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Uncovering Digital Platform Generativity: A Systematic Literature Review

Full research paper

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Abstract

Generativity is the driver for digital innovation and platform growth by engaging many actors with diverse skills on digital platforms. As the proliferation of generativity grows, the Information Systems (IS) literature demonstrates a mixed understanding of this notion and divergent research focuses. The inconsistency challenges the congruent understanding of generativity and the theorization for future research. This study conducts a systematic literature review to clarify and unify the knowledge of generativity in the digital platform context. The study shows that generativity is the social-technical system in which social actors interact with each other by employing digital technologies. Generativity is not unequivocally positive to the digital platform due to the inherent tension that requires deliberate actions among the involved actors. This study contributes to the IS research by providing a conceptual framework (i.e., the Antecedent-Process-Outcomes framework) of digital platform generativity and highlighting the aspects that require in-depth exploration for future research.

Keywords: generativity, digital platform, tension, digital innovation, framework

1 Introduction

Generativity, a driver for innovation on digital platforms, has attracted increasing attention in recent years. Zittrain (2006, p. 1980) first introduced generativity as "a technology's overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences." The generative capability is essential for digital platforms to nurture breakthrough digital innovations, and survive in facing with radical technological changes (Svahn et al. 2015). The engagement of various audiences on a digital platform creates unforeseen digital services and novel business models, propelling digital platforms forward in unanticipated ways (Eck and Uebernickel 2016).

A digital platform is a sociotechnical system with the potential to generate a larger number of complementary applications by autonomous actors (Cennamo and Santaló 2019). It consists of heterogeneous participating actors: platform owners, complementors, and end-users (McIntyre et al. 2021). These actors exchange and actualize technical resources via a platform and thus add peripheral modules to gain new value propositions, such as digital innovation (Costantinides et al. 2018; Schreieck et al. 2016).

Generativity on digital platforms (DP) is the critical mechanism underpinning this perpetual added-on integration process (Hein et al. 2020). If generativity is desirably leveraged, the cooperative and reciprocal interaction among various actors as they mix and match technological and human resources can be the source of combinatorial innovation (Jarvenpaa and Standaert 2018). For example, complementors enhance the Android ecology with the applications (Eaton et al. 2011). If undesirably leveraged, for instance, in the form of internet malware (Zittrain 2006).

The literature shows that the understanding of DP generativity is inconsistent and has different research focuses in the Information Systems (IS) field. Insights from the current literature are arranged to communicate a structured assemblage of relationships through the antecedents, processes, and outcomes (Lim et al. 2021). Various studies have examined generativity separately from the perspective of antecedents, processes, and outcomes. From the perspective of antecedents, for instance, studies introduce social and technical factors that facilitate the generative capability of digital platforms, leading to infinite product variations (Bygstad 2017; Svahn et al. 2015). From the perspective of process, generativity is a self-reinforcing process, leading to the creation of novel products depending on the tension resolution (Eck et al. 2015; Marheine and Pauli 2020; Yoo et al. 2010). Other studies argue that generativity comes from a collaborative interaction between stakeholder groups to solve problems (Ansell and Torfing 2021; Yoo et al. 2010). From the perspective of outcomes, the generative potential of digital platforms manifests itself through the diversity of solution scenarios and product capabilities, thus expanding the scope and scale of DPs (Lyytinen et al. 2017; Pauli and Lin 2019).

Some literature reviews are conducted to give an overall picture of generativity, such as one of the recent studies by Thomas and Tee (2022). They suggest that system innovation comes from the interaction between generative architecture and generative community, and governance strategy influences innovation outcomes. This review explores generativity in general in terms of its antecedents, processes, and outcomes, which is one of the initial works on an integrative view of generativity research in management study. The emergent phenomenon of the widespread digital platforms enables the diverse views of DP generativity, making it necessary to develop a unified understanding to capture the unique features of DPs. We take an antecedents-processes-outcomes perspective to uncover the DP generativity. Our study differs from Thomas and Tee's work in three aspects: first, we study the generativity of digital platforms. Second, we uncover the specific activities and their interactions involved in the process that shapes generativity. Third, we identify the outcomes specific to the context of digital platforms. Driven by the aims of 1) developing a unified understanding of DP generativity, 2) capturing the unique features of the generative process on DPs, and 3) highlighting the research directions for future research to pursue an in-depth exploration of the generativity process of DP, our research addresses the research question:

What are the antecedents, processes, and outcomes of digital platform generativity?

