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Digital Platform Ecosystem Performance: Antecedents and Interrelations

Rob Jago Floetgen
Technical University of Munich, rob.floetgen@tum.de

Marcus Novotny
Technical University of Munich, marcus.novotny@tum.de

Andreas Hein
Technical University of Munich, andreas.hein@tum.de

Jörg Weking
Technical University of Munich, joerg.weking@tum.de

Florian Urmetzer
University of Cambridge, ftu20@cam.ac.uk

See next page for additional authors

Authors
Rob Jago Floetgen, Marcus Novotny, Andreas Hein, Jörg Weking, Florian Urmetzer, Markus Böhm, and Helmut Krcmar

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Full research paper

Rob Jago Floetgen
Krcmar Lab
Technical University of Munich, Germany
Email: rob.floetgen@tum.de

Marcus Novotny
Krcmar Lab
Technical University of Munich, Germany
Email: mail@marcusnovotny.com

Andreas Hein
Krcmar Lab
Technical University of Munich, Germany
Email: andreas.hein@tum.de

Jörg Weking
Krcmar Lab
Technical University of Munich, Germany
Email: joerg.weking@tum.de

Florian Urmetzer
Institute for Manufacturing
University of Cambridge, United Kingdom
Email: ftu20@cam.ac.uk

Markus Böhm
University of Applied Sciences Landshut, Germany
Email: markus.boehm@haw-landshut.de

Helmut Krcmar
Krcmar Lab
Technical University of Munich, Germany
Email: helmut.krcmar@tum.de

Abstract

The success of many of the world's most valuable companies is based on digital platform ecosystems (DPEs). Their performance depends on integrating autonomous, individually incentivized but highly entangled actors using digital platforms to cocreate values. Extant research uses numerous dependent variables to measure the performance of different actors in isolation. These variables are often limited to the (economic) gains of single actors, where an interconnected perspective on the performance of the whole DPE is lacking. This study extracts all variables and causal links from 132 empirical articles in top information system, management, and economic outlets and aggregates them into ten interconnected antecedents of DPE performance, namely: Heterogeneity, Competition, Engagement, Governance, Quality, Network Size, Generativity, Architecture, Cost, and Motivation/Satisfaction. Based on a nomological network, we contribute an understanding of DPE performance as an interrelated, sociotechnical, and dynamic construct. Our findings aim to support practitioners in effectively navigating and steering their DPEs.

Keywords Digital Platform Ecosystem, Performance, Antecedents, Interrelations

1 Introduction

The growing dominance of digital platform ecosystems (DPEs) has a major impact on today's economy, society, and science (Böttcher et al. 2021). In essence, DPEs comprise a platform owner who implements governance mechanisms (e.g., Floetgen et al. (2022)) to promote value-creating mechanisms between an ecosystem of autonomous suppliers of complementary products and services (e.g., developers or sellers) and consumers (Hein et al. 2020). For instance, Google, which was initially launched as a search engine company in 1998, has developed many successful platform ecosystems from Search and YouTube to Android, the latter powering over 70% of the world's mobile devices (StatCounter 2021). However, whether this number can be considered as a good performance for a platform owner, the resulting consequences to their whole collective ecosystems of all complementors, users, and society have recently come under controversy, with near-monopoly DPEs squeezing both their competitors (Khan 2017), complementors and employees (Karanović et al. 2021). For example, while a growing digital platform has mostly positive implications for its platform owner and users, it can also harm complementors through increased competition and decreasing market power (Rietveld et al. 2020). This renders our understanding of the performance of the whole DPE (comprising the collective of multiple autonomous and individually incentivized actors and platform technology) to an ill-defined, "wicked problem," with no optimal solution (Lowenthal 1992). However, an understanding of the integrated DPE performance is necessary: Looking at the different DPE actors, owners need feedback on their ecosystem's performance to make the best possible governance decisions. Conversely, complementors and users continually need to decide whether to further invest their resources by developing and maintaining complements or using the platform (Floetgen et al. 2020; Floetgen, Mitterer, et al. 2021). Similarly, society should understand how a DPE's performance is interrelated to making effective policy and regulatory decisions for our digital life.

