The Openness of Smartphone Software Platforms – A Framework and Preliminary Empirical Findings from the Developers' Perspective

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Abstract: Application developers are of growing importance to ensure that smartphone software platforms gain or maintain a competitive edge. However, despite the increasing research interest in platform openness, previous research attempts have neglected to investigate the perspective of third-party developers. This paper contributes to a more sophisticated understanding of the third-party developers' individual perception of platform openness by identifying concrete facets of openness and evaluating their impact on the developers' work. For this purpose, a comprehensive qualitative investigation and a quantitative survey were undertaken. Based on our findings, we discuss practical implications regarding the management of third-party developers in smartphone platform ecosystems.

1 Introduction

The growing dynamics of software platform ecosystems has become particularly striking in the smartphone sector. Despite smartphone sales' overall growth of 72% in 2010, the previously dominant Symbian platform's market share eroded significantly due to the emergence of a new generation of software platforms like Android OS and iOS [Ga10]. However, these new platforms' overwhelming success cannot only be attributed to the hardware's superior quality or its built-in features, but should rather be attributed to the software platforms' attractiveness. By establishing open software platforms that allow third-party developers to create applications and distribute them over the platforms' built-in marketplaces, Google and Apple both managed to create prospering ecosystems around their smartphone operating systems. Consequently, Apple's *iOS App Store* and Google's *Android Marketplace* already had 350,000 apps (iOS) and 280,000 apps (Android) available at the beginning of 2011, while, with only 50,000 available applications, Symbian's *OVI Store* fell far short [An11, Ap11, Di11].

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These statistics illustrate that the availability of a comprehensive set of "apps", or more generally speaking complementary software applications, has become one of the key success factor for smartphone software platforms. However, the management of the platform ecosystem, which is composed of the platform provider, third-party developers, and end-users, is a difficult task due to the involved indirect network effects: On the one side, a software-based platform product's attractiveness for end-users is strongly correlated to the availability of complementary applications. On the other side, third-party developers (whom we refer to as *complementors*) are only willing to produce complementary applications if a platform provides an adequate potential for expected revenues[1] [CG93, RT03].

The difficulty of managing complementors and finding the right degree of openness was also emphasized by Tiwana et al (2010), who note that *"governing platforms requires a delicate balance of control by a platform owner and autonomy among independent developers"* (p. 676 f.) and, hence, suggest examining the *"formal and informal mechanisms implemented by a platform owner to encourage desirable behaviors by module developers"* (p. 680) [TKB10]. Most appropriately, such examinations should include the perspective of platform providers as well as the developers' perception of these mechanisms. However, previous contributions on the openness of platforms (see next section for a review) have focused on the providers' perspective and neglected to investigate the developers' perspective, so far.

Given these calls for research and the research gap identified above, this paper aims to contribute to a more sophisticated understanding of the complementors' individual perception of platform openness. Hence, our research questions are:

(1) What is platform openness from the perspective of third party developers?

(2) Which facets of platform openness constrain or advance the work of developers?

The remainder of this paper is structured as follows: The next section develops the theoretical basis of this work drawing on literature on openness in general and vertical platform openness in particular. We then describe the methodology and results of our two-step approach including qualitative and quantitative research methods. In the concluding section, the paper points out implications and discusses limitations together with starting points for future research.

2 Theoretical Foundation & Background

[1] Complementor's revenues can result from a multitude of monetization options, like selling applications, advertising, contract development, to name the most important options.

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The term platform has been used to describe a multitude of differing concepts, such as supply chain platforms (e.g. in the automotive industry) or internal product platforms (e.g. in the context of modularization and customization) [Ga09]. However, our idea of smartphone software platforms grounds on the concept of *multi-sided industry platforms* which are defined as *"products, services or technologies […] that serve as foundations upon which other firms can build complementary products, services or technologies"* (p. 54) and that *"facilitate transactions between different sides of the markets"* (p. 57 f.) [Ga09]. Accordingly, smartphones together with its operating systems (e.g. Android) and the associated distribution channels (e.g. Android Marketplace) form the foundation of the smartphone platform ecosystems with platform providers, third-party app developers and end-users as participants.

