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Fostering Value Co-Creation in Incumbent Firms: The Case of Bosch's IoT Ecosystem Landscape

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Abstract

The advent of the Internet of Things (IoT) forces incumbent firms to reshape their organizational structures toward platform ecosystems. However, prior research lacks concrete insights about how incumbent firms can foster value co-creation to become ecosystem orchestrators. In particular, it only sheds little light on the complex challenges incumbents face in designing and governing IoT platform ecosystems. In response, we present a single case study describing how the departments of Robert Bosch GmbH, a leading IoT company, overcame these challenges in three dimensions—IoT ecosystem, IoT platform, and value co-creation. We tie in our research with the existing body of literature, identify four prevailing tensions in ecosystem establishment, and provide actionable design and governance recommendations to resolve them.

Keywords: IoT ecosystem, IoT platform, value co-creation, incumbent firms, Internet of Things

Introduction

The proliferation of the Internet of Things (IoT) paradigm, interconnecting the physical and digital world, is moving organizations' value creation from selling physical products to exchanging connected products with integrated digital services (Marheine et al. 2021). To harness the transformative opportunities of the IoT, leading enterprises worldwide are increasingly driving the evolution of their partner networks from product-oriented supply chains to service-oriented business ecosystems (Marheine and Pauli 2020). Compared with more conventionally organized business structures, such ecosystems are praised for fostering generativity, scaling rapidly, and adapting flexibly to changing circumstances (Hein et al. 2020). Consequently, the emergence of IoT platforms and ecosystems surrounding the platform and keystone players is widespread. This phenomenon creates a highly competitive environment in multiple industries, such as mobility, manufacturing, and agriculture (Lingens et al. 2021). Besides many startups and established tech companies (e.g., Microsoft Azure, Amazon Web Services), industry incumbents also aim to preserve or strengthen their competitive position by becoming keystone players in emerging IoT ecosystems and fostering value co-creation among partners (Metzler and Muntermann 2020). Prominent pioneers from traditional industries include General Electric's Predix and Siemens' Mindsphere, where physical products are increasingly connected and extended into IoT platform ecosystems (Pauli et al. 2021).

Even though incumbent firms re-evaluate existing organizational and IT strategies, most of their established platform ecosystems have not been successful in the long run (Pauli et al. 2020). Indeed, a recent study by the BCG Henderson Institute found that approximately 85% of observed failures are related to weaknesses in ecosystem design, including wrong ecosystem configuration or governance choices (Pidun et al. 2020). Furthermore, despite numerous strategic challenges associated with ecosystem establishment, such as solving the "chicken-and-egg" problem (Stummer et al. 2018), existing findings often stem from a native platform provider's perspective, which solely deals with offering the digital platform (Hein et al. 2019). Hence, current literature lacks empirical insights into incumbents' perspectives on establishing and orchestrating IoT platform ecosystems (Marheine and Petrik 2021; Pauli et al. 2021). However, such research has a pivotal role in the academic discourse of platform ecosystems as it scrutinizes both incumbent firms' overall business transformation and strategic use of platform technologies. Against this backdrop, we pose the following research question: *How can incumbent firms orchestrate their partner network toward value co-creation to establish IoT ecosystems?* By exploring this question, we take a holistic view of ecosystem orchestration that considers different phases (i.e., initiation, scaling, and control) and levels of orchestration (i.e., technological, economic, institutional, and behavioral) (Autio 2022).

We contribute to this question by conducting a single case study (Yin 2014) within the conglomerate of Robert Bosch GmbH (hereafter abbreviated as "Bosch"), a leading IoT company offering innovative solutions for smart homes, smart cities, connected mobility, and connected manufacturing. Our analysis draws a comprehensive picture of Bosch's departments' challenges in establishing eleven different IoT ecosystems in various industry sectors. Particularly, our study reveals twelve incumbent-specific challenges related to IoT ecosystems and offers successful design and governance actions taken to approach these challenges. We structure our findings by applying the tripartite service innovation framework proposed by Lusch and Nambisan (2015) to the IoT context, deriving the dimensions of *IoT ecosystem*, *IoT platform*, and *value co-creation*. After presenting the results of our single case study, we discuss these qualitative insights and tie them in with existing research by elaborating on four prevailing tensions—*exploitation versus exploration, commitment versus accessibility, control versus openness,* and *stability versus flexibility*. Further, we provide actionable recommendations on how Bosch's IoT ecosystems reconciled the tensions to guide other incumbents towards fostering value co-creation and establishing IoT ecosystems.

The remainder of this article is structured as follows: The following section elaborates on the theoretical foundations of IoT ecosystems. Subsequently, we describe the methodological approach of our case study. In the fourth section, we present key challenges Bosch's departments encountered in ecosystem design and governance and their actions to overcome them before discussing our findings and linking them to existing research. Finally, we draw a brief conclusion on the article's limitations and further research opportunities.

Theoretical Foundations

Incumbent firms that have been successful with product manufacturing recently began to adopt IoT-related technologies to expand their value creation capabilities and to bring forth many new smart products and services (Marheine et al. 2021). The IoT combines the potential of recent technological advancements to remotely access physical products and interact and create value during product usage (Wünderlich et al. 2015). However, adopting IoT-related technologies increases the complexity of technical and organizational requirements, forcing firms to build service-oriented ecosystems (Marheine and Pauli 2020). This trend is closely related to a changing perspective on value creation processes from a goods-dominant logic, which focuses on the material goods created in an organization toward a service-dominant (S-D) logic emphasizing the importance of collaborative resource integration, value co-creation, and service-for-service exchange (Vargo and Lusch 2017). This change in perspective is also closely related to technological advancements that change our discipline's perception of information systems: for example, unlike the pre-IoT era, where information systems were designed and built for a specific purpose at a given time, purposefully designing IoT platforms and governing IoT ecosystems needs to reflect that data analysis and data output are ex-ante unknown (Ikävalko et al. 2018).

Compared to startups and digitally native tech companies, incumbent firms face unique challenges when adopting this perspective. While embarking on their digitalization journey, they need to maintain the profitability of their legacy-based business activities while reaping the full potential in radically new business fields (Frankenberger et al. 2021). However, not only these internal specifics of an incumbent impact their success but also the overall service ecosystem in which it orchestrates the co-creation of value (Hein et al. 2019; Marheine et al. 2021). This actor-to-actor perspective is required as large-sized incumbent firms often act as facilitators and major drivers of value-creating processes, thus becoming platform providers (Hein et al. 2019) and keystone actors that can "significantly influence ecosystem well-being" (Frow et al. 2019, p. 2666). To structure our research, we adapt the tripartite S-D framework of Lusch and Nambisan (2015) for the context of IoT, similar to previous research (Hein et al. 2019; Marheine et al. 2021). The framework particularity suits our research endeavor, as each dimension elaborates issues and concepts related to value co-creation via platform ecosystems, which closely aligns with our research question.