Concomitant, research on DPE performance has not reached a theoretical convergence: First, each of the DPE research fields brings their own isolated foci and lenses to the scene, studying diverse issues such as governance mechanisms and boundary resource design (Karhu et al. 2018), network externalities and competition (Rochet and Tirole 2003), and technology leadership or transitions (Ozalp et al. 2018). Second, financial measures dominate empirical research on performance. It is equated with various metrics, such as market share or transaction volume, thereby mainly taking a profit-oriented, nontechnological governance perspective that neglects anteceding influences. Nevertheless, these isolated measures cannot represent the actual value realized by all ecosystem actors as they favor instrumental over humanistic objectives (Vargo et al. 2017). Conversely, both should be foundational to information system (IS) research (Sarker et al. 2019) and DPEs (Hein et al. 2020). Thus, DPE research and participation require a collective and connected understanding of its performance, as the performance of a DPE now does not lie within a single actor, technical component, or financial measure but in their integrated link (Floetgen, Novotny, et al. 2021; Tiwana 2013). This constitutes a learning opportunity to aggregate the knowledge across the diverse research areas for the DPE, IS and management domain, as their numerous constructs are likely connected. In sum, we aim to increase our understanding of collective DPE performance and its interrelations through causal links that shape their evolution over time based on the existing empirical research. Therefore, we focus on the following research question: *"Which isolated variables have been studied empirically which describe DPE performance, and what are the interrelations between them?"*

This work follows an empirical literature review approach to build a comprehensive and interrelated overview of performance measures for all ecosystem actors and the underlying technology. We extracted all variables and causal links (i.e., empirical relationships) among them from 132 articles in top IS, management, and economic outlets, following the established review approach and coding guidelines pioneered by Lacity et al. (2010). Out of these variables, 10 interrelated antecedents of DPE performance emerged through an iterative coding process, which shape our understanding of DPE performance. Thus, we combine empirical knowledge across largely unconnected areas and showcase boundary constructs within a nomological network that can bridge theories.

2 Theoretical Background

DPE research has not arrived at a consensus regarding the performance of DPE. However, this has not hindered its measurement; DPEs rely on different sets of metrics ranging from financial (i.e., revenue, profit, and market share); engagement (i.e., utilization and adoption rate); and network size to quality or heterogeneity measures (i.e., customer satisfaction, "killer applications", and resilience) (Floetgen, Strauss, et al. 2021; Jacobides et al. 2019). Nevertheless, how exactly do these interrelate in aggregate is unknown. Without setting prior measures into context, we cannot effectively isolate the true effects of independent variables on them nor control for confounding variables, consequently impeding comparisons of studies and building a cumulative body of knowledge (DeLone and McLean 1992).

Two multidimensional theoretical perspectives on ecosystem performance have also been proposed. Drawing on the ecological metaphor of ecosystem health (Rapport et al. 1998), productivity (e.g., ROIC), robustness (e.g., firm survival rates), and innovation or niche creation (e.g., created diversity) are promoted as central measures for ecosystem performance (Iansiti and Levien 2004). However, these are targeted at analyzing business or industry ecosystems composed of networks of firms, which do not have to be centered around a digital platform and, thus, lack technical units of analysis. A framework catering explicitly to platform ecosystems is offered by Tiwana (2013), where a set of nine metrics to analyze a platform's evolution over different timespans is presented. Inspired by systems research, it encompasses *resilience*, *scalability,* and *composability* in the short term; *stickiness*, *platform synergy,* and *plasticity* in the medium term; and *envelopment*, *durability,* and *mutation* in the long term, which are described as emergent properties that capture changes in actor behavior over time. These metrics were developed to help steer DPE evolution by identifying relevant signals and consciously managing tradeoffs. All metrics are observed at the technological level, applying to both platforms and complements. Additionally, some causal links between the measures are proposed (e.g., *composability* influences *plasticity*, which then influences *mutation)*, also described as a necessary condition. Nevertheless, being measured for technical components only caters to platform owners and complementors, omitting the user's perspective which also limits its applicability to innovation DPEs. Many measures (e.g., *composability*) do not apply to transaction contexts, such as product listings on the Amazon.com Marketplace. Moreover, the proposed evolutionary measures correspond mainly to operational (i.e., availability, error rates, integration efforts, system quality) and economic goals (i.e., net revenue, competitive survival/performance). Instead of adding the performance of all local entities toward combined ecosystem performance, a global perspective or ultima on performance is required to account for emergent effects. Moreover, this framework proposes initial connections and causal links between the measures. These also cannot be considered exhaustive and lack empirical evidence. Thus, while the measures capture relevant factors, we still lack a common understanding of the likely interrelated and dynamic nature of DPE *Performance*.

