

Platform Openness: A Systematic Literature Review and Avenues for Future Research

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Abstract. Open platforms such as Facebook or Android have stimulated innovation and competition across industries. Information systems literature has analyzed platforms from a variety of perspectives. The aim of this paper is to synthesize and integrate extant interdisciplinary research on the concept of platform openness. Towards this end, we conducted a literature review and analyzed the results with deductive and inductive coding approaches. We identified five distinct themes: measurement frameworks, implementation mechanisms, drivers for opening and closing platforms, trade-offs in designing openness, and the impact of changing openness on ecosystems. We propose three avenues for future research: finding the optimal degree of platform openness, integrating perspectives on accessibility and transparency, and analyzing the influence of openness and other factors with configurational theories. This paper contributes to research on platforms by laying out the main themes and perspectives in the research stream of platform openness and by identifying areas for future research.

Keywords: Platform Openness, Digital Platforms, Platform Ecosystems

1 Introduction

Digital platforms have transformed entire industries by leveraging the concept of open innovation [1] and have stimulated generativity¹ and competition [2, 3]. The cases of the social network platforms MySpace and Facebook are prototypical examples for the competitive advantages of open platform strategies. While MySpace kept their system closed, trying “to create every feature in the world” [4] on their own, Facebook decided in 2007 to open themselves to a worldwide pool of third-party developers, allowing them to build applications on top of the social networking platform [5]. Six months later, 8.000 third-party applications had been added and one year later, Facebook surpassed MySpace in terms of unique monthly visitors [6, 7]. When Apple initially released the iPhone with its iOS² operating system in 2007, it was closed to external developers but soon after, Apple released an official Software Development Kit (SDK)

¹ We refer to generativity as “a technology’s overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences” [2].

² Until 2010: iPhone OS

and set up a distribution channel for third-party applications, the Apple AppStore [8]. Google's Android operating system entered the market of mobile platforms later but was released under an open source license and came with a less restrictive application marketplace. [9]. In 2010, Android first surpassed iOS in terms of worldwide smartphone sales and has remained the dominating mobile platform since then (with a market share of 87.8 % as of 2017) [10].

These real-world examples show the strategic role played by platform openness. Information Systems (IS) literature has analyzed the phenomenon of platforms from a variety of perspectives [3]. The concept of platform openness is commonly referred to as placing restrictions on the development, commercialization, or use of a platform [11]. More specifically, platform openness is controlled by platform owners through the use of platform governance mechanisms, such as "deliberate regulations and rules about access and boundary control" [12]. In IS literature, platform openness has started to gain traction in the last years but each study focuses on different aspects [11-17]. This is aggravated by the fact that relevant insights are also to be found in the neighboring literature streams of management [18-22] and computer science [23-25]. Hence, IS research lacks an integrated view of different, inter-disciplinary perspectives on platform openness. Due to the fragmentation of knowledge on platforms, scholars have called for consolidating extant research perspectives (see, e.g., de Reuver, Sørensen and Basole [3]).

The purpose of this paper is to synthesize the current state of research and to integrate different perspectives on platform openness in IS literature and neighboring literature streams. To this end, we conducted a systematic literature review and analyzed the resulting publications with deductive and inductive coding approaches. We find that literature focuses on technological accessibility but neglects the perspective of transparency. Furthermore, we identify five distinct themes: measuring platform openness, mechanisms for implementing openness, drivers for opening up or closing down, trade-offs in designing the degree of openness, and the impact of changing degrees of openness on platform-centric ecosystems.

The remainder of this paper is structured as follows. The first section describes the design of the literature review and the employed coding approach. The second section structures the analyzed publications with a deductive coding scheme based on different research perspectives. Subsequently, we present and discuss the identified research themes. Finally, we present and discuss areas for future research and conclude the review.

