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Microfoundations of Dynamic Capabilities for Platform Ecosystem Establishment: Evidence from Enterprise IoT

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Completed Research Paper

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Abstract

The internet of things (IoT) and digital platforms have offered industrial companies new opportunities to compete against digital platform-native companies. To succeed in this competition, industry incumbents must learn to extend their traditional product and service business through platforms. However, extant research has focused primarily on the ability of platform owners to govern mature platforms for innovation but has largely ignored how industry incumbents can build these capabilities internally during the establishment of their platform ecosystems as part of larger transformational journeys. To address this gap, we conduct a multiple case study of three incumbent organizations, drawing on a dynamic capability lens. We identify 11 practical microfoundations of sensing, seizing, and reconfiguring dynamic capabilities that aided three incumbents in establishing their IoT platform ecosystems. Besides the transformational activities, our findings contribute to the literature on platform establishment through three IoT-related shifts that deviate from known digital platform paradigms.

Keywords: Platform establishment, internet of things, digital platform, ecosystem, value cocreation, dynamic capabilities, microfoundations

Introduction

Since 2015, digital platforms have gained increasing relevance in the context of the internet of things (IoT) (Pauli et al. 2021; Wortmann and Flüchter 2015). Companies such as Microsoft (Azure IoT), Bosch (IoT Suite), and AT&T (Control Center) enable enterprises in interconnecting and digitizing their physical assets for operational efficiency gains and equip them with a base technology for extending their business through complementary applications for revenue gains, e.g., predictive maintenance services (Cusumano et al. 2019; Pauli et al. 2021). If designed openly, IoT platforms inspire the formation of business ecosystems that offer digital solutions to complex business problems across domains, such as smart manufacturing, buildings, or logistics (Porter and Heppelmann 2014; Sandberg et al. 2020). Market researchers have reported that the IoT platform market is highly fragmented, with more than 600 offerings (Lueth 2019). As none of the extant platforms launched have yet reached a maturity stage, the current picture does not align with the winner-takes-all paradigm indicating additional difficulties to establish enterprise IoT platforms (Pauli et al. 2021).

Our research departed from the notion of a platform lifecycle, describing different evolutionary stages, such as birth, expansion, leadership, and self-renewal (Teece 2017; Tiwana et al. 2010). While prior information systems (IS) research has studied the governance decisions of multiple mature platforms, insights into their establishment are scarce (De Reuver et al. 2018; Saarikko et al. 2019). However, extant studies show that the establishment phase is the most difficult, with 85% of born platform ecosystems failing to survive

(Cusumano et al. 2019; Pidun et al. 2020). Despite the various challenges associated with the establishment of platform ecosystems, such as solving the chicken-or-egg problem (Caillaud and Jullien 2003), findings often stem from consumer contexts, such as Apple's and Google's mobile operating systems (Tilson et al. 2012). The enterprise IoT offers a novel and challenging context that allows scrutinizing "how" industrial firms with traditional product and service business (referred to as industry incumbents), such as GE, Bosch, or Toyota, are transforming their internal capabilities and resources to run both pipelines and platforms (Van Alstyne et al. 2016; Hanelt et al. 2020; Vial 2019). So far, related work lacks concrete insights into the organizational processes that have helped them to thrive in their establishment, leaving room to contribute to the research stream on these challenging digital platform transformations (Pauli et al. 2021; Vial 2019).

Since IoT platform ecosystems represent uncertain and dynamic environments (Hanelt et al. 2020; Hodapp et al. 2019), we draw on dynamic capabilities (DCs) theory that helps us to explain how industry incumbents can establish IoT platform ecosystems successfully (Teece 2017; Teece et al. 1997). In particular, industry incumbents need DCs to "attract and maintain a healthy ecosystem of complementors" (Teece 2017, p. 223). However, as DCs refer to the macro-level capabilities of organizations to achieve a sustainable competitive advantage, scholars have called for more research on the micro-level practices that enable the manifestation of DCs (Schilke et al. 2018; Vial 2019). Hence, in this article, we focus on the microfoundations of DCs, which refer to the organizational processes and routines that allow explaining how DCs reveal in practice (Felin et al. 2012; Mahringer and Renzl 2018; Vial 2019). This construct provides the right granularity level allowing us to infer DCs inductively from empirically collected data. Hence, we seek to identify the microfoundations of DCs that support the establishment of IoT platforms, enabling owners to cope with ecosystem dynamics (Teece 2017). We, therefore, ask: *How can industry incumbents develop dynamic capabilities through microfoundations to establish enterprise IoT platform ecosystems effectively?*

To understand the establishment of enterprise IoT platform ecosystems from a DC lens, we used a multiple case study design (Yin 2017). We gained insights into how a software, telecommunication, and hardware provider—typical incumbent IoT platform providers (Lueth 2019)—developed their platforms, established their ecosystems, and fostered value cocreation among partners. To the best of our knowledge, this paper is the first to scrutinize microfoundations of DCs needed to establish platform ecosystems in the enterprise IoT context. Besides the identification of 11 microfoundations of DCs, we contribute prescriptive knowledge to theory and practice by shifting the viewpoint from platform owners' external activities (e.g., ecosystem governance) towards their internal transformations of effectively managing the establishment of enterprise IoT platforms. Our findings may help decision-makers of incumbent companies to implement DCs that foster IoT platform establishment journeys and to reach the maturity phase. Responding to various calls, we contribute to research on platform establishment in general and enterprise IoT platforms in particular (Jacobides et al. 2018; Pauli et al. 2021; De Reuver et al. 2018).

This paper is structured as follows: First, we present the conceptual background of IoT platform ecosystems, reassess findings of related work on platform establishment, and present the concept of DCs as a research lens. Second, we describe our qualitative, exploratory research approach using a multiple case study design based on interview data (Yin 2017). Third, we describe the 11 microfoundations that had an impact on the platform establishment. Fourth, we discuss the implications for the super-phenomenon of digital platforms (De Reuver et al. 2018), synthesizing IoT-related shifts in the form of three propositions. Lastly, we draw a short conclusion on the paper's limitations and future research opportunities.

Background

This section introduces the concept of enterprise IoT platforms, presents related work on digital platform establishment, and offers a research framework based on DCs as a theoretical lens for investigation.

Enterprise IoT Platform Ecosystems and Establishment

The rise of the IoT affects how businesses create, deliver, and capture value (Porter and Heppelmann 2014). The concept of *IoT* refers to pervasive links between physical and digital assets via the internet (Wortmann and Flüchter 2015). IoT makes a physical product "smart" as functionalities are decoupled from its corpus through code (Yoo et al. 2010). Hence, IoT solutions typically involve technical architectures that comprise four layers: hardware, connectivity, platform, and application (Porter and Heppelmann 2014; Wortmann and Flüchter 2015). They enable organizations to reduce costs by unlocking insights into internal operations

and to add value propositions through data-based services (Porter and Heppelmann 2014; Yoo et al. 2010). Besides various business-to-consumer (B2C) application contexts (e.g., wearables, smart home), growth in IoT is mainly expected in business-to-business (B2B) (or enterprise) sectors, such as smart manufacturing, energy, or logistics. Advances in product design (e.g., multi-sensors) and communication technologies (e.g., LoRa, 5G) foster the IoT market growth. To overcome technical hurdles of implementing IoT services, IoT platforms offer an interoperable and scalable digital architecture to process automatically generated data from the field and to control the assets' actuators (Wortmann and Flüchter 2015).