IoT ecosystem. A service ecosystem refers to an emergent actor-to-actor network created and recreated by actors through their effectual actions and offers an organizing logic to exchange service and co-create value (Lusch and Nambisan 2015). Lusch and Nambisan (2015) consider three underlying critical aspects: First, the service ecosystem needs to enhance both structural flexibility and integrity. Second, it must develop and maintain a shared worldview among a set of cognitively distant actors. Third, it needs to devise and implement an architecture of participation to coordinate actors and their service exchanges. Considering the proliferation of IoT and its underlying organizational and technological complexity (Pauli et al. 2021), industrial companies need to shift their perspective toward collaborating in IoT ecosystems by opening new avenues of co-creating value for a wide range of participants (Jacobides et al. 2018). Unlike purely digital ecosystems, keystone actors in the IoT cannot rely solely on third-party application providers but must also encourage sensor, software, and application providers (Hein et al. 2019). While incumbents are well-experienced in managing contractually defined supply chains to create incrementally improved products, they now must learn to form less-hierarchical networks to connect and orchestrate their actors for mutual value creation (Marheine and Pauli 2020). Ecosystem orchestration also poses unique strategic challenges to the scalability of a business model, such as solving the chicken-and-egg problem of whether to start building the demand side or the supply side to reach a critical user mass (Stummer et al. 2018).

IoT platform. A service platform provides a modular structure consisting of tangible and intangible components, facilitating the interaction of actors and resources (Lusch and Nambisan 2015). The main purpose of service platforms is leveraging resource liquefaction and increasing resource density. Resource liquefaction refers to decoupling information from its related physical form or device (Normann 2001), whereas resource density describes whether resources can be quickly mobilized for an actor (Lusch et al. 2010; Normann 2001). Overall, two platform concepts are predominant: innovation platforms as a technological foundation of innovation mechanisms and transaction platforms as market intermediaries (Cusumano et al. 2019; Pauli et al. 2021). Both concepts need to define and implement rules for the exchange of service (Lusch and Nambisan 2015). Innovation platforms enable the creation of complementary solutions by providing boundary resources such as application programming interfaces (APIs) or software development kits (SDKs) to third-party developers (Ghazawneh and Henfridsson 2013). In contrast, transaction platforms facilitate the interaction between the supply and demand side by offering marketplaces for specific resources (Parker et al. 2016). IoT platforms represent an instantiation of innovation platforms or hybrid forms combining both transaction and innovation platforms (Marheine and Petrik 2021). The overall complexity of operating IoT platforms is determined by device management, compatibility with sensors and machines, and communication protocols. (Hein et al. 2019).

Value co-creation. Value co-creation is defined as the processes and activities that underlie resource integration and incorporate different actors in the ecosystem (Lusch and Nambisan 2015). The adopted framework distinguishes three key roles to analyze value co-creation mechanisms: the ideator, designer, and intermediary. First, the ideator disseminates knowledge about specific customer needs in a unique context. Second, the designer combines and adapts existing resources or knowledge to develop new services. Third, the intermediary distributes and shares knowledge across multiple ecosystems. Ultimately, diverse actor roles must create a supportive resource integration environment. This requires promoting generativity through consistent processes and boundary resources while ensuring sufficient transparency of resource integration activities (Lusch and Nambisan 2015). The complexity, especially in an IoT context, arises from the need to bring the various stakeholders (e.g., sensor, software, and application providers) together with the customer in order to co-create value (Marheine et al. 2021).

Accounting for these three dimensions, we further incorporate a sociotechnical perspective elaborating on the areas of design and governance as primary factors affecting the establishment of IoT ecosystems. Within this work, we refer to the ***design*** of IoT ecosystems as a conceptual blueprint describing how the ecosystem is divided into a stable platform, highly variable yet easily exchangeable components, and the design rules binding on both (Tiwana et al. 2010). Further, we refer to ***governance*** of IoT ecosystems as the establishment of effective ecosystem-wide mechanisms that uniformly regulate how and under what conditions complementors gain access to the platform owner's resources and assets, therefore serving as guiding principles for value co-creation (Tiwana et al. 2010; Wareham et al. 2014). However, although scholars have been investigating IoT and platform ecosystems for years, they have scarcely touched on designing and governing IoT ecosystems from the viewpoint of incumbents.

Case Study Methodology

Our case study provides early but unique insights into the journey of Bosch's IoT initiatives across several departments, transforming their structure and roles from directional value chains to IoT ecosystem orchestrators. Therefore, the case deals with the fundamental challenges of strategic use, governance, and technology implementation and how they were overcome in three dimensions (i.e., IoT ecosystem, IoT platform, and value co-creation). Thus, our study is well suited to shed light on what design and governance choices bear in incumbent IoT ecosystems.

Case description. Our exploratory research follows a revelatory single case strategy as this is particularly suitable to analyze a phenomenon previously inaccessible to scientific investigation (Yin 2014). Even though our case study focuses on a single organization, Bosch's IoT ecosystem landscape, our analysis includes outcomes of the different IoT ecosystem initiatives within Bosch with varying maturity levels (i.e., planned, development, live, failed). In total, we cover eleven IoT ecosystem initiatives representing the embedded units of our single case by interviewing in total 14 informants (see Table 1). The embedded units are sampled from different application contexts to incorporate the perspectives of five different industries: connected mobility (Alpha, Beta, Gamma, Delta), connected manufacturing (Epsilon, Zeta, Eta), smart building and home (Theta, Iota), smart agriculture (Kappa) and renewable energy (Lambda). In doing so, we leverage the company's diversified corporate structure to analyze existing approaches to ecosystem establishment within the company. The applied sampling approach seems to provide a reasonable basis for our purpose of abstracting knowledge across multiple embedded units of analysis.