2 Design of the literature review

For conducting our literature review, we followed the guidelines of Webster and Watson [26]. Drawing on the typology of literature reviews developed by Paré, Trudel, Jaana and Kitsiou [27], our review constitutes a descriptive review since our goal was to synthesize and represent the current state of the art of research on platform openness. We restricted our review to the openness of digital platforms following the

conceptualization of de Reuver, Sørensen and Basole [3] as “purely technical artefacts where the platform is an extensible codebase, and the ecosystem comprises third-party modules complementing this codebase”. We focused on the journals included in the *AIS Senior Scholars’ Basket of Journals*. To include the perspective of management, we also selected the journals *Management Science* (MS) and *Organization Science* (OS). We conducted a search with the term “platform AND open*” on titles, abstracts, and keywords and screened the abstract of 53 publications, resulting in eleven selected articles. If the relevance for our review was unclear after reading the abstract, we read the full article. In a second step, we extended our search to highly ranked IS conferences and the IEEE Explore Digital Library to include the perspective of computer science. We restricted our search to the more specific term “platform AND openness” in order to get a manageable set of publications, resulting in 685 potentially relevant articles. Again, we screened the abstracts in order to decide whether to include the article, resulting in 14 selected publications. Afterwards, we performed a forward and backward search on the articles that were selected so far, leading to the inclusion of another 48 articles. Finally, our sample comprised 73 relevant articles (see **Table 1**).

Table 1. Summary of the literature search process

<i>Outlet</i>		<i>Search</i>	<i>Hits</i>	<i>Selected</i>
Top journals	AIS Basket of Eight	“platform AND open*” in Title Abstract Keywords	34	8
	OS		8	1
	MS		11	2
IS conferences	ICIS	“platform AND openness” in Title Abstract Keywords	28	5
	ECIS		24	3
	PACIS		12	3
	HICSS		351	2
	WI		7	0
	AMCIS		35	0
Other outlets	IEEE Xplore	Forward and backward search	228	1
	Journals		-	20
	Conferences		-	18
	Dissertations		-	2
	Books		-	4
	Other		-	4
<i>Total</i>			738	73

In a next step, we iteratively coded the articles, using both a deductive and inductive approach [28]. Our deductive scheme was adapted from the guidelines of Bandara, Furtmueller, Gorbacheva, Miskon and Beekhuyzen [29] and comprised definition and measurement frameworks of platform openness, employed research methodologies, future work, and distinct levels of openness. Regarding our inductive approach, we engaged in open coding, axial coding, and selective coding to capture and distill concepts emerging from our sample of publications [28]. Based on 50 definitions of

platform openness from our article sample, we clustered recurrent themes and extracted three distinct levels and two dimensions in order to classify extant research perspectives. Furthermore, five distinct research themes emerged throughout our open coding process³. Based on our classification and the identified themes, we derived promising avenues for future research. **Table 2** gives an overview of the results of our literature review, our approach to generate these results, and the respective section of this paper.

Table 2. Overview of the results of this literature review

<i>Section</i>	<i>Results</i>	<i>Approach</i>
3	Classification of extant research	Inductive and deductive coding of identified literature
4	Central themes in extant research	Inductive and deductive coding of identified literature
5	Avenues for future research	Analysis of classification table from section 3 and identification of unanswered questions in central themes from section 4

3 Research perspectives on platform openness

Of our analyzed articles, 68 % employ an explicit definition of platform openness (see, e.g., Eisenmann, Parker and Van Alstyne [11], Boudreau [18], Anvaari and Jansen [23], Arakji and Lang [31]) while only 30 % use or introduce a qualitative or quantitative framework for measuring openness (see, for example, Benlian, Hilbert and Hess [13], Ondrus, Gannamaneni and Lyytinen [17], Anvaari and Jansen [23]). In terms of research methodologies, we distinguish between qualitative, quantitative, mixed, design science, and conceptual research approaches [29]. A 33 % of the papers are based on qualitative research methods, such as single or multiple case studies conducted with, for example, app stores [14, 32] or mobile payment platforms [33, 34]. Quantitative research methods are employed in 31 % of the papers, comprising mostly econometric analyses [7, 15], surveys [35], and simulations [31, 36]. Conceptual and mixed approaches are represented with 19 % [37] and 13 % [38], while design science strategies are only used in 4 % of the analyzed publications [16].

Based on different definitions of platform openness, we identified three distinct levels and two dimensions. Openness can be implemented on three levels: organization, technology, and users. The organizational level “relates to the strategic involvement of key stakeholders who control the platform and provide the platform services to different user groups” [17]. The technology level refers to the provisioning of “technical means

³ For instance, the theme “trade-offs in designing the degree of openness” was derived from codes such as “Decisions to open a platform entail tradeoffs between adoption and appropriability” [11] or “[...] it may be a trade-off between attracting a developer community [...] and ensuring high standards” [30].

for complementary providers (i.e. companies that provide alternative technology, products or services for the platform) to access the core functions of the platform” [39].