2.1 Related Work on Platform Openness

Eisenmann et al. (2009) define that a software-based platform should be considered open *if the contribution, the development, the usage, and the commercialization is not restricted, or if all existing restrictions are reasonable and equally applied to all participants* [EPV09]. Based on this definition, two distinct ways of opening a platform can be distinguished [Bo10]: On the one hand, opening a platform *horizontally* means giving up some control by licensing the platform to competitors, or integrating further platform sponsors. On the other hand, granting external developers access to the market of complementary applications is regarded as *vertically* opening a platform. However, since our research interest focuses on openness as a way to manage complementary contributions, we limit the following review of related work to vertical platform openness[2].

The problem of finding the right degree of vertical platform openness arises from a fundamental trade-off known as "*diversity vs. control*" [Bo10]. When a platform is inherently dependent on a continuous supply of complementary innovations, such as the previously mentioned new generations of smartphone operating systems, opening a platform vertically to external developers potentially increases the complementary innovations' diversity [Ch03, Hi05]. However, opening a platform vertically and the resultant loss of control could pose problems for a platform provider. First, the orchestration and coordination of resources become more complex, simply because more players and interests are involved [AC10, Gr96]. Second, by delegating the production of complements to external developers, the platform provider also loses his control over the complementary platform features' agenda and, as a result, also over possible fields of application for the platform.

[2] For contributions on horizontal platform-openness, see e.g. [CMR92, SV98] or [Fa07].

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Besides contributions on platform openness's regulatory implications [EK06] and contributions on openness in platforms' technological architecture (e.g. [SSF10], or [AJ10]), contributions from the strand of literature on platform strategies have specifically focused on questions of vertical platform openness. Building on findings regarding general technology strategy, Cusumano and Gawer (2002) identified facets of vertical openness (although they not yet call them such) as part of their platform leadership levers [CG02]. West (2003) thereafter introduced the platform openness concept as a continuous degree, contrary to the idea of openness as either completely closed or open [We03]. Later, platform openness was considered an instrument to steer external innovation [BL09, Bo10, EPV09, PV09] and the resulting competitive advantages [EK06]. However, despite this constantly increasing research interest, to our knowledge there are as yet no investigations from the perspective of developers.

2.2 The Concept of Perceived Platform Openness (PPO)

Due to the lack of existing findings on the complementors' perception of platform openness, we define PPO as follows:

> *Perceived platform openness (PPO) is a platform's degree of openness as perceived by its complementary application developers.*

However, recognizing that openness is a rather abstract term, we intend to cope with the PPO's high overall complexity by indentifying sub dimensions of PPO [AJ10]. Consistent with the dual character of the above presented definition of multi-sided industry platforms, the *"technical architecture and organizing principles of these platforms jointly determine their evolutionary trajectories"* (p. 676) [TKB10]. This distinction can be transferred to the complementor perspective on smartphone platforms: On the one hand, third-party developers interact with the *technical platform* and, on the other hand, with the platform's marketplace as the major *distribution channel* for complementary applications [SSF10]. Here, the technical platform refers to all facets of the platform related to the technical development of a third-party application which includes, for example, APIs and SDKs, as well as all kinds of conditions and communications (like documentations, blogs and forums) related to the technical development. The platform's distribution channel (or marketplace) refers to all facets of application distribution. Besides the design of the marketplace, this sub dimension includes the terms and conditions of participating as well as related communications.

3 Facets of Smartphone Platform Openness

Building upon the theoretical considerations given above, we intend to derive a deeper understanding of the third-party developers' perception of openness. For this purpose, we used a two-step approach: First, a comprehensive set of concrete facets of openness was identified by means of an exploratory qualitative investigation. Second, a preliminary quantitative analysis was performed to evaluate the relative importance of the identified openness facets.

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3.1 Step 1: Qualitative Identification

Methodological Approach

Recognizing that no preliminary research on the developers' perception of platform openness was available, an inductive approach by means of an exploratory investigation with third-party developers and experts on smartphone software platforms was undertaken (see table 1 for an overview). This approach is especially well-suited for emergent or poorly understood phenomena providing the broadest possible contextual information for assessment and understanding. Thus, for our study, developers of complementary applications for the Android and iOS smartphone platforms were interviewed.