Industry Sector	**Initiative**	**Status**	**Role of Interviewee**	**Duration**
Connected mobility	Alpha	Planning	Business Developer	58 min
	Beta	Development	Product Owner	62 min
			Senior Manager	59 min
	Gamma	Development	Technical Consultant	71 min
			Product Owner	66 min
	Delta	Live	Business Consultant	52 min
Connected manufacturing	Epsilon	Development	Business Developer	46 min
	Zeta	Live	Business Model Manager	90 min
	Eta	Live	Managing Director	58 min
Smart building and home	Theta	Live	Managing Director	69 min
	Iota	Live	Vice President	45 min
Smart agriculture	Kappa	Live	Business Model Manager	60 min
			Senior Manager	51 min
Renewable energy	Lambda	Failed	Managing Director	58 min

Table 1. Overview of IoT Ecosystem Initiatives and Interviewees

Data collection. We collected data between May 2021 and June 2021 by conducting 14 interviews with experts and senior decision-makers with broad experience building and orchestrating IoT-enabled ecosystems (see Table 1). We employed a generic purposive sampling approach to identify suitable interviewees for each ecosystem initiative (Bryman 2016). In this process, we applied our previously developed understanding of IoT ecosystems as pre-defined criteria to evaluate sufficient exposure to our research problem. While carrying out the interviews, we followed a semi-structured interview guideline that ensured a similar overall structure of the interviews so that we could compare individual findings across the entire data set. Throughout the interview, we encouraged the informants to share their specific insights by asking open questions along pre-defined discussion points (e.g., ecosystem control, scaling, or monetization) about the challenges they encountered in establishing IoT ecosystems and how they overcame them. In doing so, we probed for clarification and further insights where appropriate. Using video-conference software, a single author performed all interviews ranging between 45 and 90 minutes. All interviews were recorded and transcribed before being coded and analyzed using MAXQDA software. In addition to conducting interviews, publicly available information such as websites or articles and internal documents related to the ecosystem initiatives served as secondary data sources.

Data analysis. Throughout the data analysis, we applied a qualitative content analysis approach (Hsieh and Shannon 2005; Mayring 2000), performing two iterations. In the first iteration (conventional content analysis), we performed an inductive open coding approach to grasp organizational success factors and challenges for building and orchestrating an ecosystem, focusing on the unique characteristics of the examined company and case. Thereby, the resulting codes related to different aspects of Bosch's challenges and actions taken to address them (e.g., "standardization," "monetarization," or "incentivization"). However, to ensure a consistent level of abstraction, we focused on findings transferable to a broader range of application scenarios and used the coding to abstract individual perceptions towards a rather holistic perspective. Furthermore, we ensured the validity and robustness of our analysis conducted by a single researcher by critically examining and discussing the progress of coding and the conclusions drawn from the analysis with a second researcher. In the second iteration (directed content analysis), we performed a deductive approach and defined a coding scheme based on the previously obtained theoretical knowledge and preliminary insights obtained from the first iteration. Finally, we arranged the identified codes with the theoretical coding scheme to synthesize our results into twelve separable yet related challenges. In this process, we linked and structured the identified challenges and managing actions with the three dimensions—IoT ecosystem, IoT platform, and value co-creation (Lusch and Nambisan 2015) and the areas of design and governance (Tiwana et al. 2010).

Insights from Bosch's IoT Ecosystem Landscape

To harness the disruptive opportunities of the IoT, Bosch's Corporate Strategy Development defined an overreaching corporate IoT strategy. In this regard, IoT ecosystems represented a crucial strategic pillar while obsoleting the design of directional value chains to some extent, forcing Bosch to reshape its stakeholder relationships and value creation. Nonetheless, this audacious vision starkly contrasted existing innovation practices and presented complex strategic design and governance challenges. In response, we present the key challenges Bosch's departments encountered in establishing and orchestrating IoT ecosystems and the actions taken to overcome them in three dimensions—IoT ecosystem, IoT platform, and value co-creation.

Dimension 1: IoT Ecosystem

Pursuing the corporate IoT ecosystem strategy, Bosch's departments had to shake up their pipeline business model to attract stakeholders for joint value creation. Consequently, they had to rethink their deep hierarchies and slow but well-established internal processes to establish themselves as a flexible and trustworthy orchestrator. This change raised different challenges in configuring and maintaining inter-organizational relationships and governance mechanisms (see Table 2).

Area	Challenges	Actions Taken
Ecosystem Design	Overcoming traditional legal and risk-management processes to enable fast and simple onboarding of all partners	Providing standardized and transparent onboarding processes and standardized non-disclosure agreements (NDAs) to achieve the desired ecosystem design speed
	Convincing and incentivizing all required partners through a supportive environment to join the ecosystem	Setting up low entry barriers by short notice periods and financial support and implementing traceable processes
Ecosystem Governance	Deciding on the right level of openness to encourage growth and diversity while also ensuring quality and control	Providing explicit partnership guidelines that define which participants are allowed to offer services in which categories
	Establishing strategic flexibility to adapt to changing circumstances and emerging obstacles	Introducing a flexible one-year strategy to create space for experimentation and driving agility to realize minimum viable products (MVPs) quickly

Table 2. IoT Ecosystem-Related Challenges and Actions to Address Them

Ecosystem Design: Challenges and Actions Taken

Standardized onboarding processes. The first challenge Bosch's ecosystem initiatives faced was *overcoming traditional legal and risk management processes* to enable fast and simple onboarding of all partners. Hence, Eta, Epsilon, and Kappa focused on standardizing their onboarding process to accelerate collaboration and avoid serious setbacks. For instance, Eta designed a streamlined ten-step onboarding process revealing exactly how far ahead the partner is and what steps are yet to be fulfilled to move forward. *"It creates trust when partners realize they are not dependent on any goodwill,"* Eta's Managing Director concluded. In the Kappa initiative, partners first signed general terms and conditions of collaboration in a memorandum of understanding to ensure at least a minimum of contractual assurance. As a result, however, *"the risk of partners jumping off increases, requiring the orchestrator to fill the different ecosystem roles multiple times."*, Kappa's Business Model Manager emphasized. Another challenge the ecosystem initiative Epsilon encountered was the establishment of NDAs between the ecosystem participants. For that reason, the collaboration was massively slowed, although there was no initial need to exchange critical information. Finally, the collaborating research campus solved this issue by standardizing NDAs, as a Business Developer of Epsilon concluded:

> *"It is very challenging to cooperate with new partners because you also need an NDA. That is extremely difficult, especially if you are totally motivated and want to start immediately, and then you hit the brakes completely with the NDA. [...] So thanks to [the research campus], all the partners involved have a standard NDA with each other, which is enormously practical. [...] Especially, in the beginning, it is not yet about complex issues, and there is not so much that needs to be protected."*
> (Business Developer, Epsilon)

Supportive ecosystem environment. Another critical challenge in initiating an ecosystem was *convincing and incentivizing all required partners* through a supportive environment to join the ecosystem. One example is Theta, which addressed this concern by having no participation restrictions on the supply side, thus keeping the entrance barriers low. Accordingly, Theta charged no access fees or required specific co-investments from partners to enter the ecosystem. Instead, Theta invested in the partners' compatibility, reducing the financial risk of participating. To further ease partners' fears of being tied down for an extended period, Theta has set a notice period of only six months. Besides contractual fairness, Theta's Managing Director emphasized the trust placed in incumbents like Bosch as an essential success factor in encouraging companies to participate in their ecosystem. Trust was also highlighted as a vital incentive mechanism in the ecosystem initiative Delta. The required level of trust was achieved by transparent and traceable processes that ensured all partners felt they were treated appropriately and equally. In this way, an atmosphere of trust and reliability was created, as noted by a Business Consultant of Delta:

> *"Trust, transparency and clear rules are the success factors of an ecosystem. However, this does not necessarily mean that [the orchestrator] has to deal with everyone in the same way, and everyone has the same conditions. [...] Nevertheless, everyone must theoretically have the chance and the offer to switch to the other status, and it must be clear under what conditions this happens. This atmosphere of transparency and comprehensibility, which ensures that everyone feels treated fairly in some way, is essential."* (Business Consultant, Delta)

Ecosystem Governance: Challenges and Actions Taken

Adequate ecosystem openness. In designing the governance model, Bosch's ecosystem initiatives encountered the challenge of *deciding on the right level of openness* to encourage growth and diversity while ensuring quality and control. In the initiative of Eta, this balance was achieved through explicit partnership guidelines that prescribe who is allowed to offer services in which areas. Accordingly, there are areas in the ecosystem where only Bosch offers its services, areas reserved exclusively for partners, and areas open to both. In the latter case, Bosch services compete with partner services, leaving it up to customers to choose which one they like best. In this regard, Eta's Managing Director stated, "*In some cases, it makes sense to deliberately allow things to be left to partners to demonstrate openness."* Unlike Eta, Theta's ecosystem initiative has no exclusivity for offering services, allowing partners to provide any service themselves. However, despite its open approach, the ecosystem is governed by contracts, rules, and precise distribution of roles. Accordingly, when a partner tried to bypass Theta's control points (e.g., the user interface), Theta intervened and threatened to dismiss them from the alliance to defend the ecosystem. However, the Managing Director of Theta illustrated their approach to non-exclusivity as follows:

> *"It is vital that we do not do this exclusively. If the partner wants to offer the same service under its flag, we see which service sells better. Thus, it is allowed to compete with us. The data belongs to the end-user, who must first agree to its use and then pay for the service. Therefore, the best service should simply prevail. It is all fair game within the ecosystem. We do not care because our margin on partner service is often higher than if we have to offer it ourselves. Accordingly, we win in both cases."* (Managing Director, Theta)

Flexible ecosystem strategy. Another challenge Bosch's ecosystem initiatives faced was *establishing strategic flexibility* to adapt to changing circumstances and emerging obstacles. To permit rapid innovation detached from traditional corporate structures, Bosch chose the path of spinning off several ecosystems into separate subsidiaries. One example is Iota, which was spun off from Bosch as a wholly owned startup aiming to attract more investors and accelerate the expansion of its global ecosystem through external partners. In the beginning, however, Iota struggled to hire employees with the desired technical skills and startup mentality. The latter was reflected in applicants from Bosch, who demanded to keep their existing contracts and a guarantee to return to their parent company in the event of failure. As a result, Iota hired many external employees bringing in the required agile mindset. Ultimately, flexibility and risk tolerance were incorporated into the strategy by not anticipating everything in detail and creating room for adjustments through only one year of planning. This emergent strategy gave room for experimentation and fostered agility to realize rapid MVPs, as Iota's Vice President Strategy emphasized:

> *"The success factors here are the strategy of continuous adaptation and the firm focus on MVPs. In other words, no overengineering, but always customer-oriented and tested. That also applies to the strategy. We do not have a 10-year strategy but an emergent strategy. That means we plan for one year."* (Vice President Strategy, Iota)

Dimension 2: IoT Platform

From a technical perspective, Bosch's departments each had to create an interconnected and coherent solution from various products or services provided by a group of largely independent economic players. Hence, they faced the challenge of designing and managing an IoT platform that attracts developers for joint service creation through a modular design, highly variable components, and a scalable architecture (see Table 3).

Area	Challenges	Actions Taken
Platform Design	Enabling standalone solutions that complement each other and operate on the same database	Basing interfaces on existing technical standards and providing stable APIs and a cross-manufacturer compatible control unit
	Convincing app developers to join the platform and unleash their generativity to deliver complementary applications	Offering easy-to-use and flexible SDK, setting no access fee for the platform, and hosting an app development competition
Platform Governance	Controlling the platform's accessibility while mitigating partners' concerns about overly dominant platforms	Requiring partner status before granting access to APIs and SDKs and allowing individual look and feel of partner apps
	Quickly realizing the first working version of the ecosystem to prevent partners from bailing out due to trust issues	Filling each role at least once to realize an initial MVP right from kick-off and communicate joint success stories

Table 3. IoT Platform-Related Challenges and Actions to Address Them

Platform Design: Challenges and Actions Taken

Modular platform architecture. Unlike hierarchical supply chains, the service-enabling resources of IoT ecosystems are developed independently but function as an integrated whole. Hence, Bosch's ecosystem initiatives faced the challenge of *enabling standalone solutions that complement each other and operate on the same database* in order to leverage holistic use cases. An example is Kappa, which *"[...] did not discard everything, but continued to use existing norms and established standards,"* as its Senior Manager stressed. Thus, Kappa relied on reusing existing interfaces whenever possible to significantly save time and resources in designing their data architecture. They also provided APIs and secure end-to-end infrastructure to orchestrate the flow of data from data generation to import into application providers' cloud systems. As a result, the entire system is comparable to the operating system of mobile devices. On the hardware side, the applications run on a standardized control unit that ensures cross-manufacturer compatibility. In addition, an authorized partner can quickly and easily retrofit the control unit or pre-install it on future machines. In conclusion, Kappa's Business Model Manager resumed their approach as follows:

> *"The idea of [Kappa] is to create a first-level support hotline where all partners work and communicate to provide the [customer] with a holistic solution. In practice, an operating system for agriculture runs on a control unit, onto which a wide variety of manufacturers can upload their applications. Moreover, everything takes place on standardized interfaces so that the end-user no longer has all these compatibility problems."* (Business Model Manager, Kappa)

Attractive platform environment. Another challenge was *convincing app developers to join the platform and unleash their generativity* to deliver complementary applications. Commonly, most ecosystems provide SDKs that contain development tools and standard code, allowing third-party developers to create plug-and-play solutions for the platform. One example is Kappa, which offers an easy-to-use and flexible SDK, allowing developers to freely choose between common programming languages. Besides offering a free SDK, Iota launched a developer challenge to attract software developers to join the platform. Further, to avoid stifling the growth of their ecosystem, Iota does not charge an access fee for developers but a transaction fee for purchasing applications. To conclude, Iota's Vice President described the status of partner acquisition:

> *"More and more integrators are joining in themselves, which applies to all stakeholder groups. It is a mixture of joining in because you believe in it and out of fear that you will somehow miss out on something. This effect is created because we do a lot of marketing and have formed our own brand. We are present at trade shows and ecosystem conferences. We organize app challenges and give out innovation awards. We have a lot of activities in the classic partner management."* (Vice President, Iota)

Platform Governance: Challenges and Actions Taken

Neutral platform governance. In ramping up their platform-based ecosystem, some of the investigated ecosystems faced the challenge of *controlling the platform's accessibility while mitigating partners' concerns about overly dominant platforms*. Although some of the examined ecosystems show parallels to Android for mobile devices, there are significant differences in control and openness. For example, while almost anyone can start programming an Android app, developers at Kappa must first achieve partner status before accessing the APIs and SDKs. Moreover, to guarantee the functionality and compatibility of the applications, a precisely documented certification process first takes place before applications are launched on the marketplace. Furthermore, unlike Android, Kappa retains control over the business relationship between the application provider and the end-user to preserve complete neutrality. In parallel, Kappa allowed individual branding of partner applications. Thus, the end-user only saw Kappa's branding when opening the primary user interface and had the look and feel of the respective app providers within the individual applications. The objective was to emphasize neutrality even more, as Kappa's Business Model Manager of Kappa explained:

> *"We have allowed individual branding. That means our [partners] could brand their solution, screen, or interface with their company. In this way, we made it possible in the platform for the competitors to distinguish themselves externally and still access each other's customer base to a certain extent."* (Business Model Manager, Kappa)

Rapid platform realization. Several investigated ecosystem initiatives highlighted the challenge of *quickly realizing the first working version of the ecosystem* to prevent partners from bailing out due to trust issues. In this context, Lambda and Kappa addressed this challenge by launching a basic but demonstrably successful version of the ecosystem, despite building an ambitious long-term vision. According to Kappa's Business Model Manager, intensive partner management was undertaken to fill each role in the ecosystem at least once in order to realize an initial MVP right from kick-off. Lambda's formerly appointed Managing Director noted that ecosystems "*[...] need an initial set of partners and must not think too big because otherwise high coordination costs occur, and the ecosystem becomes sluggish."* Consequently, Lambda took a similar approach to Kappa and joined forces with a limited number of partners to present a simplified version of their joint value proposition at a trade fair. Thereby, they showcased an initial low-complexity prototype consisting of a solar-powered washing machine and a simple representation of demand-side management to demonstrate the technical feasibility of the ecosystem. Not surprisingly, the first joint success and subsequent communication strengthened the existing partnerships and helped convince skeptical companies to join. Once the investigated ecosystems proved their commercial viability, they extended their initial value proposition to scale by quickly reaching a critical mass of additional players. Although Lambda's ecosystem failed due to internal conflicts, the Managing Director at the time aptly summarized:

> *"You can certainly develop a shared vision in your ecosystem [...], but then you need a concrete implementation step, which should not be too complex—a showcase project. That is actually what we did. We developed prototypes for the trade fairs. [...] The first joint successes then brought us closer together. My conclusion is that you should start small, achieve initial successes, and then communicate them. These shared success stories also help to get critics on board. [...] And then you go step by step into the future."* (Managing Director, Lambda)

Dimension 3: Value Co-Creation

Bosch's departments had to move forward from contributing as a supplier to orchestrating value co-creation by incorporating and governing different actor roles in the IoT ecosystem. To further keep the system running, it was crucial implementing both mechanisms, increasing the overall co-created value while at the same time ensuring each stakeholder is appropriately rewarded for their continued co-creation of value. In the following, we describe these value co-creation-related challenges Bosch's departments faced in designing and governing for value co-creation (see Table 4).

Area	Challenges	Actions Taken
Design for Value Co-Creation	Finding an appropriate monetization strategy that avoids stifling ecosystem growth	Awaiting sufficient ecosystem growth before monetization and charging the right side of the market (e.g., supply side)
	Allocating the generated revenue fairly, enabling all essential ecosystem participants to earn a decent profit	Breaking down and sharing revenue from value creation to the end of the value chain among all participating actors
Governance for Value Co-Creation	Establishing rules and processes that define how partnerships with competitors or much smaller firms are managed	Evaluation of rivals in competitive analysis to clarify collaboration potential and granting space for smaller firms
	Solving the chicken-and-egg problem to secure enough participation from both market sides	Partnering with highly scaled and established app providers to access end customers and secure the ecosystem

Table 4. Value Co-Creation-Related Challenges and Actions to Address Them

Design for Value Co-Creation: Challenges and Actions Taken

Scalable monetization strategy. With most traditional businesses selling well-defined, incrementally improved products directly to an existing customer base, Bosch's ecosystem initiatives struggled to *find an appropriate monetization strategy* that avoids stifling ecosystem growth. According to Beta's Product Owner, resistance to the initiative was exceptionally high among mid-level managers, who saw the risk of already changing their position by the time the ecosystem's return on investment materialized. Consequently, they were reluctant to invest substantial capital in the ecosystem initiative and pushed for immediate and direct monetization. This reservation clashed with Beta's monetization strategy, which sought indirect monetization through end-users in addition to the previous direct sale of hardware products to OEMs. Due to the risk of jeopardizing ecosystem growth, Beta initially tried to foster network effects to scale the ecosystem quickly. Therefore, they decided not to charge its platform users, as they were the primary scaling lever of their ecosystem. As the number of users increases, the number of connected sensors and, ultimately, the value of the service increases. Beta's Product Owner further stressed building up the required level of trust and awaiting user lock-in before considering asking for money:

> *"[We] make the mistake of selling something and wanting money for it immediately. [...] The point at which you can monetize an ecosystem is exactly when the pain of switching is high enough. You have quite a few foundational elements that you need to build beforehand to make that happen, and trust is the key, not hard binding. [...] It is better to earn nothing than to lose trust. That is why it is also important not to put your monetization points where you want to scale. If you want more users, forget about asking the user to pay."* (Product Owner, Beta)

Sustainable win-win situations. Another challenge was *allocating the generated revenue fairly,* enabling all essential ecosystem participants to earn a decent profit. Kappa focused on establishing multiple win-win situations among partner roles to achieve this objective. For example, while digital service providers benefited from extending and locking in their customer base through standardized interfaces, manufacturers could more easily develop functionalities for their machines through an SDK, thus decreasing development effort. Naturally, the most substantial driver for participation was tapping into additional revenue streams. Here, Kappa faced the challenge of defining a fair revenue-sharing mechanism. According to the Business Model Manager, the fundamental approach was to break down revenue from value creation to the end of the value chain. Hence, the service providers are paid directly by the end customers, and Bosch as the platform provider, receives a commission for each sale in return for market access. Following the value chain, the manufacturers received a commission share for providing their machines. Eventually, Kappa communicated its revenue-sharing approach transparently to strengthen the partners' trust. Finally, a Senior Manager of Kappa stressed the importance of fairness in their actions:

> *"The success factor is creating multiple win-win situations so that everyone plays along because they feel they are treated fairly and can make money from it, which is simply the strongest driver for any business. Only if that is given and they see business opportunities for themselves will they*

> *invest something. [...] The basic approach was to consider where added value is created and then try to charge money there. [...] Coming from the customer, you break it down further and further until you get to the end of the value chain."* (Senior Manager, Kappa)

Governance for Value Co-Creation: Challenges and Actions Taken

Unbiased collaboration model. Connecting stakeholders for value co-creation often results in various constellations of collaboration when small and medium-sized or even competing companies work together with incumbent firms. Accordingly, Bosch's ecosystems were challenged to *establish rules and processes* that define how partnerships with competitors or much smaller firms are managed. For example, direct competitors participated in Zeta's ecosystem. In this respect, Zeta's Business Model Manager pointed out that *"[...] the old enemy image of the competitor no longer exists."* Nevertheless, the rival companies were clustered and evaluated in competitive analysis. Ultimately, the analysis indicates which competitors have the potential for partnering. In the case of cooperation, extensive contracts ensure that business is conducted under fair conditions and that competition still takes place without monopolies. In contrast, Beta collaborated with newly established startups, facing the challenge of not exploiting its role as an incumbent firm and giving the partners enough room to flourish. A critical success factor of such an asymmetrical partnership is not to hinder the collaborating startups in their strategic alignment. A Senior Manager of Beta further explained:

> *"It is not always about the orchestrator dictating what to do [...] but about listening and being open. Thereby, we can learn from successful startups [...]. It is vital not to hinder their strategic orientation and what they are doing successfully today. As Bosch, we also must be very sensitive to this. When dealing with partners, it is essential to give them as much space as they need and offer them as much collaboration as possible. They should not be restricted and legitimized but listened to and understood."* (Senior Manager, Beta)

Timely supply-side scaling. Another challenge Bosch's ecosystem initiatives faced during the launch was *solving the chicken-and-egg problem* to secure enough participation from both market sides. Notably, most ecosystem initiatives we observed focused first on partner acquisition to provide a compelling value proposition for the demand side of the market from the outset. For example, Eta launched its innovation platform and built a dense network of twelve partners. These partners ranged from startups to larger companies, but according to Eta's Managing Director, bringing in one or two household names was vital to gaining traction. Finally, the app store went live with a comprehensive range of partner apps. Another example is Beta, which also focused on building supply first by partnering with app providers. Instead of acquiring nascent startups, Beta targeted highly scaled and established app providers to access their existing customer base. According to Beta's Senior Manager, this strategic decision was justified as follows:

> *"We partner with skilled, highly scaled, and successful app providers because we can also deliver added value to them with data, and the partner sort of takes over the interface to the end customer for us. [...] You can start with the app partners with very few users, but it takes a correspondingly long time for the ecosystem to become lucrative, or you can go directly to the big players. And we chose the latter because we also want to secure our ecosystem."* (Senior Manager, Beta)

Discussion

Our single case study derives empirical insights into the challenges of designing and governing platform-based IoT ecosystems. We provide actionable design and governance recommendations based on how Bosch's IoT ecosystem initiatives managed and overcame these challenges. After all, other incumbents running traditional pipeline businesses and seeking to become IoT ecosystem orchestrators face similar challenges even though they might operate in different industries. Hence, the recommendations derived from our analysis of Bosch's IoT ecosystem landscape can therefore also apply to other industry incumbents. Adding to these empirical findings, we synthesize four overreaching tensions that emerged across all three dimensions analyzed—*exploitation versus exploration, commitment versus accessibility, control versus openness, and stability versus flexibility* (see Figure 1). While these tensions are generally seen as incompatible and mutually exclusive, we present how they can be reconciled using our recommendations in the following section.

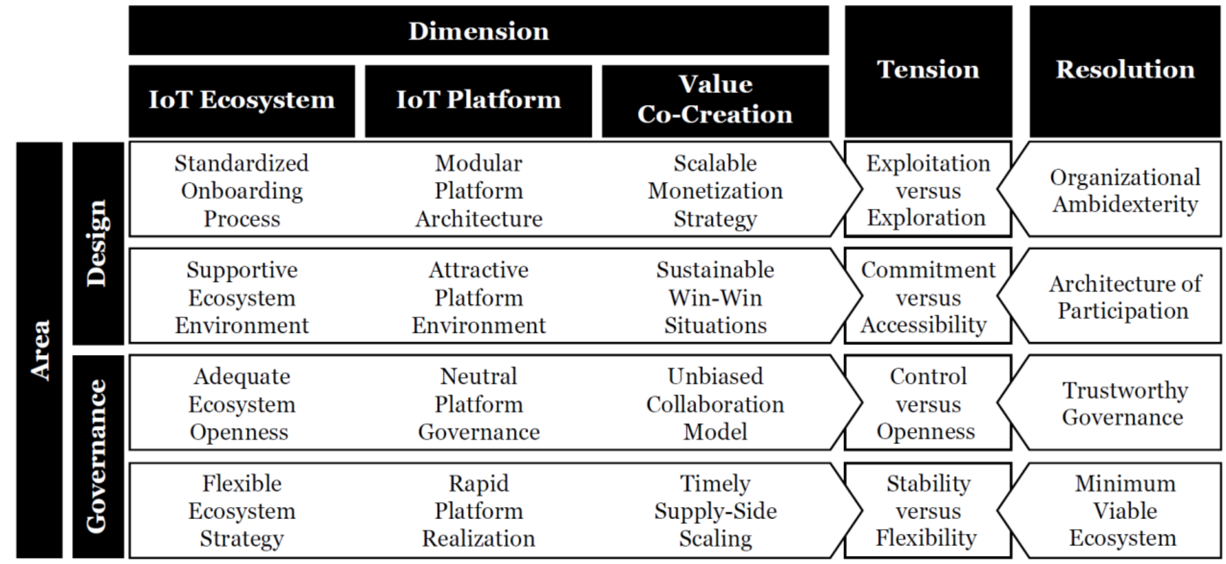

Figure 1. Summary of Case Study Findings

Organizational Ambidexterity: Exploitation versus Exploration

When shifting from conventional business processes to IoT ecosystems, incumbents must achieve organizational ambidexterity to foster both *exploitation and exploration* (O'Reilly and Tushman 2013). Especially when designing processes seeking to connect partners for value co-creation, regulatory requirements collide with the desired speed of ecosystem establishment. On the one hand, time delays due to lengthy contracts and coordination between legal departments should be prevented. On the other hand, no compromises should be made in legal and risk management. Accordingly, it is vital to reshape existing practices by standardizing processes and contracts. A high degree of standardization leads to efficiency (Farjoun 2010) and reduces the need for coordination due to the low diversity of activities, ultimately cutting onboarding time and costs.

