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Abstract:

Digital platform owners repeatedly face paradoxical design decisions with regard to their platforms' generativity and control, requiring them to facilitate co-innovation whilst simultaneously retaining control over third-party complementors. To address this challenge, platform owners deploy a variety of governance mechanisms. However, researchers and practitioners currently lack a coherent understanding of what major governance mechanisms platform owners rely on to simultaneously foster generativity and control. Conducting a structured literature review, we connect the fragmented academic discourse on governance mechanisms with each aspect of the generativity-control tension. Next to providing avenues for prospective digital platform research, we elaborate on the double-sidedness of governance mechanisms in fostering both generativity and control.

Keywords: Digital Platforms, Platform Ecosystems, Platform Governance, Governance Mechanisms.

1   Introduction

Digital platforms are currently transforming almost every industry, as exemplified in finance (e.g., Kickstarter), mobility (e.g., Uber), or telecommunications (e.g., iOS, Android) (de Reuver et al., 2018). As software-based systems, digital platforms facilitate interactions and collaboration between two or more mutually interdependent groups of participants thanks to their ability to leverage production, transaction, and innovation (Evans & Schmalensee, 2007; Thomas et al., 2014; Tiwana, 2014). Digital platforms are the central point of gravity for their corresponding platform ecosystems, comprised of a plethora of actors that contribute to the platform's survival and growth by providing complementary extensions (e.g., applications) to the platform (Bonina et al., 2021; Jacobides et al., 2018; Selander et al., 2013). Actors of the platform ecosystem include the platform owner (i.e., operator), complementors (e.g., third-party developers), and users. Since these loosely-coupled actors have individual and collective intertwined interests (Cennamo & Santaló, 2019), platform owners as orchestrators of their ecosystems need to continuously align the diverse, and sometimes conflicting, interests of all actors to ensure their digital platforms' survival and prosperity (Tiwana, 2014).

One key challenge of platform owners is to simultaneously enable the co-creation of value among platform participants (*generativity*) whilst maintaining sufficient stability over how these value co-creation processes take place (*control*). This has been conceptualized as the generativity-control tension in existing research (Eaton et al., 2015; Ghazawneh & Henfridsson, 2013). The effective management of this tension is crucial as was illustrated by the case of Google in its Android developer ecosystem. While the Android platform generally relied on an open architecture to attract complementary app developers, it was vulnerable to being exploited by hostile strategies as ultimately was the case when Amazon cloned almost the entire platform (Karhu et al., 2018). However, by critically addressing this tension, Google was able to take effective countermeasures such as adjusting the open-source license to close off selected areas of the platform's core from further development by complementors (Karhu et al., 2018). This is one of many examples that shows how the generativity-control tension can threaten the survival of a digital platform. Hence, managing the platform-inherent generativity-control tension is a dynamic process and requires substantial resources to align the interests of the ecosystem's various actors (Gawer, 2014).

To address the generativity-control tension in a systematic way, platform owners need to purposefully design governance structures allowing them to attract, coordinate, and control different groups of platform participants (Tiwana, 2014). This practice intends to harmonize platform owners' strategies with the interests, activities, and goals of their complementors (Tiwana et al., 2010), which must be a key priority due to the complementors' essential role in delineating the overall value that users derive from the platform. As complementors are generally not dependent on a single platform, platform owners need to exercise 'soft control' for shaping and influencing their ecosystems, rather than trying to direct them with command-and-control interventions (Tiwana, 2014; Williamson & De Meyer, 2012). Such governance practices are established through a portfolio of interrelated governance mechanisms (Schilling, 2005; Weill & Ross, 2004). Thus, one of the objectives of platform owners is to design effective governance mechanisms that account for and balance the interests of the platform ecosystem's various stakeholders, i.e., to address the generativity-control tension.

Governance mechanisms for digital platforms have been discussed in different research streams and with diverse terminology that inhibited scholars from identifying each other's work (de Reuver et al., 2018; Rietveld & Schilling, 2021), resulting in a growing body of fragmented, implicit knowledge that has been generated over the last years. Therefore, the existing body of knowledge needs a consolidation to systematically relate governance mechanisms to different aspects of the generativity-control tension. Since governance structures are typically implemented in a portfolio of interrelated mechanisms, it is of value for both research and practice to thoroughly comprehend each of the governance mechanisms' potential effects on effectively attaining and continuously maintaining the balance between generativity and control.

We conduct a structured literature review to identify which platform governance mechanisms have been focused on in the current literature and how they relate to each aspect, or the balance, of the generativity-control tension. Specifically, our research objective is to identify *what governance mechanisms platform owners rely on when (re)designing and managing their ecosystems to foster control and generativity*. By reviewing the digital platform literature, we aim to give an overview of each of the key mechanisms' contributions to dealing with the generativity-control tension.

The remainder of this paper is structured as follows. We first introduce the concept of digital platforms and platform ecosystems, the notion of tensions, as well as governance and its application to the platform context. Subsequently, we describe how each of the key governance mechanisms as identified in our literature review was discussed regarding control and/or generativity. Lastly, we conclude with a discussion of our findings, limitations, and suggested avenues for future research.

2   Conceptual Foundation

In this section, we provide an overview of digital platforms and platform ecosystems, introduce the notion of tensions, and explain governance and its implementation through mechanisms.

2.1   Digital Platforms and Platform Ecosystems

As socio-technical systems, digital platforms coordinate the co-creation of value among actors that innovate and/or compete, leverage economies of scope in supply and/or demand, and consist of a modular technological architecture composed of a core and a periphery (de Reuver et al., 2018; Gawer, 2014). Digital platforms function as the nexus of platform ecosystems, in which the platform *owner* offers the platform, *complementors* extend the platform's technology and functionalities through their complementary add-ons, and *users* derive certain values from the offerings jointly provided by the platform owner and complementors (Bonina et al., 2021; Cennamo & Santaló, 2019; Jacobides et al., 2018).

The platform's participants are both collaborators and competitors (Moore, 1993; Selander et al., 2013; Walley, 2007). On the one hand, complementors have a collective interest in the survival and prosperity of the central platform (Selander et al., 2013). On the other hand, they are in constant competition to materialize their own offerings and sell them to the platform's users. To ensure complementors' motivation to constantly identify innovative ways to extend the platform, a platform owner needs to identify and effectively address such conflicts of interest among the different stakeholders involved.

2.2   Tensions

Tension refers to conflicting aspects, competing demands, or opposing perspectives (Lewis, 2000; Smith & Lewis, 2011). Within tensions, Smith and Lewis (2011) distinguish between dilemmas (i.e., trade-offs) and paradoxes (i.e., dualities). Dilemmas are defined as situations in which actors need to choose one aspect over another (Lewis, 2000; Putnam et al., 2016). The dilemma is thus resolved by choosing between different aspects, weighing the advantages and disadvantages of each option, and ultimately preferring certain advantages of one aspect at the expense of those of the other aspect. Paradoxes, however, are defined as "contradictory yet interrelated aspects that exist simultaneously and persist over time; such aspects seem logical when considered in isolation, but irrational, inconsistent, and absurd when juxtaposed" (Smith & Lewis, 2011, p. 387). Therefore, paradoxical tensions require acknowledging the co-existence of the tension's diverging aspects as well as ongoing efforts of managing them to account for their duality.

Digital platforms are rife with tensions as their owners often seek to balance the divergent goals of different groups of participants (Mini & Widjaja, 2019). Our focus lies on the tension of generativity vs. control that platform owners experience when seeking to leverage the expertise of external actors whilst simultaneously encouraging or enforcing these external actors to act in desired ways (Eaton et al., 2015; Ghazawneh & Henfridsson, 2013). Generativity refers to a platform's ability to constantly generate new input, structure, or behavior (Tilson et al., 2010; Zittrain, 2006). Control is exercised by the platform owner over complementors with the goal to achieve a desirable behavior (Tiwana, 2014).

Existing research discusses the generativity-control tension using heterogeneous terminology. Examples include autonomy vs. control, which is referred to as the need for a delicate balance of control by the platform owner and autonomy among independent complementors (e.g., Karhu et al., 2018; Tiwana et al., 2010); openness vs. control, where the first term denotes a governance-related concept to determine complementor's perceived platform openness (e.g., Benlian et al., 2015); or generativity vs. stability, in which the owner aims to achieve a balance between stable and flexible aspects (e.g., Jain & Ramesh, 2015). What all these tensions have in common is their objective to align the platform participants' interests, by simultaneously facilitating value co-creation and structuring how the participants' interactions take place, i.e., resembling the generativity-control tension.