Table 3. Identified research perspectives on platform openness

<i>Article</i>	<i>Organization</i>		<i>Technology</i>		<i>Users</i>	
	Acces- sibility	Trans- parency	Acces- sibility	Trans- parency	Acces- sibility	Trans- parency
Top journals and IS conferences						
Benlian, Hilkert and Hess [13]			X	X	X	X
Boudreau [18]	X		X			
Boudreau [20]			X			
Casadesus-Masanell and Llanes [7]			X		X	
Foerderer, Schuetz and Kude [40]			X	X		
Furstenau and Auschra [41]			X		X	
Gawer [37]			X			
Ghazawneh and Henfridsson [14]					X	X
Hilkert, Benlian, Sarstedt and Hess [42]			X	X	X	X
Karhu, Gustafsson and Lyytinen [43]			X			
Kazan and Damsgaard [34]	X				X	
Kuebel and Zarnekow [44]	X		X		X	X
Kwon, Oh and Kim [36]					X	
Niculescu, Wu and Xu [45]			X	X		
Nikou, Bouwman and de Reuver [46]			X			
Ondrus, Gannamaneni and Lyytinen [17]	X		X		X	
Park, Lee and Lee [47]			X		X	
Parker and Van Alstyne [48]			X		X	
Parker and Van Alstyne [21]			X		X	
Parker, Van Alstyne and Jiang [15]			X		X	
Schreieck, Wiesche and Krcmar [49]			X			
Song, Baker, Wang, Choi and Bhattacharjee [38]			X			
Wessel, Thies and Benlian [12]					X	
West [50]	X	X	X		X	
Other papers						
	14	6	54	11	33	5
<i>Total articles</i>	19	7	62	15	40	9

On the user level, openness “is defined by the level of discrimination that the platform exercises against different segments of the potential customer base” [17]. Furthermore, openness can be categorized as either providing accessibility or

transparency [23, 44, 51]. Accessibility focuses on the degree of discrimination against different roles and determines whether providers, third-party developers, or end users are allowed to join and access the platform [23, 51, 52]. Transparency, on the other hand, relates to the “understanding of what is happening and why” and thus determines whether platform-related governance decisions are comprehensible [23, 51]. On each of these levels, a platform can be open or closed. Furthermore, for each of these levels, the platforms’ degrees of accessibility and transparency can be determined. On the technology level, for example, accessibility refers to the degree to which third-party developers are allowed to contribute to the platform by building new applications. Transparency, on the other hand, refers to the degree to which it is made understandable to these developers how and under what conditions third-party applications can be created and distributed through channels like the platform’s application marketplace. Similarly, on the user level, accessibility reflects the possibility for users to participate on a platform (such as Uber), while transparency refers to how and to what extent the rules for participating are made comprehensible. The resulting coding matrix of our publication sample shows that most papers focus on accessibility on the technology and user level, while the dimension of transparency on all the levels is mostly neglected, especially on the user and organization level (see **Table 3**).

4 Central themes in research on platform openness

4.1 Measuring platform openness

Platform openness should not be measured as a binary variable, but rather depicted as a continuum [50]. As already introduced earlier, Eisenmann, Parker and Van Alstyne [11] distinguish between four distinct roles in ecosystems (sponsors, providers, complementors, and end users) towards which platforms can be open or closed. Still, even in platforms that are seemingly open towards a specific role, openness may still be restricted to a certain degree. The source code of the operating system Linux, for example, is accessible to everyone, but contributors need to adhere to strict governance processes comprising code review and quality appraisal [18, 24]. The framework of architectural openness developed by Anvaari and Jansen [23] considers this distinction. The architecture of a platform is divided into four layers: kernel, middleware, native applications, and extended applications. The framework shows whether it is possible to modify, extend, or integrate each layer and whether permission by the platform owner is needed for these activities.

Other frameworks focus on specific architectural aspects. Schlagwein, Schoder and Fischbach [16] propose a matrix-based framework for measuring the openness of platform resources along the dimensions of access and control. Access to resources can be exclusive, on a group-basis, or open. Control of resources can be exercised by the platform owner, by a group, or by an external actor. Ghazawneh and Henfridsson [14] focus on distribution channels and present a typology for digital application marketplaces. They distinguish between closed, censored, focused, and open marketplaces with different regulatory designs. Taking the perspective of

complementors, Benlian, Hilkert and Hess [13] develop an instrument for measuring complementors' perceived platform openness along the dimensions of technical platform, distribution channel, accessibility, and transparency.