The last perspective on ecosystem performance can be adopted from the literature on value creation. Following Vargo et al. (2017), value-in-exchange (e.g., the price paid for a good or service) has dominated economic and business research since the 18th century. However, the rising importance of customer-centricity and service ecosystems has shifted the focus toward value-in-use. Value is conceptualized as a *phenomenological*, *cocreated*, *multidimensional,* and *emergent* concept. Thus, value is determined by the subjective experience of the beneficiary within its context and emerges from interactions among and exchange of resources across actors, including the beneficiary. Also, value comprises multiple dimensions beyond individual needs, including social and cultural norms. It cannot be determined ex-ante as a temporal and contextual phenomenon. As such, the whole system must be considered to understand the performance of the ecosystem as an emergent concept. This is also central for DPE, where unequal performance distributions, e.g., through a dominating platform owner, can derail entire ecosystems (Iansiti and Levien 2004).

3 Research Approach

We analyzed the empirical literature on DPEs to inductively form an understanding of DPE performance, thereby adopting the empirical study as our unit of analysis. Throughout the study, we followed established review guidelines (Okoli 2015) to ensure the comprehensiveness and robustness of our results. We organize our approach into three phases: *literature selection*, *data extraction,* and *synthesis*. Using a broad search strategy, we first identify a set of 132 empirical articles relating to DPE performance in top IS and management outlets for our analysis. Second, we extract all variables and causal links from them following established coding guidelines by Lacity et al. (2010). Third, we synthesize our data into a list of distinct master variables and causal links. We then inductively cluster into 11 DPE success dimensions. Summarizing their interrelations and impact on value realization, we propose a novel perspective on DPE success:

First, we conducted broad keyword searches in the Web of Science and SCOPUS databases following an inclusive approach, using the search string <<platform* OR ecosystem* OR network*>> in the Abstract/Title/Keywords fields. We limited our search to journals within the AIS Senior Scholars' Basket of Journals and the Financial Times Research Rank, thereby focusing on peer-reviewed information systems, business and economic articles adhering to the highest academic standard without a manual quality appraisal. We gathered an initial set of 1436 studies up to our cutoff date (January 5th, 2022).

Articles had to confirm two criteria to be included in our final set: (1) the article centrally encompasses a DPE according to the definition by Hein et al. (2020), and (2) there has been an empirical analysis of variables and causal links which contributes to research on DPEs and their actors. Thus, 1303 studies did not refer to DPEs (e.g., ideological, organizational, or internal IT platforms and business ecosystems without an IT focus; n = 639) or where the platform was not central to the article (n = 232) were removed from our list. Further articles were excluded as they did not report empirical results (n = 348) or did not contribute to research on DPE performance (n = 84). Of the remaining 133 studies, 16 had to be dropped from our sample during data extraction. They did not specify variables or empirical relationships between them. Including the 15 articles from the forward/backward search, our final set comprises 132 articles. We synthesize empirical knowledge irrespective of research methods, including 97 quantitative, 28 qualitative, and seven mixed-methods studies. In summary, our sample includes 56 transaction, 48 innovation and 28 hybrid platforms (Cusumano et al. 2019). Most analyzed DPEs followed for-profit models and showed centralized ownership structures, where the DPE was synonymous with the firm filling the platform owner role (e.g., Amazon Marketplace, Apple iOS), apart from minor exceptions such as blockchain platforms (Chen et al. 2020) and open-source ecosystems (Moqri et al. 2018). We acknowledge that the included DPEs differ in their architecture, governance, and business models. Therefore, our approach is based on the premise that there are fundamental tenants shared across all included systems relating to the collective performance of their ecosystems (Clark et al. 2007).

Second, all full texts were coded using MaxQDA to extract their variables and causal links following the approach pioneered by Lacity et al. (2010). To focus only on each study's central empirical insights, control variables, variables, and causal links from robustness checks and auxiliary or nonempirical analyses (e.g., simulation studies) were omitted. Two master lists containing all extracted variables (n = 898) and all causal links (n = 1044) were created according to our coding scheme (Table 1).