To address the research question, we conducted a systematic literature review following the guideline of Page et al. (2021) to analyze the existing research on DP generativity. This paper organizes insights from the existing literature into a structured assemblage of relationships by adopting the antecedents, decisions, and outcomes (ADO) framework into the antecedents, processes, and outcomes (APO) framework (Lim et al. 2021; Paul and Benito 2018). Our framework depicts the antecedents of digital platforms that enable the interactive and generative process and anticipated generative outcomes derived from the interaction process. In particular, our framework presents that tension and tension moderation as the mechanism that explains why generativity can be self-reinforcing.

In the remainder of this paper, we first explain the details of the research method and demonstrate how we collect and analyze data by following the **p**referred **r**eporting **i**tems for **s**ystematic **r**eviews and **m**eta-**a**nalyses (PRISMA) protocol (Page et al. 2021). Next, we present our conceptual framework, followed by a research agenda for future research and research contributions.

2 Research Method

The PRISMA protocol is well-used in IS research (Page et al. 2021). In the following, we present the process of identification, screening, eligibility, and inclusion of the PRISMA protocol in reviewing the DP generativity literature.

2.1 Data Collection

In the PRISMA method, the identification stage includes source type, search databases, search period, search keywords.

First, in terms of source type and search database, we considered conference proceedings and journal article that are listed in academic databases: Web of Science, Scopus, Business Sources Premier, and Association for Information Systems AIS Electronic Library (AISeL). Second, we selected articles published from January 2006 to October 2022. We focus on this time range because the concept of generativity was first introduced into IS in January 2006 (Zittrain 2006). This search ensures to cover most of the literature on DP generativity in the IS research field. Third, we used the following the keywords in search strings setting ("generative capability" OR "generativity") AND innovation AND ("digital platform" OR "digital infrastructure" OR "digital platform ecosystem"). This combination of multiple synonyms in the search setting ensures the comprehensiveness of the search and the focus on digital platform generativity.

With this setting, we identified 227 papers. We then screened out the duplicate papers from different databases. In total, 112 articles were removed and 115 papers remained for the next stage of data analysis.

The exclusion stage was then conducted to limit the results to high-quality publications. We considered the conference proceedings from the International Conference on Information Systems (ICIS), European Conference on Information Systems (ECIS), and Pacific Asia Conference on Information Systems (PACIS); and the eight journals in the Senior Scholars' Basket of Journals listed in AIS Website. Since IS research is interdisciplinary, we decided not to limit the range of review articles to IS-specific journals, which enables us to search the articles from ranked A and A* journals in the Australian Business Deans Council (ABDC) journal ranking list. 36 papers were excluded.

The inclusion stage was then initiated, based on the consideration of content relevance by browsing the abstracts and titles. We continued to narrow down the results by reviewing these remaining 79 articles to identify papers that examine "generativity" and "generative" in the digital platform context. In this stage, papers that briefly mention generativity were excluded. Papers that study "generative mechanism" were also excluded. In the end, 38 papers were removed from the data set. This left us with 41 articles for further data analysis. Figure 1 presents the data collection process.