Simultaneously maintaining platform control and transferring design authority to external complementors (Ghazawneh & Henfridsson, 2013) certainly has the potential to bring up conflicts of interest. We argue that the tension of generativity vs. control in platform ecosystems can be classified as a *paradox* due to the following reasons. First, the paradox requires actors to approach competing demands simultaneously. Actors embrace paradoxical tensions with a strategy of "working through", despite the juxtaposing opposites, rather than resisting or avoiding the tension (Lewis, 2000). In platform ecosystems, such strategies are essential for platform owners as they need to simultaneously give rights to complementors to promote innovation, whilst retaining a sufficient degree of control to ensure consistent quality. In other words, both aspects of the tension (i.e., generativity *and* control) need to co-exist. Second, the paradox accounts for organizational entities, such as platform ecosystems, as dynamic and complex systems (Gawer, 2014) that require attaining and retaining a delicate balance between different aspects of their inherent tensions. The latter is due to the criticality of the tension's constituent aspects for the prosperity of the system as a whole. In this study, however, despite this classification as a paradox, we continue to use the term tension for the sake of simplification.

Given the paradoxical nature of the generativity-control tension, attaining an optimal balance between the tension's two aspects requires a purposefully designed governance structure.

2.3 Governance

Governance can be defined from different perspectives. First, from a sociological perspective, each society develops its own ways of making decisions and resolving conflicts. In this regard, governance is about "the processes of interaction and decision-making among the actors involved in a collective problem that lead to the creation, reinforcement, or reproduction of social norms and institutions" (Hufty, 2011, p. 405). Second, from a corporate governance perspective, governance refers to "providing the structure for determining organizational objectives and monitoring performance to ensure that objectives are attained" (Weill & Ross, 2004, pp. 4-5). In this context, governance aims to protect stakeholder interests and prevent them from financial losses. Third, in the IT governance context, governance is defined as "specifying the decision rights and accountability framework to encourage desirable behavior in using IT" (Weill & Ross, 2004, p. 2) and ensuring that individual IT decisions are aligned with strategic objectives (Weill & Ross, 2005). What these three perspectives have in common is the orchestrated use of *mechanisms* to encourage consistent behavior, notwithstanding their specific context (De Haes & Van Grembergen, 2009; Weill & Ross, 2004). Therefore, we understand a mechanism as a means to implement governance, such that governance is exercised through a portfolio of interrelated and purposefully designed governance mechanisms.

What makes governance and governance mechanisms special in the context of platform ecosystems is the fact that platform ecosystems deviate from traditional firm settings. Platform ecosystems are shaped by loosely coupled and independent actors, who are opportunistic and pursue their own goals and interests (Tiwana, 2014). In this context, platform owners merely function as *orchestrators* to align the interests of heterogeneous stakeholder groups, to ensure that all stakeholders' interests are in place. As a consequence, traditional governance structures are hardly applicable to the platform ecosystem context, where performance-based incentives rather than punitive penalties are needed (Tiwana, 2014; Tiwana et al., 2010). A key challenge thereby lies in harmonizing platform owners' strategies with the goals and interests of the complementors (Tiwana et al., 2010), as reflected in the paradoxical tension of generativity vs. control, where each aspect refers to the interests of major stakeholders in platform ecosystems and both need to be in place simultaneously (Ghazawneh & Henfridsson, 2013). Thus, platform ecosystem governance entails the employment of governance mechanisms to purposefully operationalize paradoxical design decisions.

Various platform governance mechanisms have been discussed in existing research. The need for a new governance perspective in the context of platform ecosystems was first raised by Tiwana et al. (2010). Tiwana (2014) later applies the concept of governance to platform ecosystems and distinguishes between three dimensions of platform governance, namely the allocation of decision rights to grant autonomy to complementors, the configuration of a control portfolio to ensure integration, and pricing to create incentives. Ghazawneh and Henfridsson (2013) expand this view with their boundary resources model which refers to a platform owner's provision of resources to attract complementors and enable them to innovate on the platform. Moreover, various scholars focused on a particular platform governance mechanism such as pricing (Zimmermann et al., 2018) or gatekeeping (Zhang et al., 2022). Overall, platform governance refers to a portfolio of mechanisms through which a platform owner aligns its own

interests with those of the complementors and users (Schilling, 2005), enabling heterogeneous groups of actors to interact harmoniously (Tiwana, 2014).

3 Methodology

In this study, we opt for a structured literature review to consolidate discourses in existing digital platform research with the aim of deriving insights on governance mechanisms for managing the generativity-control tension. We applied the method in three steps: First, we describe how we selected the set of papers that best fits our research objective. Second, we introduce our analysis framework. Third, we describe the analysis procedure, i.e., how we applied the analysis framework to code the selected papers as well as the steps that we applied to derive the final results of the literature review.

3.1 Literature Selection

In order to identify relevant literature that contributes to the goal of our study, we followed the steps outlined by vom Brocke et al. (2015). We chose the AIS basket of senior scholars' journals (EJIS, ISJ, ISR, JIT, JMIS, JSIS, JAIS, MISQ) for all years until mid-2021. In order to also capture the very recent discussions in the field, we included ICIS proceedings, as the flagship conference of the IS discipline, from the years 2015 until 2020. Subsequently, we searched for relevant papers in both Web of Science and the AIS Electronic Library (AISeL) employing a search string[1] that contains variations for the terms "platform" and "ecosystem" in both title and abstract. Moreover, since cloud platforms are common and the study of cloud and cloud computing has been dominant in IS literature, we also included the term "cloud" in our search string. While the objective of our research is to gain insights into governance mechanisms to deal with the generativity-control tension, we did not restrict the search in the literature to terms such as mechanism, governance, or tension.

We obtained 164 papers on Web of Science and 191 papers on the AIS Electronic Library. After removing research-in-progress papers (80), we carefully reviewed abstracts and screened full texts and excluded papers where digital platform is not the focus of the study (142) as well as literature review (5) and conceptual/editorial papers (6). Ultimately, our final literature set consisted of 122 papers, thereof 68 from AIS basket of senior scholars' journals and 54 ICIS papers (see Table C1 in the appendix).

While the focus of our analysis is merely on information systems (IS) outlets, we also aimed to explore to what extent studies published in management and organization science outlets may complement our main findings. Since our aim is to obtain an external perspective by looking at relevant neighboring disciplines, we did not intend to analyze these studies in the same level of detail as the IS studies. To identify relevant studies, we searched in Web of Science for studies published in the Financial Times 50 (FT50) journals employing our original search string[1]. This resulted in 350 studies. To reduce the size of the literature set (i.e., define a relevant subset), we decided to analyze only studies that explicitly use the term "governance" in the title, abstract, or keywords. From the resulting 30 studies, we removed duplicates (12) that were already included in our original literature set, studies that do not focus on digital platforms (6), and conceptual/editorial papers (3). This resulted in 9 relevant studies. Owing to our focus on IS outlets, we do not include insights derived from these studies in the results section, but include those insights in the discussion section to illustrate to what extent they may complement our findings derived from IS-related studies.

3.2 Analysis Framework

Following the recommendations of Webster and Watson (2002), we developed an analysis framework to guide our coding procedure. Our analysis framework (see Table A1 in the Appendix) is comprised of three major constituents, namely tensions, governance mechanisms, and research specificities.

First, we included the generativity-control tension and its different variations discussed in the literature. We further extended this part of the analysis framework with other somewhat relevant tensions to not miss any important discussion. While we believe our list is comprehensive with regard to generativity vs. control and its different variations, platform owners certainly face other tension types, which we did not include in our analysis framework (e.g., regarding their architectural design).

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[1] platform*, ecosystem*, "eco-system*", "eco system*", or cloud* for both title and abstract.

We built our coding of governance mechanisms on Tiwana's (2014) framework. We further broadened this view and include other perspectives, such as the boundary resources model of Ghazawneh and Henfridsson (2013). In addition, we extended our analysis framework by, for instance, distinguishing between pricing and revenue sharing (Oh et al., 2015). These concepts are sometimes considered to be similar. For example, the pricing dimension of Tiwana's (2014) framework also discusses how profits are distributed among platform owners and complementors. We, however, opted for a more comprehensive analysis framework and included pricing and revenue sharing as distinct concepts. Finally, we extended the main categories of the analysis framework with sub-items, where we see the potential for additional, more detailed insights.

With respect to research specificities, we coded for units of analysis, research methods, employed theoretical lenses, and contribution types.

3.3   Analysis Procedure

Owing to the development of a comprehensive analysis framework at the outset, our analysis procedure follows a bottom-up approach. We started coding the papers according to our coding scheme. We first coded for tensions and governance mechanisms (i.e., their sub-items). We then revealed tensions and mechanisms that share semantics in spite of different designations. We grouped them according to their commonalities in an iterative fashion (axial coding). Subsequently, for each mechanism we coded whether it was discussed with regard to generativity and/or control.