In addition to representing a digital infrastructure for physical assets and data management, enterprise IoT platforms leverage the creation of digital services and are thus consistent with the concept of innovation platforms (Cusumano et al. 2019; Pauli et al. 2021; Yoo et al. 2010). Accordingly, we follow the joint notion of Tiwana et al. (2010) and Tilson et al. (2012) and coin *enterprise IoT platforms* as socio-technical systems with central, extendable software stacks and social or economic actors that adopt, extend, or appropriate IoT-based innovation (De Reuver et al. 2018). Hence, enterprise IoT platforms represent an instantiation of innovation platforms (Cusumano et al. 2019). In contrast to transaction platforms (e.g., Amazon, Uber, Google Search), innovation platforms enable complementors to innovate additional modules (e.g., Siemens MindSphere's Asset Operations Analytics). These IoT modules range from dashboards to communication protocols, sensors, applications, and full-stack end-to-end solutions (Pauli et al. 2021). Hence, the business model of enterprise IoT platforms relies typically on software-based subscription models that can create indirect network effects, that is, supply-side IoT innovation increases platform adoption of customers and vice versa, i.e., attracts partners to join the IoT ecosystem (Marheine 2020; Marheine et al. 2021).

Departing from the notion of a platform lifecycle that describes different evolutionary phases from birth to renewal (Teece 2017; Tiwana et al. 2010), prior research indicates that the earlier phases, which we refer to as the establishment, are essential to set the course for a dominant market offering (Cusumano et al. 2019). While scholars have studied multiple mature platforms (De Reuver et al. 2018; Saarikko et al. 2019) insights into the establishment, especially from the perspective of industry incumbents, are scarce (Pauli et al. 2021). These firms must change their organizational routines to add a platform business (Van Alstyne et al. 2016; Mody et al. 2020). The technological complexity of enterprise IoT solutions (e.g., heterogeneity of devices) and market fragmentation stretch this challenge. IoT platform customers expect stable, reliable, and secure solutions—especially when production operations or critical business data are involved (Pauli et al. 2021). According to IS and management scholars, companies that seek to establish digital innovation platforms, such as enterprise IoT platforms, must focus on mastering three dimensions: (1) developing a platform with a standalone value proposition, (2) establishing an ecosystem with co-specialized partners, and (3) fostering value cocreation as joint activities among partners (Ceccagnoli et al. 2012; Hein et al. 2019; Sarker et al. 2012). Figure 1 presents our understanding of the establishment phase of digital platform ecosystems.

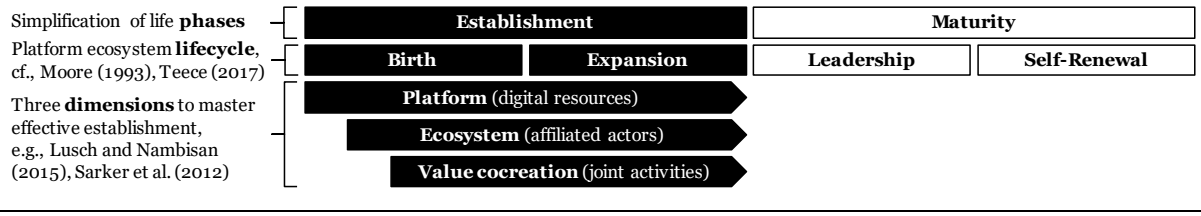


Figure 1. Conceptualization of Platform Ecosystem Establishment

Platform. First, related work suggests that firms seeking to launch a platform should develop one with a standalone value proposition (Edelman 2015). The platform should provide digital resources, empowering customers and partners to solve problems that were unsolved before (Cusumano et al. 2019; Gawer and Cusumano 2008; Saarikko et al. 2019). Successful platform launches were often studied from the viewpoint of the platform owner's governance decisions, such as openness (e.g., Gawer 2014), leadership (e.g., Gawer and Cusumano 2014), or boundary resources (e.g., Eaton et al. 2015), and market strategies, such as market entry decisions (e.g., Karhu and Ritala 2020), pricing (e.g., Stummer et al. 2018), or co-opetition (e.g., Hein et al. 2019). In enterprise IoT, platforms often comprise large solution portfolios of modular applications to solve heterogeneous customer problems, combining both software and hardware (Pauli et al. 2021; Wortmann and Flüchter 2015). Since diverse industries expect to source a variety of IoT use cases and vertical solutions from single IoT platforms (Menon et al. 2020; Pauli et al. 2021), their owners seek to

profit from additional products or services of complementors (i.e., software developers, system integrators, sensor designers) (Petrik and Herzwurm 2020).

Ecosystem. Second, to cope with the technological and business complexity in enterprise IoT (Pauli et al. 2021), platform owners need to establish an ecosystem, convincing value-adding complementors of joint goals (Jacobides et al. 2018; Petrik and Herzwurm 2020). Conceptually, ecosystems are related to platforms and describe non-hierarchal business networks that are defined through collaboration of business actors (Jacobides et al. 2018). Platform owners try to scale through complementors' platform-based products or services, so that all ecosystem actors profit from innovation, leading to positive indirect network effects (Ceccagnoli et al. 2012; Nischak and Hanelt 2019). To do so, owners must solve the chicken-or-egg problem (Stummer et al. 2018). Strategies to overcome this challenge typically rely on the commitment of marquee users (i.e., influential customers) that induce others to join the ecosystem (Edelman 2015; Jacobides et al. 2018). In IoT, the number of partners (and dependence) grows due to technological complexity and need for domain experts. As incumbents are used to managing supply chains with contractually defined quantity, time, and price of delivered goods or services, they must learn to thrive in dynamic cocreation environments (Hein et al. 2019; Marheine and Pauli 2020).

Value Cocreation. Third, platform owners should enable and incentivize joint activities between actors to generate customer value. Originating from marketing research, value cocreation has become a dominant concept in IS research (Lusch and Nambisan 2015) and platform research (Ceccagnoli et al. 2012; Hein et al. 2019; Sarker et al. 2012). Platform ecosystems build a suitable organizational form for value cocreation (Jacobides et al. 2018). They serve as a source of unprompted (and uncoordinated) innovation (Wareham et al. 2014). As they ease the interaction between ecosystem participants, each component of an IoT end-to-end solution can be provided by the "best-in-class" complementors to cope with the heterogeneity of IoT (Wortmann and Flüchter 2015). Another aspect of value cocreation is the increase in compatibility between complements, agreeing to use the same interfaces that are defined by the IoT platform owner (Ceccagnoli et al. 2012; Hevner and Malgonde 2019). In addition, value cocreation in IoT requires customer agreement, as they own the digitalized assets, generated data, and intellectual property of the solution. Table 1 shows the findings of selected studies on establishing digital (and IoT) platform ecosystems.

Article	Dimension	Main contribution
Edelman (2015)	Platform	Convincing marquee users to adopt the platform before scaling.
Khanagha et al. (2020)	Platform	Process model through collaboration with and exploitation of platform natives.
Mody et al. (2020)	Value cocreation	Emerging convergences between the platform and the product offerings.
Ofe and Sandberg (2019)	Value cocreation	Tension-derived shift towards value-driven lock-ins of ecosystem actors.
Saarikko et al. (2019)	Value cocreation	Entrepreneurial ability to leverage explorative and exploitative skills.
Stummer et al. (2018)	Ecosystem	Six platform launch strategies addressing the chicken-or-egg dilemma.
Teece (2017)	Ecosystem	Emphasizing the need for dynamic capabilities to manage platform lifecycle.
Weiss et al. (2020)	Value cocreation	Onboarding of app developers with a focus on knowledge transfer.