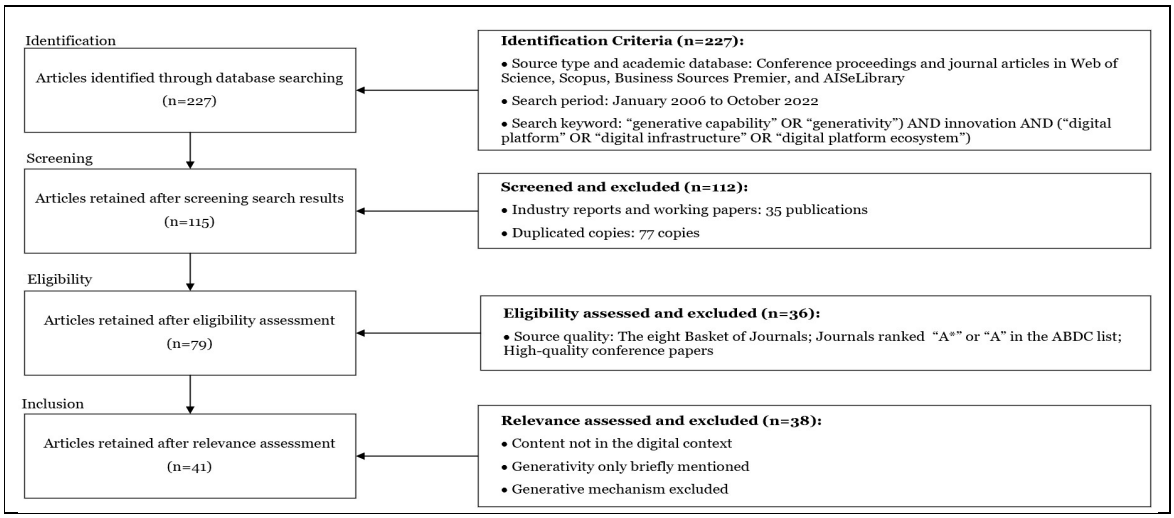

Figure 1. Procedures for selecting articles

2.2 Data Analysis

We used Nvivo, a qualitative data analysis software, to analyze data. Using the data analysis method established by Gioia et al. (2013), we closely examined each paper to identify the fundamental notions of generativity. The data analysis adopted longitudinal replication logic to identify recurring theoretical mechanisms over time to extract our 1st-order concepts (Gioia et al. 2013), adhering faithfully to the literature, as shown in Figure 2. Next, the concepts were grouped into 2nd-order themes by the commonalities of the themes. We categorized them into 17 themes. These themes were further analyzed and aggregated into 6 aggregate dimensions. Figure 2 outlines the data structure.