During this process, we found that the vast majority of studies focus on the generativity-control tension, even though other terminology might have been used. Therefore, we combined generativity vs. control with the three other dominant variations, namely autonomy vs. control, openness vs. control, and generativity vs. stability. Specifically, autonomy vs. control refers to how platform owners control the decision-making autonomy of complementors (Ye & Kankanhalli, 2018), which is ultimately the same key question in the generativity-control tension, as the interests of different stakeholders need to be aligned. The same applies to openness vs. control, where platform owners need to determine the optimal level of openness to attract complementors and give them autonomy to successfully develop complementary add-ons for the platform, whilst also ensuring rules and standards (Benlian et al., 2015). Eventually, with this approach we captured the main tension, which is omnipresent in the majority of platform studies.

Concerning governance mechanisms, our goal was to identify the most relevant and frequently discussed mechanisms in digital platforms. To derive these mechanisms, we excluded mechanisms that were only briefly discussed, such as metrics (see definition in Table A1 in the Appendix). Due to similarities in the discussions, we also combined decision rights and ownership (e.g., Fuerstenau et al., 2019; Karhu et al., 2018). We further merged intellectual property rights and licensing (two sub-items of boundary resources in our coding scheme) and discuss them together as intellectual property sharing, following Niculescu et al. (2018). Most sub-items were not discussed in much detail, therefore we did not include them in our results section. However, we specifically discuss interfaces, programming resources, and intellectual property sharing, as these three sub-items were discussed in several studies.

4   Results

In this section, we present the results of our literature review. We focus on the governance mechanisms that were identified as most relevant and describe their application in the literature toward generativity and control. Beyond our focused analysis of governance mechanisms, the Appendix (see Table B1) extends our overview to digital platform research in general.

We assumed that the effective management of the generativity-control tension requires a governance structure that is implemented through a portfolio of governance mechanisms, and that each mechanism either addresses one aspect of the tension or balances the two aspects. In this light, to contribute to the existing research on platform governance, we aggregate insights on its major mechanisms across the literature set. More specifically, we (1) screened all papers for governance mechanisms and (2) collected data on how each mechanism addresses control and/or generativity.

To systematically aggregate the fragmented, implicit knowledge in existing research, we present governance mechanisms in three fundamental pillars of platform governance. Each of the pillars is fundamental in the sense that every single one is required from the platform owner's perspective to guide the platform ecosystem's design and evolution. Following Ghazawneh and Henfridsson (2013), the first

pillar refers to *platform boundary resources* that are provided by platform owners to complementors to leverage their development of complementary add-ons. The majority of corresponding studies focus on the platform's interfaces and programming resources. Some scholars apply a broader understanding of the concept, such as knowledge resources including, for instance, information portals, documentation, helpdesks, or alignment workshops (Foerderer et al., 2019; Petrik & Herzwurm, 2020). The second pillar refers to *platform rules* that are established by the platform owner to define the scope of activities for each of the platform ecosystem's actors. The mechanisms dominantly discussed in our literature set are gatekeeping (who can have which access), decision rights (who can do which tasks), intellectual property sharing (who owns the generated innovations), pricing (what is the pricing model), and revenue sharing (who can get which share of revenue). The third pillar refers to the shared *ecosystem identity* among the actors as a sense of belonging to the platform ecosystem. Drawn from organizational identity (Corley & Gioia, 2004), this has been frequently discussed in the existing platform research as relational control that aims to facilitate mutually shared expectations and norms among the ecosystem's actors about what constitutes a legitimate behavior in the platform ecosystem (Lindgren et al., 2015). While these three pillars provide a coherent organizing structure for the mechanisms, owing to our focus on the mechanisms' individual effects, in the following we individually present the effects of each mechanism toward generativity and control. Table 1 gives an overview of the major governance mechanisms and their focus on the generativity and control aspects as discussed in the existing literature.

Table 1. Governance Mechanisms for Generativity and Control

Pillar	Mechanism	Generativity	Control
Platform boundary resources	Interfaces	• Standardize access and connection • Facilitate data exchange	• Retain fine-grained control over complementor activities • Prevent platform exploitation
	Programming resources	• Lower the threshold for complementor participation • Support complementors with the provision of tools and knowledge • Help complementors overcome knowledge boundaries	• Facilitate tight control over development quality through software tools and regulations • Increase complementor focus on selected app functionalities
Platform rules	Gatekeeping	• Facilitate connection of complementors to the platform • Increase the diversity in offered apps and functionalities	• Restrict access to ensure quality and attractiveness for complementors and users (e.g., levels of access rights) • Prevent uncontrolled variance in the platform's innovation output
	Decision rights	• Ensure decision-making autonomy of complementors to increase their innovation output	• Define the complementors' amount of freedom (e.g., regarding their goals and task types)
	Intellectual property sharing	• Attract more complementors by expanding their intellectual property rights (particularly important in the early stages of platform evolution)	• Encourage complementors to not build a superior solution • Increase control through agreements with different complementor groups • Structure formal relations to complementors
	Pricing	• Subsidize one side to reach the critical mass of complementors and users • Enhance platform adoption by complementors and users (particularly in platform markets with fierce competition)	• N/A
	Revenue sharing	• Maintain complementor motivation while extracting an appropriate share of profits	• N/A
Ecosystem identity	Relational control	• Increase complementor motivation and commitment through community building • Facilitate clans to enhance complementor performance and minimize errors	• Align platform and complementor strategy • Benefit from rather inexpensive, community-driven self-control

4.1 Interfaces

Interfaces seamlessly connect and integrate complementors' add-ons to the platform core. Application programming interfaces (APIs) are specifically designed to "accept a broad class of apps in ways that allow app developers to use the platform's capabilities without having to concern themselves with how those capabilities are implemented in the platform" (Tiwana, 2014, p. 289).

Generativity: As a mechanism for generativity, interfaces grant complementors with a standardized form of platform access to sell their complementary add-ons (Bender & Gronau, 2017; Ghazawneh & Henfridsson, 2013). In this role, APIs constitute an important part of digital platforms that connects the platform core with external complementors. Also, APIs facilitate data exchange by enabling external developers to access and retrieve data and use it to build their applications (Fuerstenau et al., 2019). As they allow a platform to connect to external data sources and smart devices, they are a key enabler for the effective diffusion of information (Spagnoletti et al., 2015). Further, it has been one of scholars' main interests to investigate which APIs developers prefer over others and why some APIs spark major changes in ecosystems, while others are mostly ignored. For instance, Um and Yoo (2016) specifically

discuss what determines the fate of different APIs, concluding that external APIs exhibit a higher influence than components offered by the focal platform system. In addition, Wulf and Blohm (2020) consolidate different perspectives on API design and provide insights into the effects of API design on complementary innovation performance.

Control: However, at the same time interfaces have a control function, in the form of design rules that are controlled by the platform owner and need to be followed by complementors (Um & Yoo, 2016). By adjusting boundary resources such as APIs, platform owners can keep control over the boundaries within which complementors can innovate (Bender & Gronau, 2017; Ghazawneh & Henfridsson, 2013). It also enables platform owners to retain fine-grained control over the possibilities of the complementors and influence community behavior by seeding them with new features (Bender & Gronau, 2017; Spagnoletti et al., 2015; Tiwana, 2015a).

4.2   Programming Resources

Programming resources (e.g., software tools, software development kits/SDKs, libraries, and documentation) are provided by the platform owner to complementors to help them develop add-ons.

Generativity: Furnishing third parties with development knowledge and tools to foster the generation of innovations is a common strategy for platform owners (Foerderer et al., 2019; Parker et al., 2017). Knowledge resources often aim to provide a holistic picture of the offered platform functionalities to support complementors in identifying possible ideas to create their complementary extensions. For example, Hukal et al. (2020) illustrate how platform owners can signal strategic interests to activate complementors to generate new platform content. Further, scholars particularly highlight the relevance of programming tools as an important means to lower the threshold to develop on the platform (Karhu et al., 2018). Various scholars discuss how a platform owner can incentivize complementors with various types of programming resources, such as Karhu et al. (2018) with regard to Google Android. Further, based on archival data from Apple iOS and Google Android, Ye and Kankanhalli (2018) show that SDKs may also be applied to positively influence complementors in innovating services (e.g., generate ideas or create add-ons on the platform).

Control: On the other hand, it is argued that programming resources can be an important mechanism for platform owners to increase control over their ecosystem (Karhu et al., 2018). For instance, SDKs facilitate tight control over software development, thereby increasing the quality of complementary products/services (Kuebel & Zarnekow, 2015). For example, platform owners can launch their own proprietary development languages in order to increase complementors' platform-specific investments which may in turn reduce their willingness to multihome in several competing platform ecosystems (Foerderer et al., 2019). Moreover, programming resources can foster the development of specific complement types by incentivizing complementors to focus on specific app functionalities (Karhu et al., 2018).

4.3   Gatekeeping

Gatekeeping (i.e., input control or bouncer rights) refers to "the degree to which the platform owner uses predefined objective acceptance criteria for judging what apps and app developers are allowed into a platform ecosystem" (Tiwana, 2014, p. 123).