Table 1. Selected Literature on Platform Ecosystem Establishment

As indicated by Table 1, contemporary research on platform establishment lacks concrete insights about the internal managerial routines that companies need to develop to thrive in the platform establishment phase. Instead, current studies focus on ecosystem governance mechanisms and strategies platform owners should incorporate when launching a platform (Ofe and Sandberg 2019; Stummer et al. 2018). While we observe much research on mature, native platform owners such as Google, Microsoft, and Apple (Cusumano et al. 2019; Eaton et al. 2015), we still know relatively little about how industry incumbents must transform to effectively establish platform business models (Van Alstyne et al. 2016). In this regard, the antecedents of governance decisions and platform strategies, which form their fundament, are still scarce (Saarikko et al. 2019). Only a few of the sighted papers shed light on the establishment decisions from the viewpoint of incumbents that are new to a platform business model (e.g., Khanagha et al. 2020; Weiss et al. 2020). As industry incumbents typically operate one or more business models both upstream and downstream, we need to explore the organizational routines and managerial processes required to foster platform-based value cocreation activities without abruptly breaking any "path dependency".

Research Framework based on the Dynamic Capabilities View

Figure 2 depicts our research framework and summarizes our understanding of an incumbent's task when establishing an IoT platform from the DC view (Teece 2017). Unlike a research model, a research framework does not claim the rigorous description of constructs and relationships (Teece 2007).

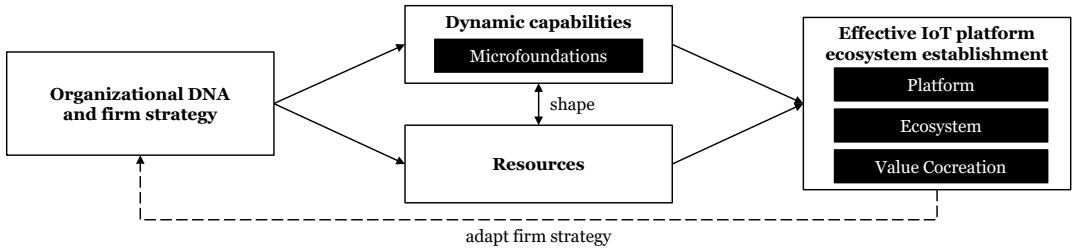


Figure 2. Research Framework

Dynamic Capabilities. The dynamic capabilities view (DCV) can be related to but extricates from other organizational theories of the firm, such as the resource-based view (RBV) (Barney 2001; Helfat and Peteraf 2003). While resources represent a firm's tangible (e.g., machines) and intangible assets (e.g., patents), *DCs* refer to a "firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments" (Teece et al. 1997, p. 516). DCs help firms to regularly adapt their resources and capabilities to the dynamics of changing technologies, markets, and competitive environments and thus have a transformative effect on the DNA of organizations in terms of their traditional business models and current strategies (Teece 2007). Hence, effective DCs represent the change management ability of a firm—i.e., the ability to proactively transform business routines with an inward (operational efficiency) and outward focus (commercial opportunities). According to Teece (2007, 2017), DCs can be disaggregated into a firm's ability to effectively **sense** new business opportunities, **seize** them, and **reconfigure** the business for strategic change. In contrast to operational or ordinary capabilities that are directed toward maintaining a firm's current production, DCs are forward-looking to explore and capture new business opportunities (Teece 2014; Winter 2003). Overall, DCs represent a recognized theory to study why and how organizations evolve and master strategic renewal (Helfat and Raubitschek 2018; Schilke et al. 2018; Vial 2019), which is otherwise difficult to explain. As depicted in Figure 2, we seek to analyze how DCs can be developed through specific microfoundations that help industry incumbents to establish their enterprise IoT platforms, that is, to develop their platforms, establish their ecosystems, and foster value cocreation (Teece 2007, 2017).

Microfoundations. To recognize and capture opportunities and threats in such dynamic environments, decision-makers in platform companies require implementation guidance for achieving or developing DCs (Helfat and Raubitschek 2018). As DCs refer to abstract, macro-level capabilities of organizations, scholars called for a micro-level construct to explain how organizations can build DCs in practice (Felin et al. 2012). The construct to achieve this analysis level is that of microfoundations (Teece 2007). *Microfoundations* represent the managerial processes, activities, and routines on an individual and organizational group level (Felin et al. 2012; Mahringer and Renzl 2018; Winter 2013). Microfoundations enable the researcher to understand how DCs can be created and benefit practice, as they help to instantiate DCs (Felin et al. 2012; Mahringer and Renzl 2018; Salvato and Rerup 2011; Winter 2013). Table 2 defines the primary constructs.

Construct	Description	Key references
Dynamic capabilities	A "firm's ability to [**sense**, **seize**, and **reconfigure**] internal and external competencies to address rapidly changing environments" (Teece et al. 1997, p. 516).	Teece (2007), Teece et al. (1997) Winter (2003)
Micro-foundations	A firm's managerial **processes**, organizational **routines** on an individual and group level explaining the dynamic capabilities on a mid-analytical level between abstract capabilities and concrete case-based manifestations.	Felin et al. (2012), Mahringer and Renzl (2018), Winter (2013)
Platform ecosystem establishment	A firm's ability to launch a **platform** with a standalone value proposition, establish an **ecosystem** with affiliated collaborating actors, and foster **value cocreation** activities among actors for value-adding complements.	Lusch and Nambisan (2015), Saarikko et al. (2019)

Table 2. Description of Constructs

Research Design

As we recognized the lack of empirical studies on microfoundations of DCs in platform contexts, we decided to collect primary data by conducting an exploratory qualitative interview study with three industry incumbents in the software, telecommunication, and hardware sector. We choose a multiple case study as the appropriate design for this research as the objective was to identify what microfoundations of DCs and how they had been applied by the cases to establish enterprise IoT platform ecosystems (Yin 2017).

Case Selection and Description

In the enterprise IoT context, platforms are offered by a variety of organizations. Among these firms are not only platform natives (e.g., Microsoft, Google, Helium) but industry incumbents, such as IBM, AT&T, or General Electric. This paper focuses on the latter, industry incumbents, that are characterized by a pipeline business that must be operated efficiently and reliably on a daily basis. Despite their strengths vis-à-vis platform natives, such as established product or service businesses, customer relationships, domain know-how, and access to an installed base, little has been reported on incumbents' experiences in setting up digital platform businesses. Although the global IoT platform market undergoes a concentration with firms like Microsoft at the forefront, it is not yet consolidating, indicated by growing numbers of platform providers (Lueth 2019). Among the incumbent owners are software (e.g., IBM), telecommunication (e.g., AT&T), and industrial hardware providers (e.g., General Electric) (Briglauer et al. 2018; Lueth 2019). To choose a representative case for each of the groups, we selected three multinational European companies, we refer to through the pseudonyms *SoftCorp*, *TelcoCorp*, and *HardCorp*. Doing so allows us to derive more general knowledge about IoT platform establishment for the whole group of industry incumbents (cross-case analysis) as well as to capture possible differences in DCs of the individual cases (within-case analysis). Table 3 briefly describes the three cases (who) and elucidates their strategic direction—expressed through the four-layer IoT technology stack—when decided to develop their IoT platform ecosystems (why, what).