Code	Meaning
Definition	Name and explain how the variable was introduced in the paper, including how it was calculated or collected.
Unit of Analysis	*Platform*: Extensible codebase hosting digital complements and mediating interactions between complementors and users *Complement*: Digital artefacts extending the value proposition of the focal platform, including software applications, product/service listings and user generated content. *Owner*: Focal platform actor/organization enabling value co-creation among complementors and users through provision of the technical platform and governance mechanisms. *Complementor*: Suppliers of complementary products and services (complements), including developers and sellers. Single actors or organizations. *User*: Service beneficiaries of platform and complements, sometimes provision of user generated content (complements). Single actors or organizations. *Ecosystem*: A study's focal platform ecosystem, i.e., the socio-technical network of actors (complementors, users, owners) and complements spanned up by the digital platform
Variable Role	Variables were employed in three roles, including their causal links: *Dependent (DV):* Endogenous outcome influenced by independent and moderator variable(s). *Independent (IV):* Exogenous effect explaining the change in the dependent variable. *Moderator (MOD):* Exogenous effect influences the strength of the causal link between independent and dependent variables. Only defined for some causal links. *Causal Link:* Directed empirical relationship between an independent and dependent variable.
Causal Links	The effect a change in the causal link's independent had on its dependent variable. It can be quantifiable (variance theories) or a necessary condition (process theories). *Positive:* An increase in the independent variable increased the dependent variable. *Negative:* An increase in the independent variable decreased the dependent variable. *Note:* The link was insignificant/had no effect. *Matter:* A relationship between the two variables mattered.

Table 1. Coding scheme.

Lastly, we synthesized the results by inductively aggregating the extracted variables to a list of distinct master variables, constructs, and higher-order categories (of which we later call 10 "antecedents") with aggregated causal links following grounded theory coding protocols for constant comparison (Corbin and Strauss 2014), thereby arriving at a feasible level of abstraction for theory development without misrepresenting the results of individual studies. By following the approach developed by Lacity et al. (2010), we initially grouped variables referring to the same measure at a common unit of analysis into distinct master variables, e.g., the *Sales* of a single *Complementor* (Li et al. 2019). This reduced our list of 898 extracted variables to 413 master variables utilized across studies. To further reduce the complexity of our data, we then clustered master variables intended to measure the same concept into constructs. As an example, variables, such as *Complementor's Sales* (Li et al. 2019), *Market Share* (Tanriverdi and Chi-Hyon 2008), or *IPO likelihood* (Ceccagnoli et al. 2012), were grouped into a *Complementor Performance* construct, thereby arriving at a list of 85 constructs. Clustering was assumed as an iterative, bottom-up approach without an initial coding scheme to avoid a priori judgments. Following clustering, we again reviewed all causal links to assure that the relationships between clustered constructs were still true to the meaning of the underlying variables.

Thereby, we realized a common theme for numerous constructs across levels of analysis. We summarized them into interrelated higher-order categories (antecedents of DPE performance) that collectively characterize the current empirical body of knowledge on DPEs and serve to organize our review. Finally, we created a nomological network to structure the causal links logically and cohesively between the antecedents of DPE performance supported by repeated empirical data.

4 Findings

4.1 The 10 Antecedents of DPE Performance and their Operationalization

By grouping all empirically studied variables and constructs, we inductively identified *Performance* as the most prevalent higher-level category and the 10 higher-level categories of *Heterogeneity, Competition*, *Engagement*, *Governance*, *Quality*, *Network Size*, *Generativity, Architecture*, *Cost,* and *Motivation/Satisfaction* as antecedents of the performance category.

Variables that directly described *Performance* were analyzed in a third of our studies (86 out of 132), mostly in the role of the dependent variable (79 studies). The *Performance* category itself incorporated a range of variables capturing the value realized by the ecosystem's actors through transactions and usage. Thereby, most measures are related to business performance; capturing sales or downloads of the platform and its complements, sales, market share, or firm survival of the platform's owner and complementors; and its users' purchasing likelihood and expenditures. While only 31 of the 91 studies used variables to capture the ecosystem's value realization, economic measures were similarly prominent. Studies have analyzed overall transaction volume, market share, or complement sales. We found that 431 of the 1044 extracted causal links, or more than 40% of our data on empirical relationships, relate to influences on *Performance* itself. Table 2 shows all the direct causal links that influence the dependent *Performance* category across the other anteceding higher-level categories. Thereby, each causal link is stated with its dependent *Performance* construct, the independent construct of the respective success dimension, the number of studies wherein it was analyzed (#), and the subset of studies that found it to have a direct *positive* (+), *negative* (–), *matter* (M), or *none* (/) effect.