Generativity: Regarding generativity, gatekeeping usually means easing access for complementors, which results in a more open platform and potentially increases diversity in offered complements (Goldbach & Benlian, 2015a). For example, Wessel et al. (2017) explore how a reduction in input control (and thus increasing platform openness) affects key performance indicators for different platform participants. In their study, they investigate a policy change on Kickstarter, a leading crowdfunding platform, where certain restrictions were reduced and platform access was facilitated. Their results suggest that increasing platform openness for complementors rapidly increased the number of crowdfunding projects on Kickstarter but project creators needed to cope with higher uncertainties due to increased competition.

Control: Therefore, it is not surprising that gatekeeping is also discussed from a control perspective, aiming to retain control over who can access the platform (Tiwana, 2015a). A lack of input control may lead to an uncontrolled variance in the platform's resulting innovation output (Thies et al., 2018). This suggests that one reason for platform owners to monitor and control

the access to their platforms is to ensure a sufficient level of complement quality for users. Specifically, the gatekeeping mechanism can influence complementor behavior through, for instance, quality requirements, stricter guidelines, or different access rights for different groups of complementors (Huber et al., 2017; Karhu et al., 2018).

4.4   Decision Rights

Decision rights can be defined as the division of authority and responsibilities between the platform owner and complementors. In general, it must become clear who decides about the strategic objectives of the platform or individual apps and how these objectives should be implemented (Tiwana, 2014).

Generativity: According to Ye and Kankanhalli (2018), platform owners should leave complementors sufficient decision rights to ensure their own decision-making autonomy, which ultimately influences the resulting innovation output (in terms of quality and quantity). Further, existing research highlights that platform owners should practice rules with both flexibility and benevolence at the same time in order to maximize complementor dedication (Hurni et al., 2021). As the platform evolves, platform owners may continuously reconfigure decision rights to incentivize complementors in different ways (Sandberg et al., 2020).

Control: From a control perspective, decision rights help platform owners define the amount of freedom complementors are given to generate content for the platform (e.g., Ye & Kankanhalli, 2018). For example, Karhu et al. (2018) articulate how platforms can successfully adjust the decision rights of complementors by structuring their resources provision. The locus of authority remains anywhere on the continuum from completely with the platform owner (concentrated) to completely with complementors (delegated) (Tiwana, 2015b). This suggests that platform owners should continuously monitor the complementors' satisfaction with their assigned authority and make adjustments as needed. Further, as different actors approach the digital platform with different expectations (Khalil et al., 2017), platform owners should consider granting different amounts of decision rights to each actor group to ensure control over their actions (e.g., complementors that develop natively on the platform vs. complementors that sell their existing solutions on several competing platforms).

4.5   Intellectual Property Sharing

Intellectual property sharing can happen in two different ways (Niculescu et al., 2018): via direct inter-firm agreements (licensing) or by making a technology accessible to the general public (open source project).

Generativity: As a mechanism for generativity, platform owners can exchange intellectual property to increase complementors' security to be able to materialize and sell their own offerings (Niculescu et al., 2018). Ceccagnoli et al. (2012) examine whether joining a platform ecosystem improves a complementor's business performance. They find that joining a major platform owner's ecosystem is associated with an increase in sales and a greater likelihood of issuing an initial public offering (Ceccagnoli et al., 2012) and that these impacts are greater when the complementor has stronger intellectual property rights (IPR). Specifically, inter-firm agreements with licensing are often applied in the early stages of digital platforms where this mechanism can help reach the critical mass of complementors by enabling licensed firms to make a sufficient return on their development investments (Giessmann & Legner, 2016).

Control: Regarding the use of this mechanism for control, Giessmann and Legner (2016) refer to IPR as a design principle to establish well-defined rules and standards to structure and control the relationship with complementors and provide a solid basis for collaboration and avoiding conflicts. In addition, IPR can set a strategic incentive for complementors to not independently build a superior solution that is not linked with the platform (Niculescu et al., 2018). Further, with reference to Apple's iOS, Ghazawneh and Henfridsson (2013) illustrate how Apple revised its developer license agreement to effectively address other actors' potential attempts for bypassing Apple's SDK and APIs. Similarly, Karhu et al. (2018) highlight that, by effectively employing IPR, platform owners ensure that their shared resources cannot easily be copied, reverse engineered, or breached. Lastly, a platform owner can retain control by making distinct agreements with different groups of complementors (e.g., to share more resources with selected groups).

4.6   Pricing

Pricing policies are used by the platform owner to create incentives for complementors to make personal investments to ensure the prosperity of their own offerings and in turn the whole ecosystem. This includes, for instance, the app pricing model, pricing symmetry, and the selection of a subsidy-side (Tiwana, 2014).

Generativity: Pricing is primarily discussed from a generativity perspective. For instance, platform owners can choose to subsidize one, highly valued side of platform participants by granting them free or inexpensive platform access over a certain time period (Thies et al., 2018). This is of particular relevance in the case of consumer platforms, as they often need to reach a critical mass of users to remain competitive. For example, in markets with fierce competition among C2C sharing platforms, a platform owner can set financial incentives (e.g., rewards) for users to significantly boost consumption, which in turn attracts more complementors (Guo et al., 2019). Further, platform owners of C2C sharing platforms in monopolistic settings should employ accurate pricing strategies that incentivize both of the platform's sides (i.e., demand and supply) to foster interactions on the platform (Zimmermann et al., 2018).

4.7   Revenue Sharing

Revenue sharing represents the degree to which the platform extracts revenue that is co-created with the complementors (Oh et al., 2015).

Generativity: Revenue sharing is primarily discussed with a focus on generativity. A platform owner extracts a part of the co-created value, such as a percentage of sales or service use (Karhu et al., 2018). A main research interest lies in the distribution of revenue shares that ensures complementors are encouraged to develop their high-quality complementary products/services on the platform (Oh et al., 2015). For instance, Oh et al. (2015) analyze different revenue sharing models, which can be employed by platform owners to increase the innovation output of the complementors. In the case of mobile ecosystems, they find that in a stable equilibrium, the platform owner receives 75% of the total value created by the platform and the complementors collectively receive the remaining 25% (Oh et al., 2015). Platform owners may also adjust the revenue shared with complementors during the evolution of the platform ecosystem or depending on the complementor type (e.g., complementors that are only active in the respective platform ecosystem vs. complementors that are active in several competing platform ecosystems).

4.8   Relational Control

Relational control, as informal control, refers to "the degree to which the platform owner relies on norms and values that it shares with app developers to influence their behavior" (Tiwana, 2014, p. 125). Relational control can be divided into self-control (e.g., set your own goals, monitor and sanction or reward yourself) and clan control (Ouchi, 1979).

Generativity: As a generative mechanism, relational control mainly refers to the benefit of a strong clan of complementors. A clan is a homogenous group of interdependent members who share common values and beliefs that influence their behavior (Goldbach & Benlian, 2015a). Through shared norms and values (formed by knowledge exchange and learning from each other), a strong community among complementors is likely to enhance their performance through fewer mistakes and less rework, thereby improving the average app quality (Goldbach & Benlian, 2015a; Huang et al., 2018). A shared vision and similar ambitions, for instance concerning design and security standards, strengthen a common understanding and bring complementors closer together (Goldbach & Benlian, 2015a). This community feeling can in turn attract new complementors.

Control: On the other hand, clan control allows platform owners to reduce the differences between complementors' activities and their own strategies (Goldbach & Benlian, 2015b). For example, because of shared values, beliefs, or common goals, complementors ideally feel obligated to follow certain procedures or provide high-quality complements. Clan control has proven to be particularly useful in situations in which, for example, the result or the amount to which a prescribed procedure is followed is difficult to measure. Another reason why platform

owners often rely on relational control is the fact that it becomes extremely difficult to retain formal control over every interaction taking place in a fast-growing, highly scalable platform ecosystem (Goldbach & Benlian, 2015b).

5   Discussion and Conclusion

Digital platforms and their significant economic impact across various industries have led to an increasing interest in this topic from researchers and practitioners alike. One considerable research gap is to understand how platform governance mechanisms are employed by platform owners to simultaneously foster generativity and control. To bridge this void, in this study we aggregated the fragmented knowledge on governance mechanisms into three pillars of platform governance and discussed how each governance mechanism can be employed to account for each aspect or balance the two aspects of the generativity-control tension.

Before we discuss the implications of our study, we acknowledge that our literature review focuses on the IS discipline. In effect, digital platforms are a multidisciplinary topic and have also been studied in the management and organization science literature. Therefore, including these outlets in the scope of an exhaustive literature review would potentially result in additional insights. To guide prospective research in this endeavor, in the following sections we discuss how studies from management and organization science outlets may complement our findings.

