competing actors. As a critical remark, the few complementors with a good overview of the ecosystem address the platform owner's focus on quantity rather than quality of the partnering companies and especially criticize the imbalance in the allocation of competencies as well as offered services and products.

## 5 Discussion

### 5.1 Facilitating Leverage

Table 4 summarizes the manifestations of leverage we found in our case study as well as (potential) impeding factors. Our insights provide evidence for all three types of leverage: production, innovation, and transaction. Many complementors use IIoT platforms to more efficiently implement existing solutions, while others create new and innovative solutions. Our interviews showed, however, that these solutions are still mostly confined to monitoring capabilities. Thus, while recent literature on digital platforms has stressed their generativity (Hein et al., 2019a; Fürstenau et al., 2019; Hein et al., 2019b), our results indicate moderate levels of generativity in IIoT platform ecosystems (Pauli and Lin, 2019). However, as generativity increases with heterogeneity of devices and actors involved in innovation (Yoo et al., 2010), the generative potential of IIoT platform ecosystems is essentially rather high.

Reasons for the nevertheless low exhaustion of this potential can, on the one hand, be the missing customer demand. Many complementors will initially transfer their existing solutions to the platform before starting to create distinct offerings. There will probably also be a move towards innovation leverage when transparency in the ecosystem rises, and customers become more open to the opportunities provided by smart services. On the other hand, the rather low levels of cooperation and competition we found might impede innovation (Bengtsson et al., 2010). Our results show that only few complementors create generic solutions or applications based on the platform. Instead, their efforts are often focused on solutions for individual customers. With no generic applications competing for customers, and individual niches occupied by the different complementors, competition and consequently pressure for innovation is low.

<i>Type of Leverage</i>	<i>Manifestation (+/~/-)</i>	<i>Impeding Factors</i>
Production Leverage	(+) Efficient provision of existing solutions	Lack of technical platform capabilities
Innovation Leverage	(~) Development of innovative solutions	Lack of technical platform capabilities Imbalance of complementor competencies Lack of collaboration/ecosystem transparency Lack of competition Missing customer demand and maturity
	(-) Development of generic solutions	Uniqueness of operational scenarios High upfront investment Adoption insecurity
Transaction Leverage	(+) Access to new customers	Supplier restrictions
	(-) Cooperation with other actors	Lack of ecosystem transparency
	(-) Distribution of generic solutions	Lack of generic solutions Necessity of consulting Supplier restrictions

Table 4. *Influencing factors on leverage in IIoT platform ecosystems*

As indicated by our findings, transparency is an essential factor in this regard, as limited knowledge about the other actors in the ecosystem and their capabilities impedes cooperation (Lyytinen et al., 2016). Finding suitable partners that complement one's capabilities is a significant challenge in nascent IoT platform ecosystems (Hodapp et al., 2019a). An increase in ecosystem transparency might lead to a state of dynamic cooptation (Bengtsson et al., 2010) that increases innovativeness and thus the exhaustion of the generative potential of IIoT platform ecosystems. A way to further trigger innovation leverage could be the market entry by the platform owner by increasingly offering own solutions. As other domains demonstrated, the resulting increasing competition stimulated innovation variety as a result of a "spillover" of the customer's attention for similar solutions (Wen and Zhu, 2019; Foerderer et al., 2018).

Regarding transaction leverage, many prerequisites are similar to what we know from other B2B domains such as enterprise resource planning (ERP) software: complementors value the potential of accessing the platform provider's large customer base and benefiting from its reputation (Wareham et al.,

2014). However, there are some domain-specific factors that inhibit transaction leverage by complementors, the most important being the lack of generic solutions because of the uniqueness of operational scenarios and adoption insecurity. The coverage of a heterogeneous market that cannot feasibly be addressed by the platform owner through complementary solutions developed by third parties is a core idea behind the establishment of platform ecosystems (Ceccagnoli et al., 2012; Wareham et al., 2014). Still, the individual solutions of complementors are typically designed to comprehensively serve a certain niche or vertical in a standardized way, as opposed to single customers. Overcoming these barriers for the provision of generic applications will therefore be critical for the facilitation of transaction leverage. Our results indicate that a way to overcome this challenge to some extent might be to include machine manufacturers as important complementors. These manufacturers might then provide an application developed for a specific machine model to all users operating the same machine.

Generally, the prospective opportunity of using the platform as a distribution channel for generic applications is the most commonly envisioned business model change. Currently, however, the complementors' business models are for the most part unaffected, with the exception being a move towards app development by many firms that previously only focused on provision of hardware or services. In line with the expected growth of innovation leverage as ecosystem transparency and customer openness increase, our findings might therefore be related to the early lifecycle stage of the platform ecosystem.