IV Dim	DV Performance Construct	IV Dimension Construct	#	+	–	M	/
Heterogeneity	Platform Performance	DPE Complement Composition	2	2			
		Platform Age	1		1		
	Complement Performance	Complement Age	4	2	1	1	
		Complement Type	5		1	4	
		Complementor Experience	1			1	
		Complementor Portfolio Composition	1			1	
		Complementor Type	1		1		
		DPE Complement Composition	1			1	
		DPE Maturity	1		1		
	Complementor Performance	Complementor Experience	2	2			
	User Purchasing	Complementor Type	1			1	
	DPE Evolution	DPE Tension	1			1	
	DPE Performance	DPE Complement Composition	1			1	
		DPE Maturity	1			1	
Competition	Platform Performance	DPE Complement Multihoming	1		1		
		Owner Strategy	1	1			
	Complement Performance	Complement Multihoming	4	2	1	1	
		Complementor Strategy	1		1		
		DPE Competition	4		1	2	1
		Owner Market Entry	2	2			
	Owner Performance	Owner Capabilities	1	1			
		Owner Strategy	3	1		2	
	Owner Value Capture	Owner Boundary Management	1			1	
		Owner Capabilities	1	1			
		Owner Market Entry	1	1			
		Owner Strategy	1	1			
	Owner Value Cocreation	Owner Capabilities	1	1			
		Owner Resources	1	1			
	Complementor Performance	Complementor Capabilities	1	1			
		Complementor Strategy	4	2	1	1	
		DPE Competition	2	1	1		
	User Purchasing	Complementor Strategy	2		1	1	
		DPE Competition	1			1	
		Owner Strategy	1		1		

IV Dim	DV Performance Construct	IV Dimension Construct	#	+	–	M	/
	DPE Evolution	Owner Boundary Management	2	2			
		Owner Strategy	1			1	
	DPE Performance	DPE Competition	3	1	1	1	
		DPE Complement Multihoming	1	1			
		Owner Market Entry	2		1	1	
		Owner Strategy	2	1		1	
	DPE Resilience	Owner Strategy	1			1	
Engagement	Complementor Performance	Complementor Engagement	3	2	1		
		User Engagement	1	1			
	User Purchasing	User Engagement	2	2			
	DPE Performance	Complementor Engagement	1	1			
		DPE User Engagement	1	1			
Governance	Complement Performance	Owner Governance Mechanisms	3	2	1		
		Owner Input Control	1	1			
	Owner Performance	Owner Governance Mechanisms	1	1			
		Owner Input Control	1			1	
	Owner Value Cocreation	Owner Boundary Resource Distribution	1	1			
		Owner Governance Mechanisms	1			1	
	Complementor Performance	Owner Boundary Resource Distribution	1			1	
	DPE Complement Performance	Owner Input Control	1	1			
	DPE Evolution	DPE Governance	2			2	
	DPE Performance	DPE Governance	1			1	
		DPE Openness	2			2	
		Owner Boundary Resource Distribution	1	1			
		Owner Governance Mechanisms	1	1			
		Owner Input Control	1		1		
Quality	Platform Performance	Platform Quality	1	1			
	Complement Performance	Complement Information	3	3			
		Complement Quality	9	8		1	
	Complementor Performance	Complementor Reputation	3	3			
		User Reputation	1	1			
	User Purchasing	Complement Information	1	1			
		Complementor Reputation	1	1			
		Platform Quality	1				1
		User Reputation	1	1			
Network Size	Platform Performance	DPE Complement Base	5	4	1		
		DPE User Base	1	1			
	Complement Performance	Complementor Portfolio Size	2	2			
	Complementor Performance	Complementor Portfolio Size	1			1	
	User Purchasing	DPE Complement Base	2	2			
		DPE Complementor Base	1	1			
		DPE User Base	1	1			
Generativity	Complement Performance	Complement Updates	6	5		1	
	User Purchasing	User Innovation	1		1		
	DPE Performance	DPE Generativity	1	1			
Architecture	Complement Performance	Complement Architecture	2	1	1		
	Owner Performance	Platform Architecture	1			1	
	Owner Value Capture	Platform Architecture	1			1	
	Complementor Performance	Platform Architecture	1		1		
	User Purchasing	Platform Features	1		1		
	DPE Complement Performance	Platform Features	1	1			
	DPE Evolution	Platform Architecture	2			2	
	DPE Performance	Platform Architecture	1		1		
		Platform Features	2			2	
Cost	Platform Performance	Platform Price	4		4		
	Complement Performance	Complement Price	4	1	3		
		User Effort	1			1	
	Owner Value Cocreation	Owner Effort	1			1	
	User Purchasing	Complement Price	2		2		
Motivation/ Satisfaction	User Purchasing	User Motivation/Expectations	1			1	