5.1   Implications for Research on Platform Governance Mechanisms

Our literature review offers implications for research on platform governance mechanisms. Our results illustrate that, while some governance mechanisms are specific to generativity or control, most of them are double-sided and address both aspects (see Table 1). This is important because several of the mechanisms have been mainly discussed toward one aspect of the generativity-control tension in existing research, such as programming resources for generativity (e.g., Foerderer et al., 2019) or gatekeeping for control (e.g., Tiwana, 2015a). The same applies to our suggested three pillars of governance (i.e., platform boundary resources, platform rules, ecosystem identity). While researchers mainly considered platform owners to provide resources for generativity (e.g., Foerderer et al., 2019) or define rules for control (e.g., Tiwana, 2014), our results illustrate that in each pillar mechanisms are employed to address both generativity and control.

Accordingly, the generativity-control focus of each governance mechanism is a context-dependent factor depending on, for instance, the platform type. For example, the revenue sharing model in the case of Apple's consumer-focused platform ecosystem, in which complementors need to pay 30% of their revenue to the platform owner (Oh et al., 2015), is relatively well-perceived by its complementors. However, it may be questioned whether this holds for other platform types. For instance, in the Salesforce enterprise software ecosystem, where the platform owner and complementors provide complex products/services to users, Salesforce (i.e., the platform owner) adjusts the required revenue share between 15% and 25%, depending on the type of complementor (Staub et al., 2021b). This stands in contrast to the example from Apple, as Salesforce's revenue sharing mechanism is dynamically adapted to different types of complementors to be in line with their particular (and sometimes non-interchangeable) contributions to the ecosystem and with their distinct generativity motives in the ecosystem.

Besides the platform type, the maturity stage of the platform is another important contextual factor. For example, platform owners often rely on a gatekeeping strategy that involves being more open in the early stages to attract a high number of complementors and users (focus on generativity), while introducing more restrictions after a certain period of time (focus on control) (Eisenmann et al., 2006).

Beyond the general platform evolution, however, sudden changes in the ecosystem's dynamics (e.g., inappropriate conduct of the ecosystem's actors, new regulation, increased competition) may require platform owners to immediately adjust the focus of their governance mechanisms in general or for certain actor groups in particular. The latter can be illustrated by the recent case of free speech social media app *Parler* which was temporarily removed by Apple from the app store within only two days after its users increasingly published posts that spread misinformation and incited violence[2]. In other words, Apple

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[2] For more information about the *Parler* case, please visit the following *New York Times* article:
https://www.nytimes.com/2021/01/09/technology/apple-google-parler.html

increased the control focus of the gatekeeping mechanism for this complementor. These examples illustrate that platform owners need to constantly assess opportunities and risks in their environment to effectively alter the generativity-control focus of their governance mechanisms.

While the focus of our analysis is on studies published in IS outlets, we observed that our consolidated insights in terms of the mechanisms' double-sided effects toward generativity and control are also reported by separate studies published in management and organization science outlets. For example, with regard to the gatekeeping mechanism, Zhang et al. (2022) examine how gatekeeping is adapted by platform owners to control the interactions between complementors. Other scholars highlight the potential of the gatekeeping mechanism to foster generativity. For example, O'Mahony and Karp (2022) highlight that gatekeeping is one aspect of governance that platform owners may use to facilitate platform adoption of complementors (i.e., foster generativity). The authors also find that that platform owners can sequentially increase the openness of their digital platforms and that the effect on generativity is moderated by different levels of decision rights. These explanations demonstrate that these studies are useful to enrich our findings from IS literature, but they do not considerably change our main results in terms of the mechanisms' double-sidedness. However, it may be worthwhile for future IS research to consider the studied cases in management and organization science outlets in order to analyze more diverse platform settings. For example, Ansari et al. (2016) investigate a television ecosystem, which had been disrupted by a start-up developing a digital platform that connects multiple actors in the ecosystem (e.g., TV providers, advertisers, content distributors). This setting is different compared to a setting in which the platform owner plays a central role and can exercise power over complementors and users to a considerably higher degree (e.g., Apple on its *iOS* platform or SAP on its *Business Technology Platform*). This is confirmed by several scholars that highlight the need to study more decentralized (Chen et al., 2020) or collective (O'Mahony & Karp, 2022) governance practices.

Overall, given the strong context-dependency of the mechanisms' effects, there is no uniform recipe for the selection of appropriate governance mechanisms. On a high level of abstraction, most mechanisms can be employed to address either of the two aspects of the generativity-control tension. In practice, however, the resulting effect of a particular mechanism is subject to the given context. The fact that the platform context changes over time illustrates the persistent nature of the tension that requires continuous attention and management. This makes it challenging for platform owners to design effective mechanisms that are targeted for their specific context. Therefore, while this study provides a comprehensive overview of the major governance mechanisms along with their potential effects on generativity and control, we currently still lack more context-dependent knowledge to better estimate whether the focus of the effects will be on generativity or control in a predefined context.

The focus of our analysis is on the effects of individual governance mechanisms. We posit that the *collective* effects of a portfolio of mechanisms can only be partially understood by comprehending the *individual* governance mechanisms' effects. Similar to the individual mechanisms, the collective generativity and/or control focus and their balance in a portfolio of several mechanisms is also expected to be context-dependent as, for instance, platform owners might shift the focus of the portfolio depending on the maturity stage of the platform (Lavie et al., 2010).

However, the complexity increases considerably when estimating the collective effects of a portfolio of mechanisms because individual mechanisms are highly interrelated and mutually dependent on one another. For example, a simultaneous change in revenue sharing (higher share goes to complementors) and programming resources (additional documentation to support complementors) is expected to increase generativity. However, we currently lack knowledge about the mutual influences of the two mechanisms, for instance, whether the effects of revenue sharing positively interact with the effects of programming resources. This challenge is even more decisive in the case of multiple mechanisms, particularly when platform owners employ various mechanisms with some of them focusing on generativity and others on control.

5.2   Future Research on Platform Governance Mechanisms

To gain more systematic insights into the optimal generativity-control focus of an *individual governance mechanism* in its specific context, we encourage prospective research to conduct in-depth studies of the governance practices of different platform types. While existing research has extensively discussed several consumer-focused platform ecosystems such as Apple iOS, Google Android, or Firefox, studying other platform cases that received relatively less attention (e.g., enterprise software ecosystems) may potentially provide additional insights on how each mechanism can be implemented in a specific platform

context. A useful example is Foerderer et al.'s (2019) case study of the resources provided by enterprise software platform owners to their complementors under various circumstances.

Further, prospective research is encouraged to conduct longitudinal studies to examine the dynamics of a governance mechanism over time. For example, Wessel et al. (2017) analyze the impact of a policy change that resulted in the platform owner relaxing the access to the platform (more focus on generativity in the gatekeeping mechanism) on a crowdfunding platform, illustrating that an increasing platform openness for third-party offerings can destabilize a platform ecosystem. This study provides important insights into how the same governance mechanism (gatekeeping) can have a different generativity-control focus in the same platform ecosystem. In this vein, future research could study policy changes in various platform governance mechanisms, which would extend our current knowledge about the application and effects of mechanisms with respect to their specific contexts.

To derive novel insights into the collective generativity and control effects of *multiple governance mechanisms*, we recommend prospective research leverage our results on individual mechanisms by systematically comparing identical combinations of governance mechanisms across different contexts. Future research is also encouraged to enhance our understanding of the mechanics of governance mechanisms, particularly their complementary or contradictory relations in reinforcing or cancelling-out one another in addressing the generativity-control tension. To gain insights into the complex interactions between the platform governance mechanisms, we particularly recommend future research to employ the case survey method (Larsson, 1993; Yin & Heald, 1975). Building on a considerable number of existing case studies (almost 35% of the platform studies in our data set (see Table B1 in the Appendix)), case surveys would enable researchers to systematically compare the simultaneous application of multiple governance mechanisms across different contexts. Through the translation of contextual factors (e.g., type and maturity stage of a platform) and a set of variables (e.g., applied governance mechanisms and their effects) into quantitative variables, this approach may further provide insights into the contextual situations that determine the application and effects of different combinations of governance mechanisms. For example, Henfridsson and Bygstad (2013) analyzed how generative mechanisms, as an effect of different configurations of interconnected contextual conditions, jointly cause digital infrastructure evolution.

In studying the complex interactions between the platform governance mechanisms, we also encourage future research to employ a simulation-based research approach (Beese et al., 2019; Haki et al., 2020; Schmid et al., 2021). Simulation makes it feasible to experimentally manipulate all the governance mechanisms in any possible combinations to observe if and how they interact with each other; an important inquiry that is virtually unfeasible in conventional empirical settings (Haki et al., 2020; Nan & Tanriverdi, 2017).

Table 2 summarizes our main suggestions for prospective research on platform governance mechanisms.