Method	Participants	N	Activities/Roles	Results
Exploratory Interviews	iOS and Android app developers	9	Open-ended exploratory interviews; Investigation of the complementors general perception of openness and identification of concrete openness-related facets	"Saturated" list of 21 openness-related facets
Card-Sorting Procedure	iOS and Android app developers	6	Assessment of content validity; evaluation of the assignment of the aspects to the two dimensions of PPO	Confirmation of facet classification
Focus group discussion	Experts on mobile software and researchers	7	Assessment of content validity; screening out of overlapping facets	Removal of in total 5 facets

Table 1: Methodological Approach and Roles of Research Participants in Step 1

Based on the recommendations by Gläser and Laudel (2006), an interview guideline was developed. However, since we were interested in covering the full extent of the developers' perception of openness, we decided to deploy open interviews which should motivate the developers to freely describe their association with the term "platform-openness" and subsequently name concrete facets or restrictions of openness they were aware of [GL06].

The criteria to select our interview partners were led by the intention to derive completeness in terms of developers' openness perceptions. For this purpose, we selected developers that cover a preferably high fraction of the diversity of all developer types of the target platforms with regard to nationalities, success scores (in terms of rankings) and genres. Furthermore, our sample of interview partners included multi-homers, which allowed us to cover the perspective of developers that are familiar with multiple platforms and could compare the different platform ecosystems. Besides the condition to cover the diversity of developer types, the size of our developer sample was determined by a predefined stop criterion: The interview procedure was repeated until three successive interviews did not reveal any new openness facets, which allowed us to assume information saturation. As a result, a total number of nine third-party application developers were interviewed. The respondents were either software company employees, freelancer, had founded their own companies or described themselves as "interested amateurs". However, all respondents confirmed to be key informants regarding the development and distribution of smartphone applications of their organisation.

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After transcribing the interviews, an inductive content analytic approach based on the recommendations by Krippendorf (2004) was performed [Kr04]. During this process, the developers' statements were recursively consolidated, resulting in a list of 11 technical facets of openness and eight facets concerning the distribution channel's openness. The assignment of openness facets to either the technical platform or the distribution channel dimension was evaluated by means of a card-sorting procedure with another set of six third-party developers [AG91, Ke86][3]. Since all six participants largely reproduced our assignments (hit-ratio = 89%[4]), our classification was confirmed. During this procedure, we also noticed that none of the facets proofed difficult to assign to one of the two theoretically derived PPO dimensions, although the facets resulted from open questions without mentioning the existence of the two sub dimensions. Accordingly, we assume that our two-dimensional concept of PPO does sufficiently cover the diversity of developers' openness perceptions.

Thereafter, the content validity of these facets was assessed by means of a focus group. Seven experts including three application developers with more than four years of experience in mobile application development[5] and four IS researchers with special expertise on mobile software platforms were invited to discuss the initial set of openness facets. As a result, a total number of three facets were excluded because the members of the focus group jointly agreed that these facets were already sufficiently covered by a superordinate facet. The resulting final framework of in total 16 key facets of openness is described in detail in the next section.

Results

Regarding *technical platform openness*, the first facet we identified from our qualitative interviews was that developers seem to have the need for advice and counsel regarding their work in form of *exchange among complementors*. Therefore it is an important facet of a platform's openness to facilitate this sort of exchange. A developer from CasaLive.de said: "*In case of more openness the web community of Apple would be larger. This would result in advantages concerning a better exchange of information and faster responses to questions or problems, which is the case e.g. for Android*". Developers further reported the need for the provision of a useful *technical documentation* to help them with their development issues. However, especially the creation of non-standard applications which involve making use of the platform in an extraordinary way can result in more complicated problems that go beyond the scope of the documentation. Since those issues can only be solved efficiently by responsible from the platform, the facet of *technical support by the provider* was found to be an important issue of openness as well. The Android developer from openintents.com commented on this: "*There is this technical blog, where they answer up-to-date questions. Moreover there is a good customer support and support for developers. There are mailing lists and office hours during which you can chat. Altogether I find that quite satisfactory*".