## 5.2 Building Successful IIoT Platform Business Models

A significant challenge for platform owners in the design of platform business models is value capture (Schreieck et al., 2017). In many cases, platform owners rely on membership-based revenue generation mechanisms or transaction-based revenue models (Rochet and Tirole, 2006; Hagi, 2006; Oh et al., 2015). Similarly, IoT platforms have been found to charge a base fee and additional fees per connected device, per API call, per request or based on the amount of data traffic (Hodapp et al., 2019b). For IIoT platforms, our results indicate that the feasibility of transaction-based revenue models, where the platform owner retains a percentage of each application purchase, is diminished by the lack of generic applications. As such, it could be advantageous to rely on business models centered on charging for provision of the technological infrastructure in the early stages of an IIoT platform ecosystem and move towards more transaction-based models later on. In line with insights from platforms in the enterprise resource planning (ERP) software domain (Schreieck et al., 2017; Parker et al., 2017; Sarker et al., 2012), we see that value capture in IIoT platform ecosystems also entails more complex mechanisms such as the absorption of complementors' solutions. In this regard, especially concerning the substantial development costs, platform owners need to find mechanisms to balance value appropriation between the different roles in the ecosystem (Huang et al., 2013).

Generally, IIoT platform ecosystems might display different strategies pertaining to their lifecycles than cases studied to date. A key discourse in platform ecosystem literature revolves around platform launch strategies aimed at overcoming the "chicken-or-egg"-problem in the sense of attracting enough customers to make the platform attractive for complementors and vice versa (Caillaud and Jullien, 2003; Stummer et al., 2018; Tiwana, 2014). In B2C or rather B2B2C platforms, research shows that platform owners invest heavily in the attraction of the consumer side in the early stages of platform emergence before addressing the business side (Bakos and Katsamakas, 2008; Muzellec et al., 2015). The results of our study indicate that in the early stages of IIoT platform ecosystems, much effort is invested in building a sizeable complementor side, which is easier because of already established long-term partnerships. However, it stands to reason whether this approach will be successful. As our results show, customers will not only decide for a platform because it can advertise with a large number of partners but require consulting and a clear business case. This is in line with Schermuly et al. (2019), who found that customers in IIoT platform ecosystems are primarily concerned with their use cases realized on the platform, without necessarily looking left or right. Positive cross-side network effects might therefore be less prominent in this domain (Parker and van Alstyne, 2005).

This also prompts the question of how the market of IIoT platforms will evolve in the coming years. As mentioned by several interviewees, they expect a consolidation of the market and considered the platform's survival prospects in their platform choice. Our results show that long-term partnerships, domain know-how, and a large market footprint are important factors for attracting complementors. Thus, while start-ups have used the concepts of platform leverage to outgrow incumbents in other domains (Jacobides et al., 2019), established industrial firms might have a head start in the IIoT domain. Furthermore, despite expected consolidation, our results indicate that in contrast to other domains, the market for IIoT platforms may not be subject to "winner-take-all" dynamics (Arthur, 1996).

## 6 Conclusion

The results of our explorative case study contribute to our understanding of why complementors choose to contribute to specific IIoT platforms and how they leverage the platform and the surrounding ecosystem. We found five primary factors that influence platform ecosystem choice: platform owner relationship, platform owner background, customer decision, platform market position, and platform features. Our results show that while complementors use IIoT platform ecosystems to their advantage, their efforts are still in an early stage. Furthermore, we found that they focus primarily on leveraging the platform for creating individual customer solutions than using the ecosystem to benefit from transactional leverage.

Our insights generated in this exploratory case study indicate that the rules of the game in the IIoT domain are different than in many platform ecosystems studied to date. Primary reasons for this can be found in technical complexity and the B2B context, which impede the development and offering of generic applications. This clashes to some extent, with the central idea of transaction leverage to reach a high number of customers through a platform without having to create individual offerings. As a result, many of the established insights on platform business models might not be easily transferable to these scenarios. As discussed above, for instance, cross-side network effects and winner-take-all dynamics may not be as prominent in IIoT platform ecosystems as in other domains.

By shedding light on leverage in IIoT platform ecosystems from the complementors' perspective, our study contributes to the emerging literature on digital platforms and the surrounding ecosystems in two ways. First, we add to the yet scarce insights from the perspective of peripheral actors such as complementors (Selander et al., 2013; Schreieck et al., 2016). Second, we show how central phenomena discussed in platform literature such as leverage, generativity and network effects manifest in the IIoT domain. Third, our findings support practitioners in the design of IIoT platform business models by providing guidance regarding barriers and potential facilitators of leverage.