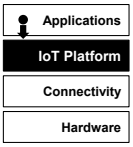
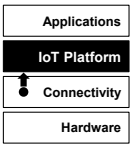
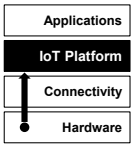
Case	Case description
SoftCorp 	SoftCorp is a well-established software company that serves its international business customers with a wide range of proprietary cloud-based and on-premises solutions (**who**). As SoftCorp already developed software-based innovation platforms for its business customers, seeing great business opportunities in IoT, SoftCorp decided to gain market share, one of the strategic initiatives being the launch of its IoT platform ecosystem (**why**). Its IoT platform complements its software licensing business and existing enterprise software suites for API management, process mining, multipurpose databases and relies on the already developed and sold building blocks of the previously sold platforms (**what**).
TelcoCorp 	TelcoCorp is a large European telecommunication provider that serves consumer and business markets with mobile and broadband connectivity, media entertainment, and cloud services (**who**). Since TelcoCorp had been facing significant operational challenges over the past years, such as stagnating sales and fierce competition against over-the-top service providers, it decided to tap into the IoT market and capture some of the data-based value (**why**). Its IoT platform complements and logically extends its connectivity solutions, such as LoRa and 5G. The IoT platform, which is well-perceived by customers in the market, can be extended through external data and innovation by its IoT business ecosystem (**what**).
HardCorp 	HardCorp is a multinational European conglomerate that serves consumer and business markets with a broad product and service portfolio yet being known for its industrial technology business (**who**). To protect its current hardware technology sales business from commoditization and digitization and as a tactical response to competition in the area of digital IoT-based services (e.g., predictive maintenance), HardCorp decided to build up software capabilities to harness more value in the digital era (**why**). As a result, the developed IoT platform initially enabled internal software development for enterprise IoT applications and was later opened to complementors along with active partner ecosystem building (**what**).

Table 3. Description of Cases

Data Collection

We conducted an interview study from April 2020 to April 2021. Since our interest was to identify microfoundations of DCs, we purposefully conducted 19 semi-structured interviews with managers to get multiple perspectives on the IoT platform decisions. All managers we interviewed had accompanied the establishment of the IoT platform ecosystems from the beginning—with a retrospective of four to six years—or had been brought into play with a leadership role early after launch. Typically, we started interviewing the representatives of the middle (e.g., head of sales, platform manager) and the senior management (i.e.,

vice president). In some cases—based on the interest in our study—they forwarded us to the C-level management (e.g., chief executive officer (CEO), chief product officer (CPO))—a sampling strategy known as snowballing (Corbin and Strauss 2014). The top management interviews aided in gaining an in-depth understanding of organizations' business history and current strategy, including their decision to tap into the IoT platform market, as top executives typically have much corporate or industry experience. Most interviews were conducted by both researchers using Microsoft Teams. While one researcher was guiding the interview, the other asked follow-up questions based on interviewees' responses (Corbin and Strauss 2014). We ended data collection when we reached theoretical saturation on the main themes, which manifested itself through repetition of these. For example, as managers of HardCorp started mentioning the same details connected to the processes of a recent company acquisition in the platform context, we felt the saturation point. Table 4 shows an overview of the interviews conducted, including the individuals' management affiliations, number, and average duration. As we conducted semi-structured interviews, we followed a pre-defined guideline derived from the literature on DCs and platform establishment that can be accessed here: https://bit.ly/3ttQRCe. While the guideline focused on questions related to the DCs, it was flexible enough to adapt to the interviewee's profile or background regarding the platform context. After the interviews were conducted, we transcribed the audio-recorded interviews for analysis. In addition to this interview study, which served as the main source of information for this research, we used other data sources, as advised by Yin (2017), to triangulate the interviewees' statements and thus test their robustness. Besides these interviews, publicly available information such as company websites, informal conversations with other company representatives, and internal documents of the case firms also served as data sources.

Management affiliation of interviewees	**SoftCorp**	**TelcoCorp**	**HardCorp**	**Total**
C-level management (e.g., CEO)	1	-	1	2
Senior management (e.g., vice president)	1	4	3	8
Middle management (e.g., head of sales)	3	3	3	9
Total (average duration in minutes)	**5** (~61)	**7** (~71)	**7** (~67)	**19**

Table 4. Overview of Interviews

Data Analysis

Before analyzing the empirical data, we read through all transcripts and the incumbents' websites to capture relevant information about the platform contexts, building a common understanding. Then, we started our three-step coding process. First, we **openly coded** relevant themes related to our pre-defined constructs (see Table 2), focusing on microfoundations of DC (i.e., processes, routines). This first identification step was conducted independently by the two researchers to prohibit potential biases (Corbin and Strauss 2014). Second, we applied **axial coding** by comparing our individual codes for each interview, case, and across cases. During this step, differences in open coding were discussed among the two researchers to arrive at a common understanding, increasing intercoder reliability. The process resulted in themes that we iteratively and continuously compared to prior literature on platform establishment, including rigorously investigated concepts, such as governance, openness, and leadership (Tiwana et al. 2010). Doing so ensured that we rather adopted established concepts and themes than renaming them. To do so, the researchers conferred in weekly online meetings lasting several hours to share their analyses and interpretations on the relevant themes. Third, recognizing the number of relevant themes, we followed **selective coding** to effectively yield answers to the research question. Therefore, we decided to exclude codes that were not (1) IoT-specific, (2) proactively related to change management, and (3) actionable, to arrive at codes that would map into our understanding of microfoundations of DCs. Lastly, we classified the final, recurring codes in Figure 3. The framework assigns all microfoundations to the three types of DCs (sensing, seizing, and reconfiguring) and the establishment dimensions (platform, ecosystem, and value cocreation). We validated the results (i.e., the classification of microfoundations in the framework) and the two dimensions of the framework regarding their appropriability to answer our research question through numerous iterations between both authors, feedback discussions with more than five of the associated IS professors of the authors' research institutes, and a brief practitioner workshop—all of which provided verbal feedback that was incorporated in the final artifact (see Figure 3) (Corbin and Strauss 2014).

Microfoundations for Establishing IoT Platform Ecosystems

Figure 3 presents the main findings of our study, showing the microfoundations (i.e., processes, routines) of DCs that the three firms developed to effectively establish their IoT platform ecosystems (i.e., platform, ecosystem, value cocreation). We use harvey balls to show whether microfoundations were extracted from statements of one (empty), two (half-full), or all three cases (full). Despite differences in the concrete activities of the case firms, we were able to identify 11 microfoundations of DCs that were backed by at least two firms from our sample.