[3] The participants were given a set of cards with one of the identified facets and a brief description. The participants were then asked to assign each of the cards either to one of the two sub dimensions or to an "ambiguous" category. During the task, the developers were asked to think aloud and explain each of the card assignments.
[4] The hit ratio calculates the ratio of correct item assignments to the total number of assignments.
[5] The group of focus group participants was distinct from our interview sample.

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Another facet that was reported is the extent of effort it requires to contribute to a certain platform. Developers are concerned with the complexity of the specific programming languages as well as with the complexity of the platform itself, generally speaking with the *learnability of technical standards*. Our interview partner from halcyonestudios.com said: "*When I hear platform openness in general I think of ease of accessibility; generally speaking an easy to obtain and easy to access platform, thinking more from the coding or API side of things*". Since the majority of developers welcomed every aid with the programming of their applications, development tools like SDKs or test-environments constitute a basic component of the expected support from the provider side. Hence we attributed the *availability of development tools* to the perceived openness of a platform. In order to reduce the development costs most developers would prefer platforms that are based on languages that are either common standard or at least closely related to those standards. This enables them to port their applications to other platforms and further facilitates data exchange. Based on those observations, we identified the *technical interoperability* of a platform with other systems or platforms as an important facet of the platform's perceived openness. A related facet is the *functional range* of a platform. This aspect showed to be relevant, because it creates the potential for differentiation, as innovative ideas often draw upon the exploitation of every functional feature a platform has to offer. The last technical facet concerns the *technical performance* and proofed to be a major issue among developers. If the platform's technical performance cannot keep up with the technological standard of the market or the state of the art development tools, developers feel restricted in their work process, because they have to adapt to the lower performance of the platform.

Concerning the *distribution channel*, developers reported that *transparent terms and conditions***,** for instance the fees developers are obliged to pay to the platform provider for selling applications via his distribution channel, are an essential aspect of strategic planning and innovative thinking. On the other hand *restrictive terms and conditions* were reported to hinder such intensions considerably. Furthermore, application developers stated that they had to adapt their expectations and their strategic planning to the rules of a platform beforehand. Therefore, we inferred that they are inherently dependent on information issued by the platform provider. Hence, application developers rely on the platform's *transparency of rules on content*. A developer from Readdle.com said: *"Openness is about having clear information about rules and principles of doing products for a platform"*. Thus it is a natural outcome that they value platforms that do not employ *restrictive rules on content*. Our interview partner from halcyonestudios.com said: "*In terms of straight-up censorship it (openness) is very important. I feel that Google's policy of being generally open and trusting that people are doing the right thing and only acting if that proves otherwise looks good on them as a company*." Another important facet for developers was being able to comprehend the ways a market functions. The rise and fall of applications, the impact of marketing and pricing strategies are obviously important information for contributors as they derived their future development planning from these. Thus the *transparent communication of market mechanisms* influences the perceived openness of a platform. In this context it was inevitable for developers to be able to communicate with the end users to derive feedback on their actions. As they reported, features facilitating such *communication with end-users* state a cornerstone of open distribution channels. Furthermore developers

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accounted to seek platforms that provide them with as much freedom as possible. Furthermore, our research showed that from a developer's point of view any monetary costs associated with the contribution to a platform impose additional risk and thus are seen as *financial entry barriers*. This monetary risk has to be compensated by the prospect of even higher revenues. For developers offering their applications to a vast number of potential customers, the *availability of a distribution channel* is an essential facet.

The resulting framework of perceived platform openness facets is presented in table 2.

Technical Platform	**Distribution Channel**
▪ Exchange among complementors ▪ Technical documentation ▪ Technical support by provider ▪ Learnability of technical standards ▪ Availability of development tools ▪ Technical interoperability ▪ Functional range ▪ Technical performance	▪ Transparency of terms and conditions ▪ Restrictive terms and conditions ▪ Transparency of rules on content ▪ Restrictive rules on content ▪ Transparency of market mechanisms ▪ Communication with end-users ▪ Financial entry barriers ▪ Availability of distribution channel

Table 2: Framework of Perceived Platform Openness Facets

3.2 Step 2: Quantitative Evaluation

For the purpose of evaluating the relative importance of the identified facets, we performed a quantitative analysis on the facets of openness identified above.