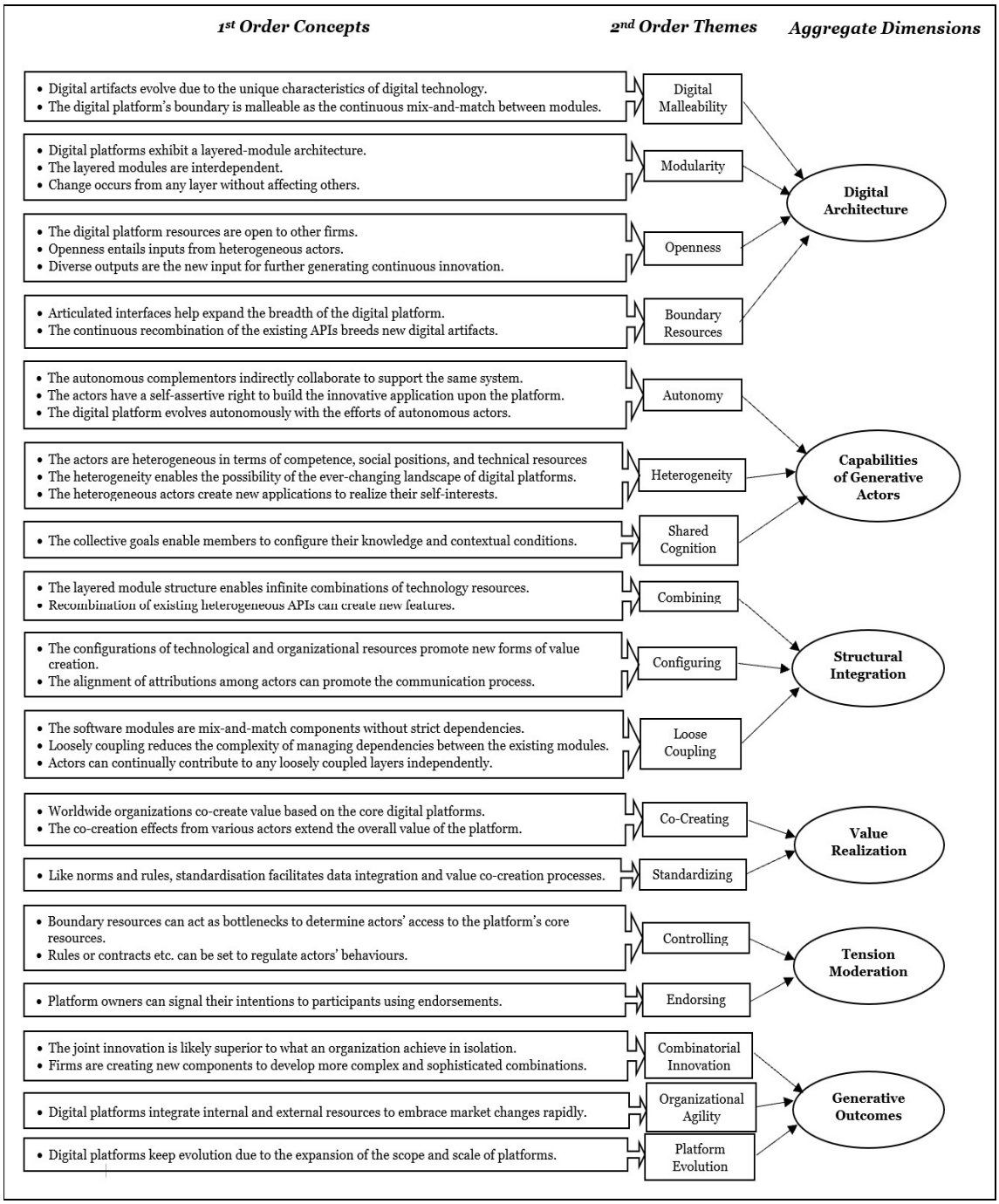

Figure 2. Data structure

3 Conceptual Framework of Digital Platform Generativity

The data analysis results show two antecedent components (digital architecture, capabilities of generative actors), three interaction activities in the processes (structural integration, value realization, and tension moderation), and three generative outcomes (combinatorial innovation, organizational agility, and platform evolution). Figure 3 presents our conceptual framework of DP generativity based on the data analysis of the literature. The framework shows the antecedents for actors engaging in interactions on digital platforms, how the interactive processes unfold over time, and the outcomes derived from leveraging the generativity of the digital platform.