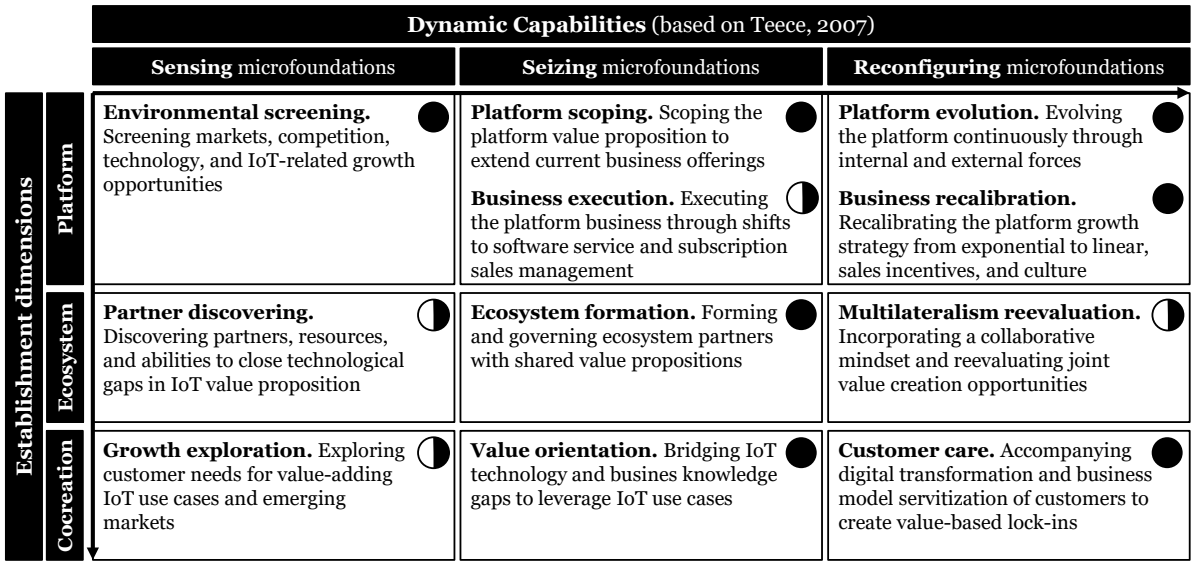


Figure 3. Summary of Findings

Sensing Microfoundations

We identified three sensing microfoundations along the three establishment dimensions: (1) environmental screening, (2) partner discovering, and (3) growth exploration.

Environmental screening. In the early days around 2015, SoftCorp, TelcoCorp, and HardCorp sensed the platformization across markets (e.g., banking, healthcare) and the use of emerging technologies, such as IoT. These environmental analyses were carried out internally or conducted by consulting and research firms. HardCorp, for example, noticed how its main competitor pioneered the platform- and IoT-based service business in the manufacturing space. In addition to responding to its direct competition at the time, HardCorp and other incumbents had to protect against the vertical business expansion of platform natives, such as Microsoft and Amazon Web Services. Microsoft, for instance, competed against SoftCorp in the software-as-a-service (SaaS) market, pushed against TelcoCorp in the network digitization space, and penetrated the digital manufacturing business, making HardCorp fear the commoditization of its product business. Their sensing ability helped the incumbents to identify the competition and prepare response tactics. Besides reacting to the external environment, incumbents realized a lot of potential in IoT, shifting their product business to a service business. In fact, multiple companies across industries have sensed the major trends of digitalization, servitization, and automation, for example, in the context of manufacturing systems. HardCorp, in particular, recognized the potential to improve its operational efficiency (e.g., cutting onsite maintenance) and commercialize digital services (e.g., asset management, predictive maintenance). Doing so independently from larger software firms required HardCorp to rethink its IoT-based business opportunities and the need for a digital platform. Hence, the company proactively evaluated the platform business potential with internal and external stakeholders. Lastly, some senior managers, who sensed the

growth potential in IoT, had a high weight on the final decision to tap into the IoT platform business in 2015, predicting that it would become the fundamental building block of a virtuous business ecosystem.

> *"Our catchphrase in 2015 was "beat [main competitor]", which led us to look at the topic much more broadly. In addition, we could not let ourselves be disconnected from our hardware and compete against commodity providers. That was the major rationale for launching the platform […]. We have also recognized the trend of servitization, which was accelerated by digitalization and IoT. Traditionally, we have been a physical product and onsite service business. From this case, we developed a strategy with concrete use cases, for example, how we could help customers in improving production operations without having technicians onsite—what we call predictive maintenance today. To offer such industrial services, we needed an IoT platform. Ideas regarding network effects came later."*—Middle manager, HardCorp

Partner discovering. Like HardCorp, SoftCorp's and TelcoCorp's managers discovered the emergence of technology-centered business ecosystems. An ecosystem represented an appropriate approach to close potential value gaps based on joint goals. Hence, incumbents scouted potential partners, resources, and abilities that could complement their core value proposition. TelcoCorp, for instance, offered connectivity solutions and profited from collaboration with sensor and device manufacturers. Likewise, SoftCorp sensed collaboration potential in the same complementor group, derived from customers' needs to retrofit assets, i.e., to equip physical assets with connectivity ex-post. In fact, few companies manufacture products with out-of-the-box connectivity, although industries such as manufacturing look at 30+ years of asset lifecycles. The incumbents' partner discovery ability came to light through various informal exchange processes. For example, one of SoftCorp's board members sensed the potential for creating a joint venture (to market IoT solutions for the manufacturing industry) together with multiple incumbents of the manufacturing industry through its supervisory function in one of the other companies. Yet, only HardCorp and SoftCorp developed dedicated partner management functions that would sustainably establish the partner discovery ability.

> *"Partner discovery happens both formally and informally or by accident. For example, [a joint venture] was born through the dual function of one of our board members: he was in our management board and the supervisory board of one of the founding members (of the joint venture). […] Think about the 38,000 manufacturing companies in Germany alone, a large portion of which, unlike the big automakers, come without connectivity. We realized early on that we required a retrofitting capability in our ecosystem portfolio to seize our IoT platform business."*—Senior manager, SoftCorp

Growth exploration. Throughout all interviews, managers equated value with customer value and described it as the most critical goal for success as it would eventually determine platform and ecosystem growth. Yet, before the incumbents could add value for their customers, they needed to understand their customers' current problems and listen carefully. TelcoCorp, for example, instructed its business developers to regularly, but unobtrusively, check in with customers about digitization projects so they would learn about IoT business cases early on. In that, they sensed the complexity within the IoT context and inferred to develop advanced consulting skills to bridge technological and business gaps for promising IoT projects. Customer workshops represented a popular method that was excessively used by SoftCorp and TelcoCorp (with little domain expertise) to identify valuable customer business cases. Hence, they profited from their employees' ability to co-explore IoT opportunities with customers.

> *"Everything we do is customer-driven, also in enterprise IoT. Our rather single-sided ecosystem approach to learning about our customer domains and their pain points helped to grow interest in the platform ecosystem and created much market attention. Our partners then grew naturally in the ecosystem, as partners see us not just as a network and platform provider but also as a sales channel."*—Senior manager, TelcoCorp

Seizing Microfoundations

We identified four microfoundations of seizing along the three establishment dimensions: (1) platform scoping, (2) business execution, (3) ecosystem formation, and (4) value orientation.

Platform scoping. As incumbents sensed the opportunity for an IoT-based platform-as-a-service (PaaS) business, they allocated resources in the form of budget, staff, and autonomy (e.g., cross-functional teams) to develop the platform. The incumbents directed their internal innovation and R&D departments to ideate functions the platform had to comprise or conducted acquisitions to accelerate the development of features and market entries. Crucially, all incumbents designed platforms primarily to extend their current business offerings. For example, SoftCorp expanded its software integration business through its IoT middleware, supplying it to third-party IoT platform providers. TelcoCorp specialized in both connectivity and device management (e.g., firmware updates) to get more load on the networks. HardCorp focused on leveraging

its installed base of hardware devices through asset management and digital twins. However, effective platform scoping required incumbents to balance internal and external content creation. To foster ecosystem innovation, they defined complementary markets that would be left untapped.