Nevertheless, this study is subject to limitations, which are at the same time potential avenues for future research. First, we interviewed only complementors that decided to join the platform. Further potential partners who decided against joining the platform would have shared a different perspective. Second, while we conducted an exploratory single case study to explore the nascent field of IIoT platform ecosystems, a multiple case study could offer more valuable insights, for example regarding the effects of multihoming on the quality of the solutions in this technically complex environment (Cennamo et al., 2018). Third, our study was only able to capture a snapshot in the lifecycle of an IIoT platform ecosystem. Therefore, as discussed above, some of our findings might be related to the lifecycle phase of the platform at the time of our study. Consequently, longitudinal studies might be appropriate and useful at this point, where many platforms are established and consolidation is expected.

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## References

- Adner, R. and R. Kapoor (2010). "Value creation in innovation ecosystems: how the structure of technological interdependence affects firm performance in new technology generations" *Strategic Management Journal* 31 (3), 306–333.
- Arthur, W. B. (1996). "Increasing returns and the new world of business" *Harvard Business Review* 74 (4), 100–109.
- Bakos, Y. and E. Katsamakas (2008). "Design and Ownership of Two-Sided Networks: Implications for Internet Platforms" *Journal of Management Information Systems* 25 (2), 171–202.
- Baldwin, C. Y. and C. J. Woodard (2009). "The architecture of platforms: A unified view". In A. Gawer (ed.) *Platforms, Markets and Innovation*, pp. 19–44. Cheltenham: Edward Elgar.
- Basole, R. C. and J. Karla (2011). "On the Evolution of Mobile Platform Ecosystem Structure and Strategy" *Business & Information Systems Engineering* 3 (5), 313.
- Bengtsson, M., J. Eriksson and J. Wincent (2010). "Co-opetition dynamics – an outline for further inquiry" *Competitiveness Review: An International Business Journal* 20 (2), 194–214.
- Beverungen, D., O. Müller, M. Matzner, J. Mendling and J. Vom Brocke (2017). "Conceptualizing smart service systems" *Electronic Markets* 29 (1), 7–18.
- Birks, D. F., W. Fernandez, N. Levina and S. Nasirin (2013). "Grounded theory method in information systems research: its nature, diversity and opportunities" *European Journal of Information Systems* 22 (1), 1–8.
- Boudreau, K. J. (2012). "Let a Thousand Flowers Bloom? An Early Look at Large Numbers of Software App Developers and Patterns of Innovation" *Organization Science* 23 (5), 1409–1427.
- Caillaud, B. and B. Jullien (2003). "Chicken & Egg: Competition among Intermediation Service Providers" *The RAND Journal of Economics* 34 (2), 309–328.
- Ceccagnoli, M., C. Forman, P. Huang and D. J. Wu (2012). "Cocreation of Value in a Platform Ecosystem: The Case of Enterprise Software" *MIS Quarterly* 36 (1), 263–290.
- Cennamo, C., H. Ozalp and T. Kretschmer (2018). "Platform Architecture and Quality Trade-offs of Multihoming Complements" *Information Systems Research* 29 (2), 461–478.
- Cennamo, C. and J. Santalo (2013). "Platform competition: Strategic Trade-offs in Platform Markets" *Strategic Management Journal* 34 (11), 1331–1350.
- Corbin, J. M. and A. L. Strauss (2015). *Basics of Qualitative Research. Techniques and Procedures for Developing Grounded Theory*. 4th Edition. Thousand Oaks: SAGE Publications.
- Eisenmann, T. R., G. Parker and M. W. van Alstyne (2006). "Strategies for two sided markets" *Harvard Business Review* 84 (10), 92–101.
- Endres, H., M. Indulska, A. Ghosh, A. Baiyere and S. Broser (2019). "Industrial Internet of Things (IIoT) Business Model Classification". In: *40th International Conference on Information Systems*.
- Foerderer, J., T. Kude, S. Mithas and A. Heinzl (2018). "Does Platform Owner's Entry Crowd Out Innovation? Evidence from Google Photos" *Information Systems Research* 29 (2), 444–460.
- Fürstenau, D., H. Rothe, A. Baiyere, M. Schulte-Althoff, D. Masak, K. Schewina and D. Anisimova (2019). "Growth, Complexity, and Generativity of Digital Platforms: The Case of Otto.de". In: *40th International Conference on Information Systems*.
- Gawer, A. (2014). "Bridging differing perspectives on technological platforms: Toward an integrative framework" *Research Policy* 43 (7), 1239–1249.
- Gawer, A. and M. A. Cusumano (2014). "Industry Platforms and Ecosystem Innovation" *Journal of Product Innovation Management* 31 (3), 417–433.
- Ghazawneh, A. and O. Henfridsson (2013). "Balancing platform control and external contribution in third-party development: the boundary resources model" *Information Systems Journal* 23 (2), 173–192.
- Glaser, B. G. and A. L. Strauss (1967). *The Discovery of Grounded Theory. Strategies for Qualitative Research*. Chicago: Aldine Publishing Company.
- Glaser, B. G. and A. L. Strauss (1998). *Grounded theory. Strategien qualitativer Forschung*. Bern: Huber.