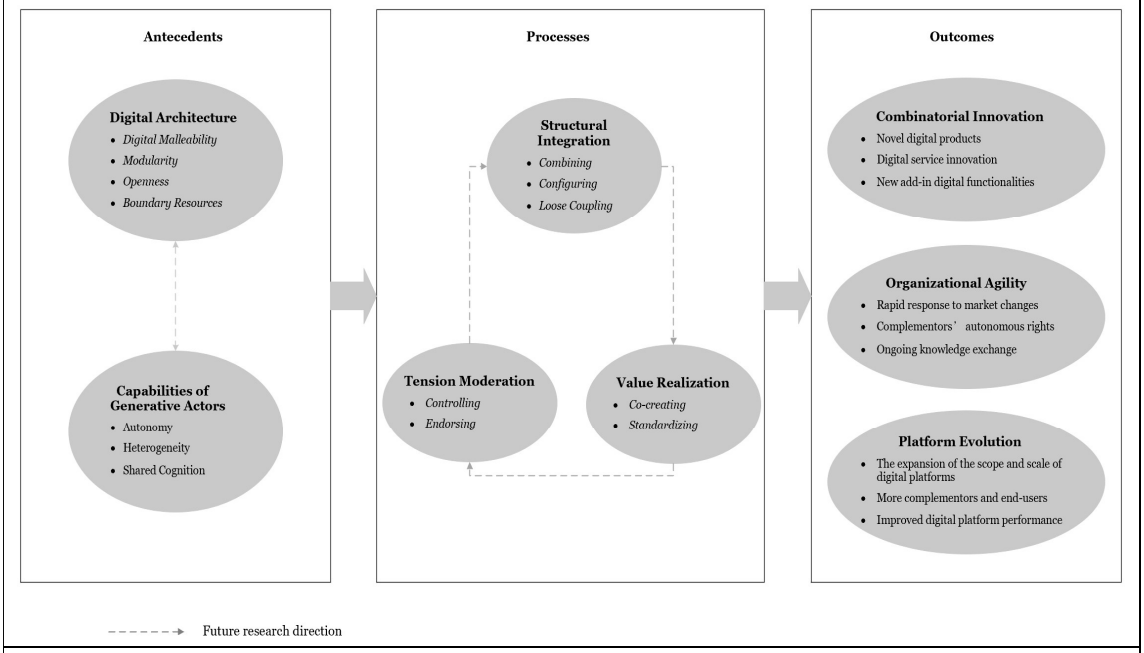

Figure 3. Conceptual framework of digital platform generativity

3.1 Antecedents to Digital Platform Generativity

Digital architecture comprises malleable, dynamic, and loosely coupled technological modules. Digital architecture is formed by four major factors: *digital malleability, modularity, openness, and boundary resources*.

Digital malleability, the ability to be easily edited and reprogrammed to adapt to new circumstances, is the fundamental attribute of the digital architecture (Yoo 2012). Driven by the features of digital technology, such as data homogeneity and re-programmability, digital architecture is malleable and rarely remains in its original form (Yoo et al. 2010). The elements of digital architecture can be designed in multiple ways and generally evolve into more complex structures. Therefore, the digital platform architecture can offer higher generativity than the original physical and hierarchical architectures (Lyytinen et al. 2017).

The *modularity* of digital technology architecture fosters generativity development because of the separate layer of devices, networks, services, and contents (Henfridsson et al. 2018). Increasingly, on digital platforms, the modules are product-agnostic, so relationships among modules are flexible without first considering the particular product architecture (Um et al. 2013). A module-layered architecture enables the separation of service from devices and the separation of content from the network. Such division makes it easier to combine technical resources in flexible ways to create new products and services (Chesbrough 2003). Recombined innovation independently emerges from specific layers with minimal consideration of other layers (Eck et al. 2015).

Openness is a condition for digital platform generativity because when a platform resource is open to other firms (Remneland-Wikhamn et al. 2011). Those firms can invent novel components and expand the platform's basic functionality. Openness entails inputs from autonomous and heterogeneous actors to co-create diverse outputs; it also means that these various outputs are the resources for further generating new combinations that allow for new possibilities (Jarvenpaa and Standaert 2018). Generativity concerns further continuous innovation in a digital platform's network (Lakemond and Holmberg 2018).

Boundary resources are interfaces, such as application programming interfaces and software development kits, provided by the platform owner to increase the interactions between the digital platform and its external complementors (Hein et al. 2019a). These interactions lead to generativity as these actors could co-create and cultivate value-adding applications (Henfridsson et al. 2018). These value-adding applications complement the platform's core functionality (Sun et al. 2021).

Capabilities of generative actors actualize the generative potential of digital architecture. Generative actors on digital platforms are the platform owners, complementors, and end-users, who are "broad and varied audiences" (Zittrain 2006, p. 1980) with varying innovative capabilities. They engage in digital architecture, autonomously using their creativity and skills without central control from platform owners (Eck and Uebernickel 2016). The actors' capacity to innovate is derived from their *autonomy, heterogeneity, and shared cognition*.

Complementors on a digital platform have *autonomy,* which is not bounded by centralized control of the platform. The high variety of complementors fuels generativity, with their innovation capabilities being mobilized to pursue their interests independently (Nambisan et al. 2019). They might not be directly partnered with one particular platform, but the group of complements together contribute to the platforms (Cennamo and Santaló 2019). This autonomy of complementors directly influences the number of innovative products or services produced in the digital platform (Ye and Kankanhalli 2018).