Table 2. Suggestions for Future Research on Platform Governance Mechanisms

Research focus		Suggested avenues	Suggested foci
Platform governance mechanisms	Individual effect of a governance mechanism	• Context-dependency (e.g., platform type, maturity stage, ecosystem dynamics) of an individual governance mechanism	• Study the individual effects of a governance mechanism (either toward generativity or control depending on various platform contexts) by conducting in-depth case studies • Study the dynamics in the individual effects of a governance mechanism (switching between generativity and control depending on time episodes of the same platform context) by employing a longitudinal approach
	Collective effect of a portfolio of governance mechanisms	• Interrelatedness and collective effects of multiple governance mechanisms applied in a portfolio	• Study the collective effects of a portfolio of governance mechanisms by comparing it across various platform contexts • Study the mechanics of governance mechanisms in a portfolio by conducting case survey and simulation

5.3   Future Research on Digital Platforms

While the focus of our investigation is on platform governance mechanisms, we also provide insights for the digital platform research in general (see Table B1 in the Appendix). In our literature set, researchers strongly focused on prominent examples of thriving cases of digital platforms. This is demonstrated by the five most discussed cases in our literature set (i.e., Google's Android, Apple's iOS, Kickstarter, Taobao, and Firefox). However, studying cases of failed platforms may potentially extend the existing knowledge and provide important insights on the major obstacles during the early maturity phase of digital platforms (e.g., Cusumano et al., 2019). This is an important inquiry since many platform businesses have emerged, and are about to emerge, in different industries due to the phenomenal rise of the platform economy (Kenney & Zysman, 2016; Parker et al., 2016), a considerable number of which cannot survive and thrive in their market (Gawer & Cusumano, 2008; Hagiu & Altman, 2017; Zhu & Furr, 2016).

Similarly, compared to consumer-focused platform ecosystems that have drawn considerable attention in existing research, analyzing the underrepresented B2B platform ecosystems in various industries (e.g., enterprise software, manufacturing, oil and gas) has the potential to yield complementary insights (Blaschke et al., 2018; Matzner et al., 2021; Pauli et al., 2021; Schreieck et al., 2021). The latter is due to the distinct characteristics of B2B platform ecosystems that often make the platform owner more dependent on complementors and users, for example during the provision of highly complex solutions that requires diligent integration of diverging resources provided by various actors (e.g., Ceccagnoli et al., 2012; Foerderer et al., 2019). This may require platform owners to consider more decentralized approaches for the design and management of their digital platforms (Chen et al., 2020).

Our review further reveals that the majority of the studied cases are platform-native cases such as Apple's iOS and Google's Android. This leads to a limited comparability between studies, as other platform types do not share the same characteristics. For example, only a small set of research explores how incumbents enter into the platform economy and strategically reorientate from a product-based to a platform-based competition strategy (Sandberg et al., 2020). However, incumbents in various industries such as financial services, healthcare, or enterprise software are increasingly adopting platform business models (de Reuver et al., 2018). Examples are SAP and Salesforce that nowadays consider themselves platform ecosystems rather than merely enterprise software providers (Staub et al., 2021b). Studying such underexplored cases of *platformization* can result in interesting theoretical and practical insights. Existing research has already started discussing the build-or-join decision, i.e., whether incumbents should build their own or join an existing platform ecosystem (e.g., Cusumano et al., 2019). Prospective research could complement these studies by identifying additional strategies of incumbents in entering the platform business and ensuring their sustainable evolution in platform-driven markets (e.g., Hermes et al., 2021).

With regard to the methodological approach, dominantly employing a descriptive approach to explain and theorize on platform cases restricts the extracted knowledge to what has been (successfully) tried. Nevertheless, considering the necessity of both descriptive and prescriptive knowledge (Gregor & Hevner, 2013), we lack knowledge on what could or should be tried. Therefore, we encourage design-oriented studies capture, synthesize, and share design knowledge for digital platforms. In particular, future research may propose taxonomies of digital platforms from various perspectives to differentiate distinct platform contexts, thereby enabling the identification of patterns and the systematic comparison of different platforms across major aspects (e.g., Hein et al., 2018; Staub et al., 2021a).

Platform researchers also applied a variety of theoretical lenses to guide the derivation of their theories on digital platforms. Although a large number of different theories were applied, there are still relatively few dominant theories in platform research, as illustrated by the fact that only three theories have been used more than three times (i.e., game theory, complex adaptive systems theory, and modular systems theory). We further encourage employing theories that help theorizing on paradoxical platform design decisions. For instance, ambidexterity theory helps articulate different circumstances under which the duality and the two aspects of a paradox can be dynamically and simultaneously achieved (Lavie et al., 2010). Specifically, extant ambidexterity research has conceptualized four modes, namely contextual, structural, temporal, and domanial ambidexterity (Lavie et al., 2010) that may support future research in providing insights on addressing the paradoxical tensions inherent in the design and evolution of digital platforms.

Regarding the unit of analysis, our review reveals that the majority of existing studies take a platform owner, complementor, or user perspective. Nevertheless, a thorough understanding of digital platforms as socio-technical systems entails the need for their investigation from the standpoint of all the ecosystem's actors (i.e., platform owner, complementors, and users). Thus, we call for more studies on the ecosystem level to account for a triangulation of perspectives from different actors and their reciprocal impacts in delineating an ecosystem's status-quo and evolution. When the role of individual ecosystem's actors is concerned and considering the current status of research, we further suggest that future research focuses more on complementors due to their essential role in co-creation of value in platform ecosystems (Cennamo & Santaló, 2019; Ghazawneh & Henfridsson, 2013). Examining complementors helps better understand their motivation to join a platform in different settings (e.g., platform types), specifically in the abovementioned cases of a company's transition from a product-based to a platform-based competition strategy whose success is very much contingent on attracting complementors to conduct their business on the platform.

Table 3 gives an overview of our main suggestions for future digital platform research.

Table 3. Suggestions for Future Research on Digital Platforms

Research focus		Suggested avenues	Suggested foci
Digital platforms	Platform cases	• Major obstacles in the early maturity phase of platforms • Platform's diverse characteristics to increase the comparability of platform studies	• Study cases of failure • Study cases in B2B contexts • Study cases of platformization
	Research methods and contribution types	• Design knowledge and principles to guide the design and evolution of platforms	• Employ prescriptive approaches (e.g., DSR)
	Theories	• Theoretical perspectives for addressing paradoxical platform design decisions	• Employ relevant theoretical lenses to inform theory building on managing paradoxical tensions inherent in the design and evolution of platforms
	Unit of analysis	• A platform ecosystem view as well as complementors' strategic reactions to platformization	• Study platforms with a multi-actor view (i.e., platform owner, complementors, users)

5.4 Implications for Practice

Our insights on platform governance mechanisms also have practical implications. Due to the necessity of both generativity (to facilitate innovation) and control (to enable structural stability), platform owners constantly encounter paradoxical design decisions in their ecosystems. Thus, platform owners benefit from our comprehensive overview of the major mechanisms to govern their platform ecosystems with

respect to each mechanism's role in fostering generativity and/or control. In particular, the discussed governance mechanisms serve as guidance for digital platform designers that consider building a digital platform (and define an appropriate governance structure) as well as for digital platform managers that aim to identify possible adaptations of their current portfolio of governance mechanisms.

Further, our study gives rise to the double-sidedness of governance mechanisms, requiring platform designers and managers to take into account each mechanism's contextual and temporal conditions as well as the potential dynamics of their interaction effects. Therefore, we call for practitioners' particular attention to the contextual use of each mechanism along with the purposeful bundling of mechanisms into a portfolio to effectively address the generativity-control tension. While our results are important for platform owners, complementors can also benefit from our research. Specifically, a more detailed understanding of the potential motivations (generativity and/or control) of platform owners to employ or alter certain governance mechanisms may support complementors' strategic positioning in a platform ecosystem.

5.5   Conclusion

Our literature review consolidates fragmented academic discourses on platform governance mechanisms that have been accumulated in different literature streams. The main result of our literature analysis is to show which mechanisms from the existing platform research are most relevant with regard to the generativity-control tension as well as how each of them can be applied by platform owners to account for both aspects of the tension. Lastly, we provide avenues for prospective research and discuss our results in terms of the importance of contextual factors when designing and implementing governance mechanisms as well as their mutual interrelatedness when applied in a portfolio.