Furthermore, when designing IoT platforms, stability is required to leverage joint investments in standard components and variability to meet changing market demand (Wareham et al. 2014). Consequently, a modular setup with a stable core and interchangeable components has become the dominant platform design (Tiwana 2014). An alternative approach to developing everything from scratch is to exploit existing or proprietary standards such as standardized communication systems or APIs. This results in significant time and resource savings in platform design. Apart from this, the stability of platforms and boundary resources such as APIs ensures that complementary modules are developed and integrated, while the modular architecture enables the scalability of new modules (Hein et al. 2020; Tiwana et al. 2010). However, due to the hardware component and user heterogeneity, scaling and network effects tend to be weaker for IoT platforms than purely digital ones (Jung et al. 2021).

Since it is not enough for companies to build and run an ecosystem, they also need to monetize it sustainably. Therefore, it is critical to design monetization mechanisms so that revenue grows with the ecosystem without burdening it with high fixed costs when it is still in its infancy (Williamson and De Meyer 2019). Therefore, incumbents must defer monetization and finally charge the right side of the market to avoid stifling ecosystem growth. Apart from that, in IoT ecosystems, compatibility is often made possible by selling physical connection units in the first place. Hence, a duality of traditional one-time revenue and scalable platform monetization emerges. In summary, a well-designed IoT ecosystem is a prime example of an ambidextrous organization resolving the tension between exploitation and exploration.

Architecture of Participation: Commitment versus Accessibility

Building IoT ecosystems is mainly about creating an architecture of participation (Lusch and Nambisan 2015) that balances *commitment and accessibility* by encouraging potential partners to join and specifying the level of engagement they must bring in. Transparent partner management processes and clear rules of exchange must be established to create an atmosphere of trust between partners and prevent abuse of the orchestrator's power (Moore 2006). However, this does not necessarily mean that the orchestrator grants access to all aspirants and collaborates with every partner on the same terms. Nevertheless, everyone must theoretically have the chance to participate and improve their conditions. Especially in IoT ecosystems, access control can be helpful since the enormous complexity places a significant demand on the collaborating technology providers (Hein et al. 2019). However, we also found IoT ecosystems without participation restrictions, incentivizing participation via contractual fairness and covering partners' ecosystem-specific costs (Perscheid et al. 2020).

In addition, an accessible platform design encourages stakeholders in their intent to participate and service contribution, ultimately increasing their level of engagement (Storbacka et al. 2016). To reinforce this effect, platform owners provide boundary resources stimulating the partners' generativity (Ghazawneh and Henfridsson 2013). While technical boundary resources such as APIs and SDKs govern access to core modules of the platform, social boundary resources such as developer communities and hackathons promote creativity and community building (Marheine and Pauli 2020).

Last, the architecture of participation also defines how participants benefit from the exchange and are rewarded for their engagement (Lusch and Nambisan 2015). While value co-creation is one of the main drivers of forming an ecosystem, a profitable overall business model is crucial to its sustainability and resilience (Beverungen et al. 2020). Especially in the IoT context, the ecosystem design must reflect win-win situations among all roles, including sensor, software, application, and platform providers (Heinz et al. 2022). Therefore, fair revenue allocation among all value-adding parties is essential for a healthy ecosystem (Pauli et al. 2021). In summary, the architecture of participation is built on the pillars of fairness, transparency, and incentivization that balance commitment and accessibility.

Trustworthy Governance: Control versus Openness

As incumbent firms establish IoT ecosystems, they must face the central question of managing the tension between *control and openness* (Tilson et al. 2010; Wareham et al. 2014). A decisive issue involves input control—the extent to which orchestrators define rules and guidelines to judge whether a partner's offering should be allowed to be placed on the platform (Cardinal et al. 2004; Tiwana et al. 2010). Hence, explicit and transparent partnership guidelines must enable third-party developers to fully understand how to create and distribute their solutions on the platform (Benlian et al. 2015). In this context, it is promising to either have no exclusivity in approving partner solutions or grant full transparency on the areas in which partners can offer solutions.

Further, to balance this tension, the orchestrator must control critical points such as boundary resources to ensure the complementors' generativity (e.g., designing apps). Fundamentally, boundary resources (e.g., API, SDK, or marketplace) provide practical governance means by which digital platforms are exploited and defended (Karhu et al. 2018). Interestingly, fundamental differences in the governance of business-to-consumer (B2C) and business-to-business (B2B) platforms are noted. For example, B2B platforms are used only by legal organizations for mainly business-critical processes and are characterized by significantly higher complexity (Hein et al. 2019). In the case of industrial IoT platforms, partners must enter contractual commitments, and platform owners must provide quality-assuring certification processes for apps before they are listed on the marketplace. In addition, partners should be able to differentiate themselves from competitor solutions and the platform interface through custom branding and unique application design.

Finally, the orchestrating incumbent must also determine the degree of openness to value co-creation with competitors or startups. Fostering the ecosystem's transparency could lead to dynamic co-opetition (Bengtsson et al. 2010), increasing the capacity to innovate and thus exploit generative potential (Pauli et al. 2020). In the case of asymmetric partnerships (Schleef et al. 2020), the incumbent's adoption of a restrained position of the incumbent could have a similarly positive effect, as the startups are given sufficient space to develop and rapidly build on their strengths. In summary, a coexistence of openness and control is best achieved with transparent governance regulated by boundary resources.

Minimum Viable Ecosystem: Stability versus Flexibility

IoT ecosystems require incumbents to balance stability and flexibility demands through configuring digital infrastructure and governance mechanisms (Tilson et al. 2010). Due to well-established internal processes, a vast customer set, and incrementally improved core products, ensuring long-term stability is not the central issue for incumbents. Instead, they have to overcome slow decision-making processes and deep hierarchies, as partner companies are aware of their interdependencies and are likely to lose trust in the orchestrator if things develop too slowly (Lingens 2021). Ultimately, incumbents can achieve the required flexibility, for example, by outsourcing the department responsible for orchestrating the ecosystem, thereby replicating startup-like structures and cultures (Lange et al. 2021; Svahn et al. 2017)

In addition, it is critical to start with a minimal viable ecosystem and offer basic but unique value to increase the chances of a quick time to market. (Adner 2012). Furthermore, the associated governance model should be as less complex as possible and thus easy for partners to understand. In order to respond to changing circumstances, the platform governance strategy must be regularly monitored and adjusted (Jain and Ramesh 2015). Finally, the platform's scalability and flexibility leverage extraordinary growth in scale and scope. (Tilson et al. 2010). However, the chicken-and-egg problem must be solved in advance to reach a critical user mass that generates network effects.