Heterogeneity means that complementors are diverse and differentiated in their competence, social position, and interests (Msiska and Nielsen 2018). Heterogeneous complementors seek partners who differ substantially in terms of their expertise and experiences. They engage with each other and learn from each other in pursuit of their self-interest (Um et al. 2013). Consequently, the heterogeneity of these resources fuels generativity since complementors can create a variety of innovations (Svahn et al. 2015).

Connected to the above process is the expectation that complementors engage in *shared cognition* to develop shared purposes and norms. A shared worldview or the alignment of diverse interests among heterogeneous complementors enables various outputs (Jarvenpaa and Standaert 2018). Furthermore, the mutual sensemaking of the context can overcome the stickiness of knowledge and communication challenges and open new worlds of digital innovation (Lyytinen et al. 2016).

3.2 Processes of Digital Platform Generativity

Our data analysis results show three types of interaction activities: **structural integration, value realization,** and **tension moderation**.

The emergence of innovation on digital platforms stems from the **structural integration** of resources from heterogeneous actors. Such integration depends on various ways of producing novel innovations, namely *combining, configuring, and loose coupling*.

First, generativity can originate from creatively *combining* previously existing software code modules in new ways or from creatively disassembling already existing modules and recombining them to fit a new situation (van Osch and Avital 2010). The layered modular architecture, which separates functions from forms, and contents from media, enables a wide variety of technical resource combinations to create new digital products and services (Jarvenpaa and Standaert 2018).

Second, the digital platform is inherently malleable as organizational and technological resources can be *configured* to meet user requirements and accelerate the development of new technologies (Yoo 2012). This configuration or reconfiguration aims to align various attributes among actors, such as configurations of technical infrastructure, use of intellectual property, and organizing actions (Remneland-Wikhamn et al. 2011). Innovation on digital platforms as a collective and societal activity is full of uncertainty and change. Actors need to track such changes carefully and then keep configuring specific complementarities among their activities (Cennamo and Santaló 2019).

Third, the interactions of *loosely coupled* technology, standardization, and organization strongly support the generativity (Bygstad 2017). In principle, generativity should work where technical

components are loosely coupled rather than tightly integrated so that a change in one part does not affect the other part's operation (Bygstad 2017). A loosely coupled relationship enables each part to have its separate development cycle with minimal dependency (Henfridsson et al. 2018). Loosely coupled relationships attract complementors to continuously contribute to the focal digital platform without needing too much consideration of its dependencies with other modules (Tiwana 2015).

Value realization is the second type of interactive process related to the fundamental business value of a digital platform. The overall platform value to users and complementors is generated from various actors who pursue intrinsic values for themselves. The collaborative value-creation processes in digital platforms are independent of the platform owner (Hein et al. 2019a). The creation process occurs through a process of *co-creation* and *standardization*.

First, new ideas and market offerings are *co-created* through a collective exchange between various platform actors. Digital platforms allow actors to take advantage of network externalities, where actors provide the majority of complementary products or services (Hein et al. 2019b). Platform innovation is open to collaborative networks from interconnected complementors regarding the employment of resources and capabilities. The complementarity between individuals, groups, and organizations can satisfy customer needs in multisided markets and thereby extend the overall value of the digital platforms (Foerderer et al. 2014).

On the other hand, the co-created value must be *standardized* by platform owners. Standards like APIs and other protocols set by platform owners provide rules for various complementors to integrate their modules in a way that customizes the customer's needs (Marheine and Pauli 2020). Standardization is a crucial step to make modules compatible across diverse actors.

Tension moderation is the third mechanism we identified through various activities performed by actors of digital platforms. Generative outcomes depend on the delicate balancing and moderating tension of digital platform activities (Lyytinen et al. 2017). The inherent tensions would be either drivers or hinderers of the generativity that shapes the evolution of a platform (Tiwana 2015). We identified three types of tensions: *stability vs flexibility, control vs autonomy,* and *reputation spillover effect vs free-rider effect*. These types of tensions are moderated through *controlling* and *endorsing*.