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Appendix A: Analysis Framework

Table A1. Analysis Framework

Coding item		Explanation and examples	References
Tensions		*Tensions refer to conflicting aspects, competing demands or opposing perspectives.* • Generativity vs. control • Autonomy vs. control • Openness vs. control • Generativity vs. stability • Ability to charge vs. openness • Governance costs vs. control • Individual vs. collective • Old identity vs. new identity • Securing vs. resourcing	Ghazawneh & Henfridsson (2013), Huber et al. (2017), Jain & Ramesh (2015), Karhu et al. (2018), Lewis (2000), Lindgren et al. (2015), Parker & Van Alstyne (2018), Smith & Lewis (2011), Wareham et al. (2014), Ye & Kankanhalli (2018)
Governance mechanisms	Boundary resources	*Boundary resources refer to resources that are used by external developers to support their development work.* • Intellectual property rights • Licensing • Interfaces (e.g., APIs) • Programming resources	Ghazawneh & Henfridsson (2013), Foerderer et al. (2019)
	Decision rights	*Decision rights refer to the division of authority and responsibilities between the platform owner and complementors.* • App implementation • Platform implementation • App strategic • Platform strategic	Thies et al. (2018), Tiwana (2014)
	Gatekeeping	*Gatekeeping (i.e., input control, bouncer rights) refers to the degree to which platform owners use predefined acceptance criteria to judge what complementors are allowed into the ecosystem.*	Boudreau (2010), Evans et al. (2006), Tiwana (2014)
	Metrics	*Metrics (i.e., output control) refer to the degree to which the platform owner rewards or punishes complementors based on the degree to which their outcomes achieve performance metrics.*	Tiwana (2014), Wareham et al. (2014)
	Ownership	*Platform ownership goes beyond the legal entity that owns the digital platform (owner, group of partners or peer-to-peer network); it also refers to centralized or decentralized distribution of power in ecosystems.*	Hein et al. (2020)
	Pricing	*Pricing policies are used by the platform owner to create incentives for complementors to invest their resources to ensure prosperity of their own offerings and in turn the whole ecosystem.* • Access or usage fees • Subsidy-side • App pricing model • Symmetry	Tiwana (2014)
	Process control	*Process control refers to the degree to which a platform owner rewards or punishes complementors based on their success/failure in following prescribed methods, rules, and procedures.*	Rochet & Tirole (2003), Tiwana (2014)
	Revenue sharing	*Revenue sharing represents the degree to which the platform extracts revenue that is co-created with the complementors.*	Oh et al. (2015)
	Relational control	*Relational control fills the gaps left by formal agreements and refers to the degree to which platform owners rely on shared norms and values with complementors to influence their behavior.* • Organizing socialization • Reinforcing common • Setting examples identity	Dhanaraj & Parkhe (2006), Tiwana (2014)
Research specificities	Units of analysis	• Complementors • Platform owner • Ecosystem • Users • Platform	Gregor (2006), Hein et al. (2020), Nicholson et al. (2018)
	Research methods	• Analytical modeling • Grounded theory • Case study • Literature review • Case survey • Longitudinal • Conceptual • Mixed methods • Design science research • Simulation • Experiment • Survey	
	Theories	*We applied open coding to capture any theoretical lenses that are*	

		employed by the reviewed studies. Some examples are the following: - Ambidexterity theory - Complex adaptive systems theory	- Game theory - Institutional theory	
	Contribution types	- Conceptualization - Confirmation of hypotheses - Design artifact	- Design principles - Propositions	

Appendix B: Overview of Digital Platform Research

Besides the major findings on platform governance mechanisms, our literature review provides several insights with respect to the research specificities applied by digital platform researchers (see Table B1).

Table B1. Overview of Digital Platform Research3

Research methods	Count and share of publications		Theories	Count and share of publications	
Analytical modeling	60	45.1%	Game theory	5	3.8%
Case study	45	33.8%	Complex adaptive systems theory	5	3.8%
Longitudinal	26	19.5%	Modular systems theory	4	3.0%
Survey	16	12.0%	Social capital theory	3	2.3%
Experiment	8	6.0%	Institutional theory	3	2.3%
Conceptual	7	5.3%	Resource dependency theory	3	2.3%
Literature review	6	4.5%	Signaling theory	2	1.5%
Design science research	5	3.8%	Technology acceptance model	2	1.5%
Simulation	5	3.8%	Social exchange theory	1	0.8%
Grounded theory	3	2.3%	Expectancy theory	1	0.8%
Delphi study	2	1.5%	Control theory	1	0.8%
Units of analysis			**Contribution types**		
Platform	88	66.2%	Conceptualization	57	42.9%
Platform owner	36	27.1%	Confirmation of hypotheses	56	42.1%
Complementors	32	24.1%	Propositions	16	12.0%
Users	31	23.3%	Design artifact	2	1.5%
Ecosystem	7	5.3%	Design principles	2	1.5%

First of all, our review indicates that digital platform researchers adopted a variety of different methods. Analytical modeling (quantitative, mathematical equations that specify parametric relations among different variables), such as panel analyses or different variations of regression analysis, was the most common method, followed by case studies and surveys. Within case studies, single case studies (25; 18.8%) were the most common option, followed by multiple case studies (13; 9.8%) and field studies (7; 5.3%). Many of the case studies applied a longitudinal analysis. Few studies made use of other methods such as simulation or design science research (DSR).

Several of the papers applied at least one specific theory. The most frequently used theories were game theory, complex adaptive systems theory, modular systems theory, social capital theory, institutional theory, and resource dependency theory. Regarding the contribution types, research focused on the conceptualization before confirmation of hypotheses and derivation of propositions.

Moreover, prior research has focused on digital platforms as a major unit of analysis, followed by the platform owner, complementors, users, and the ecosystem. In addition, we identified Google Android (12; 9.0%), Apple iOS (10; 7.5%), Kickstarter (5; 3.8%), Taobao (3; 2.3%), and Firefox (3; 2.3%) as the major cases in our sample.

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[3] The percentage values indicate the share of the total number of papers. Regarding the research methods, theories, and units of analysis, multiple choices for one paper are possible (e.g., case study *and* longitudinal). Besides the 122 reviewed papers, the table includes literature review (5) and conceptual/editorial (6) papers that were excluded from the literature analysis.

Appendix C: List of Papers

Table C1. List of Papers

Outlet	Year	Publication
EJIS	2015	Jain, R. P., & Ramesh, B. (2015). The roles of contextual elements in post-merger common platform development: An empirical investigation. *European Journal of Information Systems, 24*(2), 159-177.
EJIS	2019	Bogusz, C. I., Teigland, R., & Vaast, E. (2019). Designed entrepreneurial legitimacy: The case of a Swedish crowdfunding platform. *European Journal of Information Systems, 28*(3), 318-335.
EJIS	2021	Hurni, T., Huber, T. L., Dibbern, J., & Krancher, O. (2021). Complementor dedication in platform ecosystems: Rule adequacy and the moderating role of flexible and benevolent practices. *European Journal of Information Systems, 30*(3), 237-260.
ISJ	2013	Ghazawneh, A., & Henfridsson, O. (2013). Balancing platform control and external contribution in third-party development: The boundary resources model. *Information Systems Journal, 23*(2), 173-192.
ISJ	2016	Giessmann, A., & Legner, C. (2016). Designing business models for cloud platforms. *Information Systems Journal, 26*(5), 551-579.
ISJ	2017	Huang, Q., Chen, X., Ou, C. X., Davison, R. M., & Hua, Z. (2017). Understanding buyers' loyalty to a C2C platform: The roles of social capital, satisfaction and perceived effectiveness of e-commerce institutional mechanisms. *Information Systems Journal, 27*(1), 91-119.
ISJ	2018	Thies, F., Wessel, M., & Benlian, A. (2018). Network effects on crowdfunding platforms: Exploring the implications of relaxing input control. *Information Systems Journal, 28*(6), 1239-1262.
ISJ	2019	Foerderer, J., Kude, T., Schuetz, S. W., & Heinzl, A. (2019). Knowledge boundaries in enterprise software platform development: Antecedents and consequences for platform governance. *Information Systems Journal, 29*(1), 119-144.
ISJ	2019	Tan, F. T. C., Pan, S. L., & Zuo, M. (2019). Realising platform operational agility through information technology-enabled capabilities: A resource-interdependence perspective. *Information Systems Journal, 29*(3), 582-608.
ISJ	2021	Bonina, C., Koskinen, K., Eaton, B., & Gawer, A. (2021). Digital platforms for development: Foundations and research agenda. *Information Systems Journal, 31*(6), 1-34.
ISR	2010	Tiwana, A., Konsynski, B., & Bush, A. A. (2010). Platform evolution: Coevolution of platform architecture, governance, and environmental dynamics. *Information Systems Research, 21*(4), 675-687.
ISR	2014	Anderson, E. G., Jr., Parker, G. G., & Tan, B. (2014). Platform performance investment in the presence of network externalities. *Information Systems Research, 25*(1), 152-172.
ISR	2015	Tiwana, A. (2015a). Evolutionary competition in platform ecosystems. *Information Systems Research, 26*(2), 266-281.
ISR	2016	Hann, I. H., Koh, B., & Niculescu, M. F. (2016). The double-edged sword of backward compatibility: The adoption of multigenerational platforms in the presence of intergenerational services. *Information Systems Research, 27*(1), 112-130.
ISR	2017	Huber, T. L., Kude, T., & Dibbern, J. (2017). Governance practices in platform ecosystems: Navigating tensions between cocreated value and governance costs. *Information Systems Research, 28*(3), 563-584.
ISR	2017	Qiu, Y., Gopal, A., & Hann, I. H. (2017). Logic pluralism in mobile platform ecosystems: A study of indie app developers on the iOS app store. *Information Systems Research, 28*(2), 225-249.
ISR	2018	Cennamo, C., Ozalp, H., & Kretschmer, T. (2018). Platform architecture and quality trade-offs of multihoming complements. *Information Systems Research, 29*(2), 461-478.
ISR	2018	Constantinides, P., Henfridsson, O., & Parker, G. G. (2018). Platforms and infrastructures in the digital age. *Information Systems Research, 29*(2), 381-400.