Table 2. Direct influences on DPE performance by the 10 antecedents.

4.2 Interrelations among the Antecedents of DPE Performance

We summarized the primary drivers of value realization studied in DPE research by detailing the causal links directed toward *Performance* from our 10 performance antecedents. Extending this view, our DPE performance model (Figure 1) details all direct causal links between the performance category. Thereby, nodes represent the DPE performance construct and its antecedents and edge the causal links. Both scaled proportionally to the number of studies wherein they were analyzed. Similar to Delone & McLean

(1992), we did not integrate aggregated trend measures ("positive", "negative" or "matter") into our Figure 1, as we cannot propose universally valid links yet. While some links exhibit strong patterns (e.g., *Engagement*, *Generativity,* or *Quality* are generally beneficial for *Performance*), they may not be valid across all platform contexts. To reduce complexity and visualize all causal effects in DPEs, we aggregated causal links from all actors, as is common for such causal models when aiming to show overall system behavior (Clark et al. 2007).

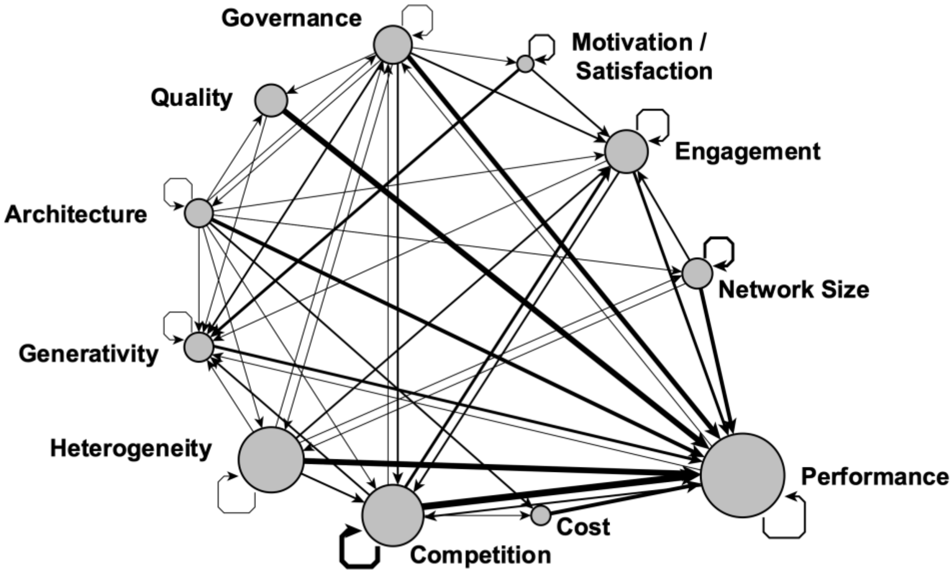

Figure 1. Nomological network of the antecedents of DPE performance

We make three observations. First, we found that the antecedents of *Performance* are not only direct antecedents of *Performance* but also antecedents of each other, thereby contributing to value realization in various ways and mediating their effects. For example, *Motivation/Satisfaction* was a major driver of *Engagement* and *Generativity*, thereby ultimately, *Performance*. Exemplary studies have shown how a user's motivation (Chen et al. 2018) drove their content contributions and loyalty. This underscores that humanistic goals in IS research may not only be an end in themselves (Sarker et al. 2019) but also drive future innovation and value realization. Second, several dimensions show self-reinforcing feedback loops, the most prevalent being *Competition*, *Network Size, Motivation/Satisfaction,* and *Performance*. For example, several studies about *Competition* have shown how actors use strategic moves in sequence, including owner's successive deployment of capabilities (Tan et al. 2015). Additionally, complementors may adapt their strategy based on competitive changes in their ecosystem (Pervin et al. 2019), such as owner's market entry (Wen and Zhu 2019). On the ecosystem level, strategic moves of competing platform owners, such as platform forking, may be intensified due to their potential to simplify multihoming (Karhu et al. 2018). Third, dimensions can also strongly moderate the causal links between them. Thereby, *Heterogeneity* was the most common moderator, followed by *Competition* and *Quality*. Regarding *Heterogeneity,* several studies have shown, for example, how the impact of reviews on sales varied across the platform and product types (Rosario et al. 2016; You et al. 2015).