> *"One success pattern, we had to learn, was to develop the platform offering, focusing on both internal and external value. Regarding our market offering, we started with a focus on specific niches and then grew increasingly broadly. We kept this focus phase very short, which led to difficulties."*—Senior manager, HardCorp

Business execution. To seize the IoT platform opportunity, incumbents had to master software product development and sales management. First, HardCorp, in particular, reported some transitions that had to be learned in the area of software platform development, such as availability, incident, change management, and service desk processes. The focus was on becoming a software company and allowing for an appropriate and state-of-the-art customer experience in the case of errors. Second, the platform launch was promoted by dedicated sales teams. As the incumbents sensed potential internal conflicts between traditional product line sales teams and platform sales teams, they launched new sales units trained to sell the PaaS offerings. However, platform and software sales, which were closed on 3-year consumption-based subscriptions on average, were less attractive than large, perpetual software license sales regarding the sales bonuses. To solve this tension, SoftCorp's management, for instance, calculated theoretical bonuses looking three years into the future. To allow for shifting from license sales to subscription revenues, incumbents had to create much legal, financial, and operational groundwork to pay and receive subscriptions.

> *"Even if it sounds trivial, it is very difficult to handle a subscription model commercially. Although SAP only offers options for the traditional product and service business, we have to be able to sell subscriptions. We have developed 1000 pages of financial reporting guidelines for this. Without this groundwork, we would always have hit the wall because no one would have been able to book a subscription."*—Middle manager, HardCorp

Ecosystem formation. To effectively outmanage tasks and innovation, two incumbents started building dedicated partner ecosystems. Instead of following the notion of large partner ecosystems, all firms briefly realized a different saying to be true, namely "few but valuable partners help a lot". Hence, they focused intensely on developing transparent onboarding processes. Managers of SoftCorp and HardCorp reported a shared value proposition to be of major relevance, as the business potential and the partners' raison d'être had to be proven through training, joint prototypes, a co-selling strategy, and leads. In parallel to platform development, incumbents defined ecosystem rules and determined the complementary markets that would be left untapped. In fact, the goal was to leave specific, complementary markets untapped for companies to innovate and create platform traffic. However, for some incumbents, the same internal tensions in sales became apparent when competing for profit within the ecosystem, impeding ecosystem development. As a result, several companies that became partners of the incumbents failed to meet their sales targets, leading to the termination of the partnership. Others flourished in collaboration with joint marketing, service, and co-selling strategies. SoftCorp, for example, allowed new partners six months to complete foundational training, develop an initial IoT prototype, and acquire a paying customer. Missing out on this goal, partners would drop out of the partner program. A similar process, but not as a standalone function, could be seen at TelcoCorp, which changed its strategy to offer more services on its own, reducing the number of partners. These performance-oriented participation architectures helped incumbents to decrease ecosystem noise, helping customers and partners to find each other and to increase their level of engagement.

> *"We actively collaborate with a company that develops augmented reality solutions. These solutions nicely complement our platform business and one of our larger application areas—process mining. Once partners show they are worth the time and effort that they and we put into the evaluation, onboarding, co-developing, and co-selling process, we typically generate great business outcomes and give more value to our customers and partners than take."*—Middle manager, SoftCorp

Value orientation. To seize value from the platform and ecosystem, SoftCorp, TelcoCorp, and HardCorp fixated on customer value orientation, painting the picture backward from customers to products/services. Doing so, required them to focus on bridging IoT technology and business knowledge gaps. SoftCorp and HardCorp, for example, stated that working with customers and learning about their industries and cases was required to define valuable IoT business cases. To achieve such value orientation, incumbents had to develop a consulting ability involving actions, such as asking the right questions, hinting at useful solutions and technologies, and connecting customers to internal experts or trusted ecosystem partners in cases of knowledge gaps. As a result of a valid IoT business case, incumbents prototyped and tested it in an agile fashion to evaluate its technical feasibility and potential to scale. On a strategic level, this value orientation

ability—especially making sense of or solving customer business cases—allowed incumbents to enter new markets outside their traditional business domains, such as manufacturing, energy, or buildings.

> *"You have to roughly understand the customer's industry and use case and be able to empathize with the customer and his culture […]. But understanding the customer's business case is not enough. You have to translate this business case into IoT or IT know-how. So, you have to make sure that digital assets, whether that's a database, a data model, or a networking solution, can be developed, operated, maintained, and supported […]. There is a large difference in going from a proof-of-concept with few connected devices to mass production, to roll-out, and to managed operations—especially with regard to the hardware and when considering that many assets must be retrofitted to be IoT-capable."*—Middle Manager, TelcoCorp

Reconfiguring Microfoundations

We identified four microfoundations of reconfiguring: (1) platform evolution, (2) business recalibration, (3) multilateralism reevaluation, and (4) customer care.

Platform evolution. To realize a platform offering demanded in enterprise IoT, SoftCorp, TelcoCorp, and HardCorp had to improve their IoT platforms continuously. In fact, we could identify platform evolution to be driven by internal and external forces. Internally, incumbents shifted software development procedures towards methods and tools that would be aligned with the way the PaaS and SaaS offerings were consumed by customers. For example, incumbents adopted the DevOps paradigm, evolving from larger release cycles to producing and deploying small software increments at shorter intervals. Yet, to avoid code-breaking or dependencies as a result of frequent updates, they automated the testing of code and platform updates before deployment. In addition, they developed basic IoT services that worked across different domains to support all applications, for example, in fault diagnosis. For instance, the diagnosis of a sensor-based error message could be caused by a plant, sensor, or software error. Building software-based monitoring abilities with machine learning models was essential to detect and eliminate negative effects from model predictions, such as data biases in error diagnoses. HardCorp, in particular, described how recalibrating its software development, deployment, testing, and monitoring capabilities required expert developers and data scientists. Externally, incumbents acquired firms with a software or platform development background and integrated (or cored) the platform technologies over time. For example, SoftCorp purchased a platform that would enable device management, TelcoCorp profited from buying a connectivity management platform to manage its IoT devices across national borders, and HardCorp absorbed a low-code platform to empower its subject matter experts in their development endeavors. Doing so, allowed the incumbents to absorb the knowledge, best practices, and mindset of acquired or partner companies to boost platform evolution.

> *"There was a tectonic shift from developing the [platform] compared to classic software development. The [platform], along with a few platforms at [HardCorp], was the first to follow the DevOps approach (you make it, you run it) and this awareness that you always have to be online, meet SLAs, and cannot afford downtime anymore every Thursday. […] With a versioned development in terms of quality management, we have transformed a lot"*—Senior manager, HardCorp

Business recalibration. Building an IoT platform required the incumbents to recalibrate several aspects of their business strategy, organizational structure, and internal culture. First, regarding platform strategy and its scaling approach, incumbents realized they needed to expand their (business investment) planning cycles from 1-3 years known from their traditional business to 5-10 years. This learning process was due to the wrong role models, such as Apple and Airbnb, used for planning goals, KPIs, and governance. Once the incumbents experienced that early IoT platform adoption would not scale exponentially but rather linearly, they implemented success measures, emphasizing value-based traffic over short-term monetization (e.g., from expensive PaaS subscriptions to focus on exceptional free trial experiences). As the platforms did not perform standalone from a financial viewpoint, one incumbent reorganized the platform business as a cost center, not a profit center, which had a synergistic effect on multiple business units when working with or for the platform. Second, all incumbents created expert sales functions shortly after their platform launches. They were deliberately guided and trained to market the subscriptions (with 1-3-year contracts). SoftCorp, for example, incentivized the sales of PaaS and SaaS subscriptions via theoretical bookings over standard 3-year contracts. Building this ability helped incumbents combat the lack of incentives of subscription sales compared to perpetual software licenses. As a consequence, they had to create new incentives to sell PaaS subscriptions. Accordingly, expert sales gained authority to design the fiscal, legal, and internal processes for platform-related subscription sales. Third, an even bigger platform-related shift involved the change of culture and leadership. For example, HardCorp trained its management with platform experts like Van Alstyne. This top-down enforcement for managers to educate on platform strategies prompted awareness

and company-wide interest in platform thinking and architectural design issues. Moreover, the training, workshops, and cross-functional discussions supported the discovery of new IoT use cases.