ISR	2018	Foerderer, J., Kude, T., Mithas, S., & Heinzl, A. (2018). Does platform owner's entry crowd out innovation? Evidence from Google photos. *Information Systems Research, 29*(2), 444-460.
ISR	2018	Gal-Or, E., Gal-Or, R., & Penmetsa, N. (2018). The role of user privacy concerns in shaping competition among platforms. *Information Systems Research, 29*(3), 698-722.
ISR	2018	Karhu, K., Gustafsson, R., & Lyytinen, K. (2018). Exploiting and defending open digital platforms with boundary resources: Android's five platform forks. *Information Systems Research, 29*(2), 479-497.
ISR	2018	Khern-am-nuai, W., Kannan, K., & Ghasemkhani, H. (2018). Extrinsic versus intrinsic rewards for contributing reviews in an online platform. *Information Systems Research, 29*(4), 871-892.
ISR	2018	Kumar, N., Qiu, L., & Kumar, S. (2018). Exit, voice, and response on digital platforms: An empirical investigation of online management response strategies. *Information Systems Research, 29*(4), 849-870.
ISR	2018	Niculescu, M. F., Wu, D. J., & Xu, L. Z. (2018). Strategic intellectual property sharing: Competition on an open technology platform under network effects. *Information Systems Research, 29*(2), 498-519.
ISR	2018	Rolland, K. H., Mathiassen, L., & Rai, A. (2018). Managing digital platforms in user organizations: The interactions between digital options and digital debt. *Information Systems Research, 29*(2), 419-443.
ISR	2018	Tiwana, A. (2018). Platform synergy: Architectural origins and competitive consequences. *Information Systems Research, 29*(4), 829-848.
ISR	2019	Jung, D., Kim, B. C., Park, M., & Straub, D. W. (2019). Innovation and policy support for two-sided market platforms: Can government policy makers and executives optimize both societal value and profits? *Information Systems Research, 30*(3), 1037-1050.
ISR	2019	Liang, C., Shi, Z., & Raghu, T. S. (2019). The spillover of spotlight: Platform recommendation in the mobile app market. *Information Systems Research, 30*(4), 1296-1318.
ISR	2020	He, S., Peng, J., Li, J., & Xu, L. (2020). Impact of platform owner's entry on third-party stores. *Information Systems Research, 31*(4), 1467-1484.
ISR	2020	Tan, B., Anderson Jr, E. G., & Parker, G. G. (2020). Platform pricing and investment to drive third-party value creation in two-sided networks. *Information Systems Research, 31*(1), 217-239.
JAIS	2015	Tan, B., Lu, X., Pan, S. L., & Huang, L. (2015). The role of IS capabilities in the development of multi-sided platforms: The digital ecosystem strategy of Alibaba.com. *Journal of the Association for Information Systems, 16*(4), 248-280.
JAIS	2018	Zimmermann, S., Angerer, P., Provin, D., & Nault, B. R. (2018). Pricing in C2C sharing platforms. *Journal of the Association for Information Systems, 19*(8), 672-688.
JAIS	2019	Bar-Gill, S. (2019). Game of platforms: Strategic expansion into rival (online) territory. *Journal of the Association for Information Systems, 20*(10), 1475-1502.
JAIS	2019	Leong, C., Pan, S. L., Leidner, D. E., & Huang, J.-S. (2019). Platform leadership: Managing boundaries for the network growth of digital platforms. *Journal of the Association for Information Systems, 20*(10), 1531-1565.
JIT	2009	Basole, R. C. (2009). Visualization of interfirm relations in a converging mobile ecosystem. *Journal of information Technology, 24*(2), 144-159.
JIT	2013	Selander, L., Henfridsson, O., & Svahn, F. (2013). Capability search and redeem across digital ecosystems. *Journal of Information Technology, 28*(3), 183-197.
JIT	2015	Benlian, A., Hilkert, D., & Hess, T. (2015). How open is this platform? The meaning and measurement of platform openness from the complementors' perspective. *Journal of Information Technology, 30*(3), 209-228.
JIT	2015	Lindgren, R., Eriksson, O., & Lyytinen, K. (2015). Managing identity tensions during mobile ecosystem evolution. *Journal of Information Technology, 30*(3), 229-244.
JIT	2015	Oh, J., Koh, B., & Raghunathan, S. (2015). Value appropriation between the platform provider and app developers in mobile platform mediated networks. *Journal of Information Technology, 30*(3), 245-259.

JIT	2015	Ondrus, J., Gannamaneni, A., & Lyytinen, K. (2015). The impact of openness on the market potential of multi-sided platforms: A case study of mobile payment platforms. *Journal of Information Technology, 30*(3), 260-275.
JIT	2015	Sørensen, C., de Reuver, M., & Basole, R. C. (2015). Mobile platforms and ecosystems. *Journal of Information Technology, 30*, 195-197.
JIT	2015	Spagnoletti, P., Resca, A., & Lee, G. (2015). A design theory for digital platforms supporting online communities: a multiple case study. *Journal of Information Technology, 30*(4), 364-380.
JIT	2016	Rode, H. (2016). To share or not to share: The effects of extrinsic and intrinsic motivations on knowledge-sharing in enterprise social media platforms. *Journal of Information Technology, 31*(2), 152-165.
JIT	2017	Wessel, M., Thies, F., & Benlian, A. (2017). Opening the floodgates: The implications of increasing platform openness in crowdfunding. *Journal of Information Technology, 32*(4), 344-360.
JIT	2018	de Reuver, M., Sørensen, C., & Basole, R. C. (2018). The digital platform: A research agenda. *Journal of Information Technology, 33*(2), 124-135.
JIT	2020	Alaimo, C., Kallinikos, J., & Valderrama, E. (2020). Platforms as service ecosystems: Lessons from social media. *Journal of Information Technology, 35*(1), 25-48.
JMIS	2008	Bakos, Y., & Katsamakas, E. (2008). Design and ownership of two-sided networks: Implications for Internet platforms. *Journal of Management Information Systems, 25*(2), 171-202.
JMIS	2012	Mantena, R., & Saha, R. L. (2012). Co-opetition between differentiated platforms in two-sided markets. *Journal of Management Information Systems, 29*(2), 109-140.
JMIS	2015	Tiwana, A. (2015b). Platform desertion by app developers. *Journal of Management Information Systems, 32*(4), 40-77.
JMIS	2018	Benlian, A., Kettinger, W. J., Sunyaev, A., Winkler, T. J. (2018). Special section: The transformative value of cloud computing: A decoupling, platformization, and recombination theoretical framework. *Journal of Management Information Systems, 35*(3), 719–739.
JMIS	2018	Kazan, E., Tan, C. W., Lim, E. T. K., Sørensen, C., & Damsgaard, J. (2018). Disentangling digital platform competition: The case of UK mobile payment platforms. *Journal of Management Information Systems, 35*(1), 180-219.
JMIS	2019	Guo, Y., Li, X., & Zeng, X. (2019). Platform competition in the sharing economy: Understanding how ride-hailing services influence new car purchases. *Journal of Management Information Systems, 36*(4), 1043-1070.
JMIS	2019	Kuang, L., Huang, N., Hong, Y., & Yan, Z. (2019). Spillover effects of financial incentives on non-incentivized user engagement: Evidence from an online knowledge exchange platform. *Journal of Management Information Systems, 36*(1), 289-320.
JMIS	2019	Nan, G., Yao, L., Ho, Y.-C., Li, Z., & Li, M. (2019). An economic analysis of platform protection in the presence of content substitutability. *Journal of Management Information Systems, 36*(3), 1002-1036.
JMIS	2020	Hong, S. J., Bauer, J. M., Lee, K., & Granados, N. F. (2020). Drivers of supplier participation in ride-hailing platforms. *Journal of Management Information Systems, 37*(3), 602-630.
JMIS	2020	Kathuria, A., Karhade, P. P., & Konsynski, B. R. (2020). In the realm of hungry ghosts: Multi-level theory for supplier participation on digital platforms. *Journal of Management Information Systems, 37*(2), 396-430.
JMIS	2020	Soh, F., & Grover, V. (2020). Effect of release timing of app innovations based on mobile platform innovations. *Journal of Management Information Systems, 37*(4), 957-987.
JMIS	2020	Wulf, J., & Blohm, I. (2020). Fostering value creation with digital platforms: A unified theory of the application programming interface design. *Journal of Management Information Systems, 37*(1), 251-281.
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