5 Discussion

Extracting all variables and causal links from 132 empirical articles on DPE retrieved from top IS and management outlets, we inductively identified 10 interrelated antecedents of DPE *Performance* analyzed across individual social actors and technological entities and its collective ecosystem. We realize the need to study DPE *Performance* as an interrelated, sociotechnical, and dynamic concept.

Interrelated: Looking at our aggregate set of empirical studies, the 10 antecedents of DPE *Performance* affected value realization directly and indirectly (Figure 1); thus, all of them should be considered when analyzing a DPE's current *Performance* and future potential. Conversely, individual studies generally show a unidimensional conception of *Performance,* with single financial measures dominating as dependent variables across levels and units of analysis. Each study only considers a subset of our antecedents. Also, theoretically proposed evolutionary metrics, such as those by Tiwana et al. (2013, Chapter 7), do not cover the value realized by all ecosystem actors (i.e., users) and were not prevalent in our sample. Thus, while more holistic perspectives of DPE *Performance* may be theoretically acknowledged, empirical analyses are largely reduced to single, specific measures. This leads to logical discrepancies when abstracting findings based on financial measures to DPE *Performance*, as it is also criticized in management research on firm performance (Chet Miller et al. 2013). Instead, an interrelated perspective is imperative for both theory and practice. Academically, it aids the formation of a cumulative body of knowledge, as we cannot isolate the effects of independent variables on *Performance* if we measure it with different dependent variables without knowing their interrelations (DeLone and McLean 1992). Practically, the literature on performance measurement and management has long proposed multidimensional perspectives that combine past-oriented financial measures with operational metrics shaping future performance (Neely et al. 1995), such as customer satisfaction, process quality, and innovativeness, exemplified in established instruments like the balanced scorecard (Kaplan and Norton 2005).

Sociotechnical: DPEs are sociotechnical systems composed of collectives of social actors and technological entities. Our findings also show that DPE *Performance* needs to be understood as a sociotechnical construct, as our dimensions comprised variables measuring both social actors' behavior (e.g., governance mechanisms and user engagement) and technical properties (e.g., platform or complement architecture) that influence value realization. Simultaneously, DPE *Performance* measurement cannot be reduced to technical systems as in Tiwana (2013, Chapter 7). The technical attributes of the digital platform and its complements are what separate it from business ecosystem success frameworks (Iansiti and Levien 2004). This sociotechnical perspective should also capture the achievement of both instrumental and humanistic goals across actors, with the latter, however, being understated in our data, just as in larger IS research (Sarker et al. 2019). To illustrate, nine studies analyze *Performance* measures relating to users' purchasing likelihood and expenditure without estimating the value they realize from DPE adoption and participation, which will concern users in real life. Nevertheless, considering our *Performance* antecedents in aggregate can address both humanistic and instrumental goals through dimensions, such as Motivation/Satisfaction.

Dynamic: Figure 1 reveals how all our antecedents of DPE *Performance* are interrelated, thereby showing the potential for self-reinforcing and larger, more complex feedback loops. Introducing changes in single antecedence is likely to set off different effects, which are difficult to anticipate. For instance, changes to Governance mechanisms, such as input control, might increase complement *Quality* in a DPE (Song et al. 2018). However, they can also raise developer costs, promoting desertion and reducing engagement (Tiwana 2015). Thus, linearly extrapolating from prior findings is inadequate to predict future system behavior (Benbya et al. 2020). Further complexity is introduced as actors are likely to change their behavior depending on the value. They realize that in DPE participation (e.g., causal links outgoing from our *Performance* dimension) is understated in prior work. This shows the need for more systems approaches in DPE research, which are virtually nonexistent today beyond studies of network effects (Gretz et al. 2019), to help us understand how the interplay of the different antecedents shapes DPE *Performance* over time. Research is needed on, e.g., the ending conditions (i.e., balancing loops) of these self-reinforcing effects since these effects most likely do not increase to infinity but might end at some point.