4.2 Mechanisms for implementing openness

For structuring mechanisms for implementing openness, we draw on the notion of horizontal and vertical openness by Eisenmann, Parker and Van Alstyne [11]. Horizontal openness refers to allowing rival platform's users to interact with the own platform or allowing additional parties to participate in the platform's commercialization or technical development. Vertical openness refers to granting third-party developers access to resources for developing complementary applications.

For implementing horizontal openness, platform owners choose to establish interoperability with other platforms in order to increase their market potential, either as part of a competitive or collaborative strategy (see, for example, the interoperability agreement between the instant messaging services of Yahoo and Microsoft) [11, 17]. Another strategy, that is especially attractive for mature platforms, consists of licensing the own platform to additional providers while retaining control over the platform's technology (see, e.g. Microsoft Windows) [11]. Going even further, platform sponsors may also give up ownership over technology and invite partners for joint sponsorship and development (see, for example, the Linux operating system or other open source software projects) [11, 18, 50].

Vertical openness is implemented through boundary resources [49, 53], i.e. the "software tools and regulations that serve as the interface for the arm's length relationship between the platform owner and the application developer" [8]. In practice, this includes technical boundary resources such as Application Programming Interfaces (APIs), SDKs and non-technical boundary resources such as technical documentation and support or the provided community [54-56]. Furthermore, distribution channels such as app stores are offered to facilitate the diffusion of third-party complements [14]. From a policy perspective, platform owners can restrict access to resources, e.g., by charging usage fees or by reserving access to selected groups of developers [18, 57]. In addition, they can exercise content control on distribution channels through prescreening, review, and approval processes [14, 58, 59].

4.3 Drivers for opening up or closing down

Platform owners decide to open up platform boundaries when seeking to stimulate growth by increasing their user base [17]. A larger end user base leads to higher market shares while a higher developer base allows the platform owner to access external resources and stimulate innovation even or especially when lacking own competencies to innovate [60, 61]. In the case where changing the level of openness is complicated through technological or cultural constraints owners tend to more liberally open the platform when expecting an increasing developer base [15, 17]. The need to comply with or the uncertainty about legal regulations may also be factors to open or close a

platform (see, e.g., the lawsuit provoked by Microsoft’s decision to bundle Windows with Internet Explorer) [41, 53, 60].

The degree of openness is not a fixed, static choice, but may vary over time, shifting from closed to open or vice-versa [30, 62]. Platform-to-platform competition, for example, where each platform intends to attract more developers may incentivize platform owners to increase openness [7, 22]. On the other hand, certain features of a platform may become so valuable over time that the platform owner does not gain any more benefits by keeping these parts fully open [15]. This can be observed at the practical examples of platforms such as LinkedIn, Twitter, or Instagram. In 2015, all three of these platforms announced the discontinuation of a large portion of their formerly open APIs, mentioning, among others, competitive threats to their businesses [63-65]. This led to the shutdown of several third-party application who could not afford the transition to the companies’ partner programs or whose application use cases did not meet new terms of service [66].

4.4 Trade-offs in designing the degree of openness

Two central trade-offs need to be balanced by platform owners: adoption vs. appropriability⁴ [15, 50] and diversity vs. control [18, 30, 68]. First, as already shown, higher openness leads to adoption by complementary developers. Higher openness however also reduces switching costs and increases inter-platform competition, thus making it more difficult to appropriate profits [50]. Second, higher openness leads to more diversity of complementary applications through open innovation. On the other hand, the platform owner may lose control over the quality of applications and be faced with complex coordination of resources and strategic interests [18, 20]. During the so-called “Atari shock”, for example, a high number of low-quality games for the video gaming platform Atari that exercised no content control at all led to its eventual demise [69].

4.5 Impact of changing degrees of openness on platform-centric ecosystems

On the sponsor level, higher platform openness leads to the necessity of increasing modularity and more complex system architectures on the technology level [70]. In collectively sponsored platforms, increased openness on the sponsor layer may be a source of conflict resulting from deciding on the inclusion of new sponsors [33]. Sponsors and providers may also benefit from lower development costs through effectively outsourcing innovation [15, 71].