> *"We tried to make a lot of money too fast with our platform and charged partners 30% after the first year. Then they asked why. For what? For customer access? At the end of the day, every platform lives from traffic. If we were to realign our platform business, our products would have to pay for the platform to get traffic. It's not just money, it's a competitive disadvantage to monetize early. You have to place the question of traffic in the whole corporation and think in a 10-year horizon. You have to convince customers who trust you and the added value and also need manpower to launch, scale, and operate the business and drive sub-transformations [...] You can't achieve exponential growth in B2B. It's more complex than Clubhouse or Tik-Tok."*—Senior manager, HardCorp

Multilateralism reevaluation. The establishment of ecosystems aimed at enabling complementors to add technology, knowledge, data, and pecuniary value contributions to the incumbents' platform offerings. Hence, a major microfoundation was the ability to reevaluate multilateral partner management with KPIs associated with it. The multilateralism included partnerships that were not traditionally established by the incumbents prior to their entries into the IoT platform business. While SoftCorp, for instance, had often collaborated with software providers and system integrators, it additionally built close ties with IoT device manufacturers. All incumbents reflected the ecosystem spirit through a high degree of openness, diversity, and tolerance for competition, manifested in contracts that asked to obey clear rules. The tenor behind the positive interpretation of "co-opetition" was that partners were better off doing business (in collaboration) than not doing business (because of competition in other business fields). To manage this multilateralism, incumbents developed new KPIs to evaluate onboarded partners (e.g., co-sales) and measure the ecosystem value (e.g., ecosystem sales, churn). For example, SoftCorp dictated clear co-selling targets with its partners, the first of which had to be achieved within 6 months (in the form of subscription sales).

> *"The key challenge lies in understanding how to leverage your ecosystem partners to scale the IoT platform business, similar to SAP's business that got multiplied through its integration partner ecosystem. While we have always had certified software integration partners, we now have hardware, system integration, consulting and other partners, so not just a larger variety of partners but a shift in tasks and responsibilities to deliver constant and recurring customer value."*—CPO, SoftCorp

Customer care. After companies like SoftCorp and HardCorp incentivized the sales teams in selling PaaS subscriptions and increase IoT platform adoption, it became evident that they had no after-sales customer care process, i.e., a routine to stay with and talk to customers and observe their platform adoption journey. Business developers were typically compensated by larger transactions and once they signed up for a 3-year subscription, things quickly went quiet. Accordingly, customer success management represented a function that was introduced by all incumbents. The creation of this function and customer success manager role was, for example, initiated bottom-up at SoftCorp after having made a major acquisition. Customer success managers accompany customers in their own transformational journeys when adopting, integrating, and extending platform services to their needs. This way, customer success managers can help customers while receiving incentives for supporting the customers' expansion of platform use, e.g., measured based on PaaS consumption that is fostered through cross-selling and up-selling of SaaS services. This new role had to be filled with hires. TelcoCorp also mentioned that their customers wanted close guidance on the IoT journeys, which would require dedicated consulting skills and ecosystem partners to scale. This microfoundation was based on incumbents' ability to understand their customers' transformational readiness as a dominant force for linear, consumption-based platform growth and to generate high value-based lock-ins in the future.

> *"You need someone else to focus on customer value, and that's the customer success manager. It's a role that we didn't have in the past. These people come in after the sales and take the customer from land to expand. [...] As soon as customers gain value from a connected asset, process, or plant, they want more, it's a continuum. This is how scaling works in IoT without pushing, because customers recognize the value and apply it to other use cases or industries."*—Middle manager, SoftCorp

Discussion

In this paper, we offer insights into how industry incumbents with established business models, associated product portfolios, and existing processes developed DCs to create and operate IoT platform ecosystems. We identified 11 microfoundations (i.e., processes, routines) and analyzed how the case firms implemented them to establish their IoT platforms effectively. In that, we attempted to address a research gap on dynamic capabilities for IoT platform establishment (Pauli et al. 2021; Teece 2017). Therefore, our findings have two major contributions: first, they contribute to platform research in general and the challenge for incumbents to launch and scale IoT platforms in particular (Moore 1993; De Reuver et al. 2018; Teece 2017). Second, we add to the DCV as a valuable management lens to scrutinize platform ecosystems, helping to understand

internal transformations required to integrate a platform business model. In the nexus between platform and management research, we add to a research dialogue about the DCs needed to develop and manage digital platform ecosystems (Li et al. 2018; Linde et al. 2021; Teece 2017) and respond to calls for research on the microfoundations for successful digital transformations (Schilke et al. 2018; Teece 2007; Vial 2019).

Contribution to Research

Platform. The microfoundations of DCs, found in the primary data, provide an intra-organizational view of the transformation processes needed to establish an IoT platform. In contrast, platform launch strategies describe the general themes platform owners must master or goals they must achieve, yet, often without contextualization and externally observable (Edelman 2015; Stummer et al. 2018). These strategies lack insight into how incumbents that are tied to their traditional business models can achieve such goals. Two particular results, extending our knowledge on IoT platforms (Pauli et al. 2021), came to the fore. First, we contribute to platform scoping (Gawer and Cusumano 2008). Although scholars have extensively discussed platform scoping from a supply-side perspective with results on horizontal vs. vertical approaches (Hein et al. 2019) or standalone value propositions (Edelman 2015), we recall earlier understandings of a platform's value contribution—not only to an external but to an internal user group (Gawer 2014). In particular, our cases show that incumbent business units are using IoT platforms internally for software development. Aligning an incumbent's traditional product portfolio with the platform and partner offerings becomes a strategic objective for platform scoping and is thus associated with the phenomenon of platform-pipeline convergence (Mody et al. 2020). Second, we extend findings on pricing strategies for digital platforms (Caillaud and Jullien 2003; Stummer et al. 2018), shifting the discussion from subsidization problems to business model implications. In particular, the cases show that platform offerings were marketed as subscriptions which caused challenges for business operations in areas such as paying operating costs, budgeting, or even stock market valuation. In that, it became clear that the managerial pressure to capture value from the PaaS offering alone—without value-added SaaS offerings—led to false growth assumptions fueled by perceptions of a winner-takes-all paradigm that was grounded on misleading B2C platform examples. In contrast to prior findings, our results indicate a slower, linear (non-exponential) path pattern to platform growth when establishing IoT platforms. Hence, we propose:

> **P1:** *Effective IoT platform development requires a shift from exponential to linear growth thinking in the establishment phase.*