- Guth, J., U. Breitenbucher, M. Falkenthal, F. Leymann and L. Reinfurt. "Comparison of IoT platform architectures: A field study based on a reference architecture". In: *Cloudification of the Internet of Things*.
- Hagiu, A. (2006). "Pricing and commitment by two-sided platforms" *The RAND Journal of Economics* 37 (3), 720–737.
- Harry, B., K. M. Sturges and J. K. Klingner (2005). "Mapping the Process: An Exemplar of Process and Challenge in Grounded Theory Analysis" *Educational Researcher* 34 (2), 3–13.
- Hein, A., M. Schrieck, T. Riasanow, D. S. Setzke, M. Wiesche, M. Böhm and H. Krcmar (2019a). "Digital platform ecosystems" *Electronic Markets* 43 (1), 39.
- Hein, A., D. S. Setzke, S. Hermes and J. Weking (2019b). "The Influence of Digital Affordances and Generativity on Digital Platform Leadership". In: *40th International Conference on Information Systems*.
- Hein, A., J. Weking, M. Schrieck, M. Wiesche, M. Böhm and H. Krcmar (2019c). "Value co-creation practices in business-to-business platform ecosystems" *Electronic Markets* 29 (3), 503–518.
- Hodapp, D., F. Hawlitschek and D. Kramer (2019a). "Value Co-Creation in Nascent Platform Ecosystems: A Delphi Study in the Context of the Internet of Things". In: *40th International Conference on Information Systems*.
- Hodapp, D., G. Remane, A. Hanelt and L. M. Kolbe (2019b). "Business Models of Internet of Things Platforms. Empirical Development of a Taxonomy and Archetypes". In: *14th International Conference on Wirtschaftsinformatik (WI)*.
- Huang, P., M. Ceccagnoli, C. Forman and D. J. Wu (2013). "Appropriability Mechanisms and the Platform Partnership Decision: Evidence from Enterprise Software" *Management Science* 59 (1), 102–121.
- International Telecommunication Union (2012). *Overview of the Internet of things (Y.4000/Y.2060)*.
- Jacobides, M. G., C. Cennamo and A. Gawer (2018). "Towards a theory of ecosystems" *Strategic Management Journal* 39 (8), 2255–2276.
- Jacobides, M. G., A. Sundararajan and M. van Alstyne (2019). *Platforms and Ecosystems. Enabling the Digital Economy*. Briefing Paper. World Economic Forum.
- Kapoor, R. (2018). "Ecosystems: broadening the locus of value creation" *Journal of Organization Design* 7 (12).
- Katz, M. L. and C. Shapiro (1985). "Network Externalities, Competition, and Compatibility" *American Economic Review* 75 (3), 424–440.
- Ketokivi, M. and T. Choi (2014). "Renaissance of case research as a scientific method" *Journal of Operations Management* 32 (5), 232–240.
- Klein, H. K. and M. D. Myers (1999). "A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems" *MIS Quarterly* 23 (1), 67–93.
- 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.
- Muzellec, L., S. Ronteau and M. Lambkin (2015). "Two-sided Internet platforms: A business model lifecycle perspective" *Industrial Marketing Management* 45, 139–150.
- Oh, J., B. Koh and S. Raghunathan (2015). "Value Appropriation between the Platform Provider and App Developers in Mobile Platform Mediated Networks" *Journal of Information Technology* 30 (3), 245–259.
- Papert, M. and A. Pflaum (2017). "Development of an Ecosystem Model for the Realization of Internet of Things (IoT) Services in Supply Chain Management" *Electronic Markets* 27 (2), 175–189.
- Parker, G., M. van Alstyne and X. Jiang (2017). "Platform Ecosystems: How Developers Invert The Firm" *MIS Quarterly* 41 (1), 255–266.
- Parker, G. G. and M. W. van Alstyne (2005). "Two-Sided Network Effects: A Theory of Information Product Design" *Management Science* 51 (10), 1494–1504.
- Parker, G. G., M. W. van Alstyne and S. P. Choudary (2016). *Platform Revolution: How networked markets are transforming the economy and how to make them work for you*. 1st Edition. New York: W. W. Norton & Company.