Several qualitative and quantitative studies show that higher openness leads to increasing adoption among complementors and a high quantity and variety of complementary applications [7, 17, 19, 44, 59, 72-75]. Puvvala, Dutta, Roy and Seetharaman [54] support these results and show the importance of provisioning tooling and reasonable license costs. A case study on the crowdfunding platform Kickstarter

⁴ We refer to appropriability as “the ability of different stakeholders to retain for themselves the financial benefits that arise through the exploitation of an innovation” [67].

shows that increased openness on the complementor side may lead to a destabilized ecosystem [12]. After relaxing the screening processes for new campaigns on their platform, campaign success rates decreased and competition between project creators increased because of an altered ratio of campaigns to backers. A particular challenge lies in determining the right degree of openness. While granting access to complementary developers is associated with a rising innovation rate, after a certain threshold the rate decreases again in a curvilinear manner due to excessive competition between developers [18, 20].

On the user level, Müller, Kijl and Martens [32] argue that stricter content control leads to higher quality of third-party applications but on the other hand, higher competition induced by low control also leads to lower prices for end users. In terms of end user adoption, Hagiü [76] and Moon and Choi [9] suggest that lower openness may induce higher use adoption due to increasing competition. Finally, the openness towards third-party developers does not influence adoption among end consumers, as shown by Nikou, Bouwman and de Reuver [46].

5 Avenues for future research on platform openness

In this section, we point out and discuss central avenues for future research that appear promising based on our literature review. First, we call for further research on finding the optimal degree of platform openness. Second, we suggest integrating perspectives on accessibility and transparency. Third, we discuss the adoption of novel research methodologies in the context of organizational and technical configurations and the role of platform openness.

The findings of Boudreau [18] and Parker, Van Alstyne and Jiang [15] characterize the relationship between innovation and openness as curvilinear, suggesting that platform openness can be optimized [13]. However, little is known about the factors that influence the threshold at which innovation decreases again. The evidence presented by Boudreau [18] is based only on data on handheld computing systems from 1990-2004 and has since then not been verified nor replicated using data on more recent platforms. As of today, recent examples of platforms with varying degrees of openness (see, as already discussed: Hofer-Shall [63], Instagram [64], Trachtenberg [65]) provide data that allow for reexamining the question of optimal openness and its accompanying conditions. The results could be valuable for theoretical advances on platform research as well as for practical guidelines on effective platform governance.

As our coding has shown, few articles consider the transparency dimension on openness, such as technical documentation, communication with end users, or transparency of market mechanisms. Yet research has demonstrated that aspects of transparency considerably influence platform adoption among complementors [54, 77, 78]. Hence, integrating perspectives on accessibility and transparency regarding platform openness promises to be a fruitful research area. For example, different best practices regarding the implementation and promotion of transparency could be identified through a multiple-case analysis of successful platforms. This could yield

insights on the design of successful platform ecosystems for end users and complementors, ultimately resulting in higher platform adoption.

Several studies have identified and discussed drivers and impacts of changing degrees of openness. However, we argue that the complex causal interplay of these drivers and organizational and technical preconditions in the firms and platforms influence the degree of openness, rather than stern linear relationships (see Vis [79] for a detailed discussion). For this reason, we call for the use of research methods that take into account equifinality and complex non-linear relationships, such as fuzzy-set Qualitative Comparative Analysis (fsQCA) [80]. FsQCA with platforms as unit of analysis has been employed by, for example, Dellermann and Reck [81], Dellermann and Reck [82] and Dellermann, Jud and Reck [83] for analyzing user loyalty, platform governance, and perceived risk. Future research could examine the effect of the interplay of openness and other factors such as the number of sides or the amount of partners on successful or unsuccessful platform launches [84], deriving relevant insights for practitioners.

6 Conclusion

The goal of this paper was to synthesize the current state of research on platform openness and to identify avenues for future research. Literature analyzes platform openness on different levels and dimensions, but neglects aspects of transparency. The main themes comprise measurement frameworks, implementation mechanisms, drivers for opening and closing platforms, trade-offs in designing openness, and the impact of changing openness on ecosystems. Based on our results, we propose three distinct issues for future research: finding the optimal degree of platform openness, integrating perspectives on accessibility and transparency, and analyzing the interplay of openness and other factors with novel research methods.

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