The paradox of *stability and flexibility* are conceptually contradictory, yet interdependent with each other (Sun et al. 2021; Sun and Zhang 2018). Tilson et al. (2010) suggested controlling as means to understand the tension between stability and flexibility. Platform owners should exercise appropriate control to ensure the digital platform's stability, while empowering complementors with autonomy to encourage further development (Tiwana et al. 2010). Therefore, the core challenge of maintaining stability while keeping flexible is achieved by continuously balancing the paradox of *control and autonomy*, one of the key strategic actions of platform actors. The existing literature focuses on how to access value-creation activities and how to properly balance control points between the centralization and decentralization of particular rights (Elaluf-Calderwood et al. 2011; Foerderer et al. 2014; Ghazawneh and Henfridsson 2013). The control points define the behaviours and constraints for external involvement, such as maintaining and fostering varying levels of openness, guiding potential contributors, and rewarding value creation over free riding (Remneland-Wikhamn et al. 2020).

The paradox of the *reputation spillover effect and free-rider effect* arises due to the competing interests of actors in the value creation process. This tension greatly influences platform end users' satisfaction (Cennamo and Santaló 2019) because not all complementors contribute equally to addressing customers' needs. Complementors' self-selected contribution to the platform is risky because a notable information asymmetry exists between the platform owner and the complementors. The information asymmetry causes challenges for complementors because they may not know where platform generativity is desirable (Lehmann et al. 2022). Some complementors may get a free ride on the platform's co-creation efforts made by prominent complementors, lowering the average performance of the digital platform.

Control is the process identified to moderate these types of tensions. In the IS literature, tension control is often referred to as tension moderation (Eaton et al. 2011). On the one hand, the concept of control points enables a generative platform by supporting digital innovations and, on the other, exerts strict control over the innovation approval (Tilson et al. 2010). Input controlling and process controlling are two types of control actions to achieve the balance of control. The balance of control provides a stable and flexible digital platform on which many complementors innovate.

In input controlling, boundary resources operate as bottlenecks where platform owners can grant or deny actors access to the core resource of the platforms (Ghazawneh and Henfridsson 2013). With increasing third-party access to platform's core resources, a concern is the interoperability between

value-adding applications and a platform's core resources. Controlling through boundary resources may expand the breadth of value-adding activities without disrupting the platform's core stability (Hein et al. 2019a).

In contrast, in process controlling, the platform owners set rules for actors' activities on digital platforms by contracts or a protocol to entitle qualified actors to use the platform (da Rocha and Pollock 2019). For example, some platforms utilize a blockchain to code the rules for smart contract transactions, automate the rules, and store the transaction records in distributed and irreversible ledgers (Schmeiss et al. 2019). Because of blockchain's distributed characteristics, qualified blockchain actors can control their processes independently of a central authority.

The second form of tension moderation is *endorsing*. Endorsements are signals sent by platform owners to indicate where generativity is desirable at a given evolutionary stage of the digital platform (Hukal 2018). Complementors are more likely to hold positive expectations towards their contributions to digital platforms when they understand the platform owners' intention. The platform owners, therefore, instil confidence in complementors that their dedication to the platform is desirable (Lyytinen et al. 2017).

3.3 Outcomes of Digital Platform Generativity

Our data analysis results show three types of outcomes: **combinatorial innovation**, **organizational agility**, and **platform evolution**.

Combinatorial innovation refers to the creation of novel digital products, services or new functionalities resulting from the generative community's (re)combination or integration of technological modules (Thomas and Tee 2022; Yoo 2012). These newly created digital products and services are, to a large degree, complementary to the core platform's existing products and services. Therefore, digital innovation activities enable digital platforms to serve the market's ever-changing needs. These new products or services are unanticipated, and in other words, emergent, and move beyond the original anticipation of the platform owners (Bygstad 2017; Lyytinen et al. 2016).