- Pauli, T. and Y. Lin (2019). "The Generativity of Industrial IoT Platforms: Beyond Predictive Maintenance?". In: *40th International Conference on Information Systems*.
- Rochet, J.-C. and J. Tirole (2003). "Platform Competition in Two-Sided Markets" *Journal of the European Economic Association* 1 (4), 990–1029.
- Rochet, J.-C. and J. Tirole (2006). "Two-sided markets: a progress report" *RAND Journal of Economics* 37 (3), 645–667.
- Saldaña, J. (2013). *The coding manual for qualitative researchers*. 2nd Edition. Los Angeles: SAGE Publishing.
- Sarker, S., S. Sarker, A. Sahaym and N. Bjørn-Andersen (2012). "Exploring Value Cocreation in Relationships Between An ERP Vendor and Its Partners: A Revelatory Case Study" *MIS Quarterly* 36 (1), 317–338.
- Schermuly, L., M. Schreieck, M. Wiesche and H. Krcmar (2019). "Developing an Industrial IoT Platform Trade-off between Horizontal and Vertical Approaches". In: *14th International Conference on Wirtschaftsinformatik (WI)*.
- Schreieck, M., M. Wiesche and H. Krcmar (2016). "Design and Governance of Platform Ecosystems Key Concepts and Issues for Future Research". In: *24th European Conference on Information Systems*.
- Schreieck, M., M. Wiesche and H. Krcmar (2017). "The Platform Owner's Challenge to Capture Value – Insights from a Business-to-Business IT Platform". In: *38th International Conference on Information Systems*.
- Selander, L., O. Henfridsson and F. Svahn (2013). "Capability Search and Redeem across Digital Ecosystems" *Journal of Information Technology* 28 (3), 183–197.
- Sisinni, E., A. Saifullah, S. Han, U. Jennehag and M. Gidlund (2018). "Industrial Internet of Things: Challenges, Opportunities, and Directions" *IEEE Transactions on Industrial Informatics* 14 (11), 4724–4734.
- Stummer, C., D. Kundisch and R. Decker (2018). "Platform Launch Strategies" *Business & Information Systems Engineering* 60 (2), 167–173.
- Teece, D. J. (2018). "Profiting from innovation in the digital economy: Enabling technologies, standards, and licensing models in the wireless world" *Research Policy* 47 (8), 1367–1387.
- Thomas, L. D. W., E. Autio and D. M. Gann (2014). "Architectural Leverage: Putting Platforms in Context" *Academy of Management Perspectives* 28 (2), 198–219.
- Tiwana, A. (2014). *Platform ecosystems. Aligning architecture, governance, and strategy*. Waltham: Morgan Kaufmann Publishers.
- Walsham, G. (1993). *Interpreting information systems in organizations*. Chichester: Wiley.
- Walsham, G. (1995). "Interpretive case studies in IS research: nature and method" *European Journal of Information Systems* 4 (2), 74–81.
- Wareham, J., P. B. Fox and J. L. Cano Giner (2014). "Technology Ecosystem Governance" *Organization Science* 25 (4), 1195–1215.
- Wen, W. and F. Zhu (2019). "Threat of platform-owner entry and complementor responses: Evidence from the mobile app market" *Strategic Management Journal* 40 (9), 1336–1367.
- Wheelwright, S. C. and K. B. Clark (1992). "Creating project plans to focus product development" *Harvard Business Review* 70 (2), 67–83.
- Wortmann, F. and K. Flüchter (2015). "Internet of Things. Technology and Value Added" *Business & Information Systems Engineering* 57 (3), 221–224.
- Xu, L. D., W. He and S. Li (2014). "Internet of Things in Industries: A Survey" *IEEE Transactions on Industrial Informatics* 10 (4), 2233–2243.
- Yin, R. K. (2018). *Case study research and applications. Design and methods*. 6th Edition. Los Angeles, London, New Dehli, Singapore, Washington DC, Melbourne: SAGE.
- Yoo, Y. (2010). "Computing in Everyday Life: A Call for Research on Experiential Computing" *MIS Quarterly* 34 (2), 213–231.
- Yoo, Y., R. J. Boland Jr., 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). "Research Commentary: The New Organizing Logic of Digital Innovation: An Agenda for Information Systems Research" *Information Systems Research* 21 (4), 724–735.

Zittrain, J. L. (2006). "The Generative Internet" *Harvard Law Review* 119 (7), 1974–2040.