6 Implications, Limitations and Future Research

Our findings have profound **implications** for both DPE **research** and **practice**. From a theoretical perspective, our understanding of DPE *Performance* provides a novel, comprehensive view of DPE performance's interrelated, sociotechnical, and dynamic nature. The 10 identified antecedents of DPE *Performance* affected value realization directly or indirectly and should be considered together to eliminate confounding variables and make research results more comparable. Second, the antecedents highlight DPE *Performance* because of interactions between both social actors and technological entities and cover instrumental and humanistic goals, thereby strengthening the sociotechnical perspective of IS for DPE research (Sarker et al. 2019). Third, we underscore how the dynamic nature of DPE success introduces challenges for its measurement and management through complex feedback dynamics and highlight the need for systems approaches in its further study. Our DPE success model contributes to a holistic understanding of the interrelated antecedents relevant to a collective ecosystem's performance from a practical perspective. This is relevant for all DPE actors, such as for platform owners, our framework contributes to improved DPE governance, as our analysis has shown that managers often misjudge cause–effect relationships in complex systems (Sterman 1989). Our model allows platform owners to measure the drivers of value realization in their ecosystem to combat this complexity. Thus, identifying further levers for growth and anticipating the possible effects of improved decision making. Also, complementors and users can leverage our framework to increase their value realization in DPEs. It provides an overview of measures that may impact their *Performance*. Thus, they can judge the attractiveness of a DPE when making adoption, multihoming, or continued usage and development decisions.

Naturally, our approach is not without **limitations**: Just as prior studies following our approach (Lacity et al. 2010), we prioritize the significance of causal links over their effect sizes, the actual strength of the causal relationship between two variables (Cohen 2004), which would be important when comparing causal links that implicate variables in diverging ways. While we agree that establishing effect sizes should be the end goal of empirical inquiries, this is not possible when integrating quantitative and qualitative studies. We aimed to cover both the process and variance theories on DPE *Performance*. Moreover, although we covered a large body of research in our review (132 studies), our dataset is not exhaustive. While a larger forward/backward search could have been conducted, we were able to attribute exemplary articles published beyond our cutoff date to them. Thus, our work mainly aimed to form an initial understanding of DPE *Performance*.

Our findings open three avenues for **future research** on DPE performance. First, we want to encourage future research to go beyond a single DPE's *Performance* by studying, e.g., the coevolution of DPEs and their environments. In our sample, levels of analysis beyond the focal platform's ecosystem, such as its encompassing market or "category ecosystem," were included only in 16 of 132 studies and, thus, largely excluded. However, ecosystems do not exist in the cavity. Thus, they are necessarily also shaped by the environments and ecosystems. While we excluded exogenous influences from our analysis due to lack of data and to focus on our approach, they are important. DPEs can also shape their larger category ecosystems, e.g., by enabling the emergence of competitors through platform forking (Karhu et al. 2018) or through co-evolving in exchange with external heterogeneous actors through a distributed tuning of boundary resources (Eaton et al. 2015). Thus, we encourage the DPE research field to aim to study performance and value creation within single platform ecosystems and explore their emergent dynamics at higher levels of analysis, and thus their contributions to society as a whole. Second, researchers could gain further insights into the generalizability of knowledge across platform types and contexts by incorporating (i.e., positive, or negative) trends of causal links. However, our findings uncovered a common core of relevant causal links explaining the interrelations of antecedents of DPE *Performance*. We also found that causal links were not neutral across contexts. As an example, direct network effects on the complementor side ranged from negative trend for video game consoles (Kretschmer and Claussen 2016), over no significant effect for Taobao (Chu and Manchanda 2016), to a positive trend for Kickstarter (Thies et al. 2018). Thus, analyzing the trends of causal links across different platform contexts could ultimately reveal which dimensions are especially imperative for the performance of the transaction, innovation, or hybrid DPEs and may also lead to the formation of new DPE typologies based on shared sets of causal links and their trends driving their evolution. Lastly, the establishment of effect sizes for causal links between performance antecedents at the ecosystem level could be leveraged for future systems research on the evolution of DPE using approaches, such as System Dynamics (Fang et al. 2018).

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