Ecosystem. In addition, our study moves forward the ecosystem research stream, creating a link between a platform owner's existing product portfolio and complements in the ecosystem (Jacobides et al. 2018). In IoT, platform owners not just seek complementors specialized in designing, developing, integrating, and maintaining software products but also need expertise in hardware devices (e.g., sensors, gateways, assets) and specific industry domains (e.g., process manufacturing, automotive) (Petrik and Herzwurm 2020). In addition, IoT spans traditional industry boundaries as physical assets become pivotal points of two or more value propositions and market sides (Porter and Heppelmann 2014), e.g., Schindler's smart elevator infotainment services. In particular, we contribute to the famous chicken-or-egg problem with the strong endorsement that incumbents value customers over partners' joining decisions. However, we also found that the incumbents do not clearly separate between the two stakeholders, as both sides are priced (Caillaud and Jullien 2003). Regarding the partner-side, focused on within the ecosystem analysis, we found that all incumbents valued the quality of partners over quantity, mentioning early mistakes they made when trying to scale through partners. While the idea of scaling through large partner ecosystems is correct, the effort generated for platform owners with each new partner acquired is often underestimated. In B2B domains, such as enterprise IoT, partner management cannot be fully automated. Platform owners need to better understand heterogeneous IoT partners to leverage them on the platform, which is challenging because these partners have the domain expertise that platform owners often do not have. In addition, costs for partner management (i.e., evaluating, onboarding, training, co-selling) are not yet offset by revenues, especially if joint revenue is not generated on a regular basis (Huber et al. 2017). Our microfoundations not just describe but prescribe how "platform wannabes" can do the "right things" to effectively grow their ecosystems in IoT and, more broadly, in B2B contexts. We thus propose:

> **P2:** *Effective IoT ecosystem establishment requires a shift from quantity to quality of partners in the establishment phase.*

Value cocreation. Furthermore, we contribute to platform research on value cocreation (Ceccagnoli et al. 2012; Lusch and Nambisan 2015; Sarker et al. 2012). Acknowledging a paper that focused on knowledge transfers to complementors in IoT platform establishment (Weiss et al. 2020), our primary data show that customers represent the more important stakeholder group within the establishment phase. This is in line with various papers (Hein et al. 2019; Pauli et al. 2021). Customer workshops, training, and cocreation have still remained relatively unexplored in prior research on platform establishment. Above all, customers must be trained and persuaded to adopt IoT platforms as the internal transformations of the incumbent platform owners are closely linked to the digital transformations of their customers as paying platform users. We thus extend the understanding of value-driven lock-ins (Ofe and Sandberg 2019), which was previously largely determined by the design of boundary resources, by showing that value-driven lock-ins are achieved through solution-oriented ecosystems and a value orientation towards cocreation activities. In addition, we found that incumbents have expanded their sales function for continuous and value-oriented support of customer solutions through customer success management. This function has become more important due to the shift to subscription-based revenue streams, demonstrating how difficult it is to scale or standardize coordination activities with IoT platform customers, unlike in the B2C space. Thus, we propose:

> **P3:** *Effective IoT value cocreation requires a shift from product-centered to value-based lock-ins in the establishment phase.*

Dynamic capabilities. As an attempt to stop the paucity of platform ecosystem analyses through a DCV, our results add to Teece's (2017, 2018) findings on DCs in digital platform ecosystems by exploring a more detailed, microfoundational level of analysis in the complex enterprise IoT context (Helfat and Raubitschek 2018; Linde et al. 2021). Resting on Linde et al. (2021), who studied DCs for ecosystem orchestration, DCs present an appropriate research lens to analyze the dynamic nature of platforms and how firms transform to thrive and survive in dynamic contexts such as IoT platform ecosystems (Teece 2017). We thus provide a transformational view of the processes required for platform establishment. Accordingly, we realized the research gap between knowledge on platform natives vs. non-natives like industry incumbents. Therefore, we call for more research looking at DCs and transformational processes required for successful platform and ecosystem launches. DCs and their microfoundations help to understand the transformation, establish an adequate platform design, set the right goals, and accomplish effective governance. In this direction, we see the potential for research in the nexus between platform research, strategy and management research, and digital transformation (e.g., Khanagha et al. 2020; Li et al. 2018).

Contribution to Practice

To this point, both platform research and research on DCs lack practice-oriented applicability (Helfat and Raubitschek 2018; Mahringer and Renzl 2018; Teece 2017). Therefore, our findings may help managers of industry incumbents to instantiate DCs to foster their success in establishing IoT platform ecosystems. We thus offer 11 microfoundations of DCs to managers that had been operationalized in practice. Moreover, we present the empirical details on how the three case firms built the microfoundations, involving the methods (e.g., DevOps), functions (e.g., customer success management), and organizational structures (e.g., cost center) that could be (partly) applied by other incumbents. In this regard, we want to recall that DCs (and microfoundations) must be developed internally and cannot be simply bought in or copied. They require years of development until they are established fruitfully (Teece 2007, 2018; Winter 2013). We recommend managers also to focus on the three principles for early platform establishment: (1) linear growth thinking (platform), (2) quality of partners (ecosystem), and (3) value-based customer lock-ins (value cocreation). Since the identified microfoundations of DCs turned out to be largely IoT-unspecific, they can also be used as a guideline for larger digital transformation journeys in the B2B context, in particular, when establishing platform ecosystems.

Limitations and Outlook

In conclusion, our findings are generalizable and applicable by incumbents seeking to extend their existing business through a platform business model (Van Alstyne et al. 2016). However, this paper has limitations that must be considered. First, despite a careful case selection, we realized that the "effective" or "successful" establishment of IoT platform ecosystems is difficult to assess and thus to claim. While this understanding supported us in our qualitative, explorative research design, we cannot argue to have studied successfully established IoT platforms as the case companies have not yet completed the establishment process. Due to

the immature and fragmented state of the IoT market, it is also not possible to find mature companies among the incumbents. However, the microfoundations and learnings identified provide more guidance to current research and practice than postponed insights would. Second, as a consequence, our findings do not claim to be exhaustive or applicable to native platform companies. While we have selected three cases to exhaustively represent each of the three IoT platform owner groups (i.e., software, telecommunication, and hardware providers), our findings were not verified by other companies in these groups. In terms of applicability, the microfoundations might turn out to have different relevance for more established platform native companies, as they are used to different processes and routines since their founding, such as Google which pursues management via the objectives and key results (OKR) approach. Besides, our data sample mainly relies on the coding of the interview data. Despite the consensus among the authors on the coded microfoundations of DCs, the results must be viewed cautiously. In the future, we intend to improve the robustness of the findings by conducting expert workshops or additional interviews.

Setting out to the future, we see great potential in furthering our understanding of platform establishment through a DC lens (Teece 2017) and believe the enterprise IoT context is suitable for further investigation of this phenomenon due to its complexity and novelty. First, empirical research into the routinization of microfoundations can be continued in the context of enterprise IoT platforms. In particular, one could determine the weight of and relationships between the microfoundations quantitatively to measure differences in their impact on IoT platform establishment or potential moderating effects. Because several microfoundations identified (in the value cocreation layer) are about customer value, explorative follow-up research is required to bridge the value-based strategy (Brandenburger and Stuart 1996; Helfat and Raubitschek 2018), scrutinizing specific cocreation activities during establishment. Second, in a broader context, it seems important to contrast successful cases with more unsuccessful innovation ecosystems, launched by incumbents (Jacobides et al. 2018). Such work would help bolster the evidence on whether the absence of DCs would hinder enterprise IoT platform ecosystem development and innovation. Doing so would require a cross-sectional longitudinal research design. One had to follow up on current cases on the one hand and extend the sample through less innovative firms on the other hand. As the control of the variables is difficult to reach, we could also imagine the use of a longitudinal qualitative research design.

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