A little-commented-upon outcome of digital platforms' generativity is **organizational agility**, i.e., "fostering the continual readiness of an organization to rapidly embrace environmental change" (Kretzer et al. 2014, p. 2). The effort to balance the paradoxical tension between stability and flexibility provides a suitable basis to advance organizational agility (Tilson et al. 2010). Balancing the inherent tension between stability and flexibility enables organizational agility. Digital platforms need to empower actors to swiftly make use of their flexibility while being sufficiently stable to integrate the ongoing knowledge exchange and provide predictable means to connect to this (Harraf et al. 2015).

Digital platform evolution is ongoing due to its generative capability. Digital platforms undergo continuous evolution due to their traits that "they are never fully complete, that they have many uses yet to be conceived of, and that the public and ordinary organizational members can be trusted to invent and share good uses" (Sun et al. 2021, p. 2). Many scholars state that the digital platform evolution enabled by generativity is inherently recursive and open-ended because a platform is adaptable (Avital and Te'Eni 2009; Jarvenpaa and Standaert 2018). The diverse innovation outcomes are turned into input resources to generate new combinations that again create new business value and allow for new possibilities.

4 Discussion

This review set out to uncover the existing understanding of DP generativity. In addressing our research question, we develop a conceptual framework that posits antecedents, processes, and outcomes to unify the understanding of digital platform generativity. Our conceptual framework suggests that DP generativity displays specific interaction activities in the looping processes that lead to generative outcomes, which contribute to generativity research by 1) advancing the current understanding of what is digital platform generativity, with a key focus on how to shape generativity in the digital platform context; 2) moving beyond current research focus on the broader understanding of generativity in general in management, and 3) highlighting the research directions for further substantial generativity impact research in the areas of digital platforms. Each of the levels is discussed below.

Firstly, our framework suggests that generativity is the social-technical system that social actors interact by displaying digital architecture. The reciprocal, interactive process stems from the structural integration of social-technical resources, which results in a combinatorial innovation (Eck et al. 2015). The value of combinatorial innovation is realized through the co-creation efforts from heterogeneous actors and standardization measures of the platform owner; thus, the digital platform is agile to market

changes (Tilson et al. 2010). Organizational agility is a key outcome that DP generativity brings into an organization, which has not been highlighted by prior review articles on generativity. Tension moderation is the actions that enable the interaction process to be congruent and recursive, thus resulting in platform evolution and improved digital platform performance (Sun et al. 2021).

Secondly, with the emergence of digital platforms, there is a tendency in IS literature to study innovation on digital platforms (Yoo 2012). This review contributes to the generativity research by capturing the unique features of digital platforms. Our framework has shown similar antecedents with the prior review article (e.g., Thomas and Tee 2022) that examines generativity in general but also moves beyond it. We found that DP generativity is also influenced by the antecedents of boundary resources from the digital architecture and shared cognition from the capabilities of generative actors. DPs display specific interaction activities in the looping processes that lead to different generative outcomes. Our study advances the current understanding of how to shape generativity in general and in the digital platform context specifically (Marheine and Pauli 2020; Thomas and Tee 2022; Yoo et al. 2010).

Thirdly, based on the conceptual framework, this review proposes future research to investigate the notion of generativity. One opportunity is to examine the structural integration of social and technical factors that achieve value realization. Research could investigate how incumbents might alter the combination of organizational and technological resources to foster digital innovation and ground-breaking capability development. Future researchers can also explore how social and technical dimensions mutually influence each other to align with the generativity potentials of digital architecture and social actors. It is also essential to examine how various digital technologies may assist companies in changing their current resource configurations. The second opportunity is the practical challenges of merging and coordinating newly discovered assets across the operational divisions. Another opportunity is to examine the types of tension that arise from value realization; and the role of tension moderation in affecting subsequent loops of structural integration.

In addition, we encourage more empirical studies because that most of the existing research remains at the conceptual level of discussion. Future research could develop a contextualized theory based on empirical work on generativity. We hope our conceptual framework serves as a foundation for future research to develop a mid-range theory of digital platform generativity in an empirical context.

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