Building an appropriate IoT ecosystem network goes beyond including third-party developers as fully digital ecosystems since sensor, software, and application providers, such as consumers, must also be involved (Hein et al. 2019). Nevertheless, we found that a stable supply side must first be established in order to be able to offer industrial customers a compelling range of services. Finally, an initial set of partners ("minimum viable ecosystem") is required, with each role filled at least once, to enable a stable platform core and agile value co-creation.

Conclusion

In this article, we investigated the business departments of Robert Bosch GmbH, an IoT incumbent, on their transformative journey from acting in hierarchical supply chains to orchestrating IoT ecosystems. Our work contributes to the existing literature on IoT ecosystems by describing twelve interrelated challenges and corresponding design and governance decisions to bridge them. We demonstrate that the tripartite S-D framework (Lusch and Nambisan 2015) and the areas of ecosystem design and governance (Tiwana et al. 2010) complement each other in describing value co-creation practices. Finally, based on our findings, we synthesize four overarching tensions that have emerged in all three dimensions and provide actionable empirically based recommendations on how to reconcile them. We argue that decision-makers operating in business ecosystems must deliberately address these challenges cohesively to foster value co-creation.

Theoretical implications. As a first theoretical implication of our research, we introduce the perspective of incumbents to the discussion of IoT ecosystems by deriving a general framework of service innovation consisting of three dimensions and two areas that can be applied by further research on the topic. Our framework adopts a holistic, long-term view that crosses and connects the boundaries of the different phases of ecosystem orchestration (Autio 2022)—initiation, scaling, and control. For instance, governance aspects such as a neutral platform environment, flexible strategic alignment, or appropriate openness are essential throughout the lifecycle of an ecosystem.

Second, we elaborate on the IoT incumbent's perspective and emphasize the IS-specific balance between technical and socio-organizational aspects. More specifically, our results include possible solutions to address challenges regarding both aspects arising in ecosystem orchestration. For example, in terms of scalability, the framework we propose helps to combine both perspectives by considering a solution to the chicken-and-egg problem and the realization of modular platform architecture. Eventually, this study supports the idea that an IoT ecosystem is an inseparable socio-technical system whose technical and socio-organizational challenges underlie strong interactions (Alter 2013). On the one hand, the socio-organizational requirements for managing platform access determine the technological requirements. On the other hand, the technological possibilities determine the solution space for managing the platform.

Third, we identify four tensions across the three dimensions*: exploitation versus exploration, commitment versus accessibility, control versus openness*, and *stability versus flexibility* (see Figure 1). These tensions can serve as a starting point for further research to assist incumbents' managers in leading their company's transition to become an IoT ecosystem orchestrator. Such research could be of different nature: further empirical research could, for example, focus on one of the identified tensions and provide more in-depth insights on resolving the tensions in the context of IoT-ecosystem design and governance. Another approach could be to derive design-oriented knowledge on management assistant tools or define well-suited key performance indicators to assist the managers' decision process.

Practical implications. Up to this point, current research lacks empirical findings with practical applicability for establishing IoT ecosystems from the perspective of incumbent companies. Therefore, our findings may help business leaders previously operating in linear value chains to reshape enterprise design and governance mechanisms to facilitate value co-creation. To this end, we present the empirical results of a single case study covering eleven IoT ecosystems from various industries and provide insights into strategic decision-making to coordinate monetization, scalability, or incentivization. In this regard, we provide twelve design and governance-related challenges and corresponding actions to overcome them.

Although we selected an IoT incumbent and its embedded ecosystem initiatives as our unit of analysis, our focus was also to draw a comprehensive picture of the challenges and actions taken. Accordingly, our research also contains insights into the overarching topic of establishing and orchestrating ecosystems that are not only inherent to incumbents or IoT (e.g., modular architecture, strategic flexibility). Nevertheless, we have drawn specific insights for IoT incumbents from these general themes. For example, all types of platform ecosystems are usually characterized by a modular architecture, but in the field of IoT, additional hardware components need to be standardized, ensuring cross-manufacturer compatibility. Moreover, IoT ecosystems are usually long-term initiatives that require a resilient governance model that can adapt to changing circumstances. In the case of incumbents, this challenge is even more difficult to overcome, as they usually pursue an overarching long-term strategy. Consequently, they must maintain profitability in their legacy-based business while at the same time exploiting the full potential of disruptive ecosystem businesses.

Finally, the explorative findings can help managers of incumbent firms address the identified tensions. Thereby, we recommend focusing on four concepts for IoT ecosystem establishment—*organizational ambidexterity*, *architecture of participation*, *trustworthy governance*, and *minimum viable ecosystem*— to reach the audacious vision of becoming an incumbent orchestrator.

Limitations and future research. Like any study, ours is subject to limitations which are, at the same time, potential avenues for future research. First, within a single case study, we investigated challenges and recommendations for action among eleven Bosch ecosystems with various focuses and degrees of maturity. Therefore, we took on a rather exploratory high-level perspective trying to capture as many different facets as possible to form an initial big picture. Instead, we could have zoomed in on one of these specific ecosystem initiatives for in-depth investigation within a longitudinal case study or zoomed out to examine Bosch's IoT journey from a holistic company perspective.

Second, despite the successful provision of our case study overview with its corresponding challenges and tensions, we cannot yet make a statement about the interdependence of the individual challenges and tensions. In addition, our analysis did not include the classification regarding suitability and significance of the individual challenges and tensions among all eleven initiatives studied or compare the investigated initiatives and associated industries. Instead, our research provides a comprehensive overview of challenges in establishing IoT ecosystems across initiatives and industries. In future research, we might re-engage with the interviewees and other informants familiar with our case to validate our findings and gain further industry-specific and industry-agnostic insights into the design and governance of IoT ecosystems (e.g., through a Delphi study, workshops, further interviews, or focus groups).

Finally, despite carefully selecting multiple units of analysis, specifying a general roadmap for the incumbent's IoT ecosystem establishment is challenging to assess. Therefore, the generalizability and, thus, the external validity (Yin 2014) of our results are subject to certain limitations and must be further verified. For instance, our findings do not claim to be exhaustive or applicable to every incumbent operating in the IoT. Looking ahead, we see great potential in using the case of Bosch's IoT ecosystem landscape to explore one of the four theoretical concepts we elaborated on in the previous section in more depth to gain further insights into the phenomenon of IoT ecosystems. However, in-depth studies with a stronger focus on other incumbent forms in the IoT sector beyond Bosch should complement this research to improve the results in terms of applicability to other companies.

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