Methodological Approach

In preparing an online survey, each of the facets of openness was transformed into an easily understandable statement. In the survey instrument, an introduction including our definition of openness was presented. Then, the developers were asked to mark all openness-facets that had an impact on their platform-related development activities. In order to derive some background information, a few simple questions on the organizational background and the demographics of the developers were included. Due to the results of a pre-test among five application developers and two researchers, several of the openness statements were refined to eliminate possible misunderstandings and ambiguity. A number of 4,978 Android application developers were invited to participate, resulting in a total of 254 valid responses. The Android platform was chosen due to the following considerations. First, Android is one of the currently leading smartphone platforms and can be considered as a "typical" smartphone platform. Second, unlike other platforms, the "Android Marketplace" features an email address to contact the developer of an application which allowed us to conveniently contact a randomly drawn sample of third-party developers.

The data-analysis was performed in two ways. First, to evaluate the relative importance of the different platform openness facets, the facets were ranked by the percentage of respondents that nominated the respective facet for having an impact on their platform-related work.

Second, to capture the perspective of different developer types, the data was segmented. Since one result of our qualitative interviews was that especially the groups of

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professional developers (employed and freelancers), amateurs (hobby programmers and students) and entrepreneurs differed in their assessment of the openness-facets, the organizational background was chosen as segmentation variable. For this purpose, the participants of the quantitative survey were asked to complete the sentence *"I primary develop smartphone apps as ..."* by selecting one of the options *"employed developer"*, *"contract developer / freelancer"*, *"hobby programmer"*, *"student (learning how to develop apps)"* or *"entrepreneur (my business is built on smartphone apps)"*. Accordingly, the assignment of each respondent to one of the three above mentioned groups resulted from the developers' self-reported primary background. For each of the three groups, analogous descriptive rankings based on the number of nominations were generated. Furthermore, the distributions of facet nominations were compared among the three groups by means of an one way ANOVA followed by a Turkey HSD post hoc test [BZ09].

Results

Regarding the technical facets of openness, 30% of the developers in our sample indicated that the *technical documentation* had an impact on their work. Ranking second, 29% of our respondents nominated the *provision of development tools* for having an impact on their work. On the other end, developers cared little about the *exchange with other developers* (11%) and t*echnical support from the platform provider* (9%).

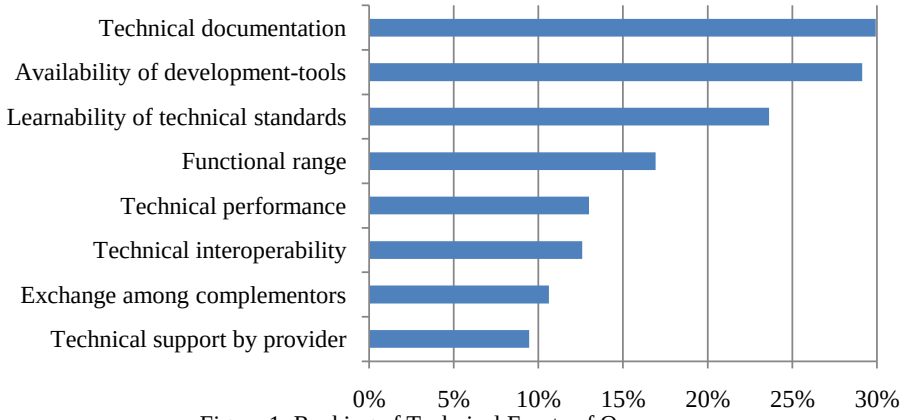

Figure 1: Ranking of Technical Facets of Openness.

Regarding the openness of the distribution channel, the most important facets were the possibility to *communicate with end-users* (26%), followed by the general *availability of a distribution channel* (22%). Surprisingly, and contrary to the public perception, the *transparency of terms and conditions* (9%) and the *communication of rules on the content* (10%) turned out to be the least important facets of the distribution channel's openness.

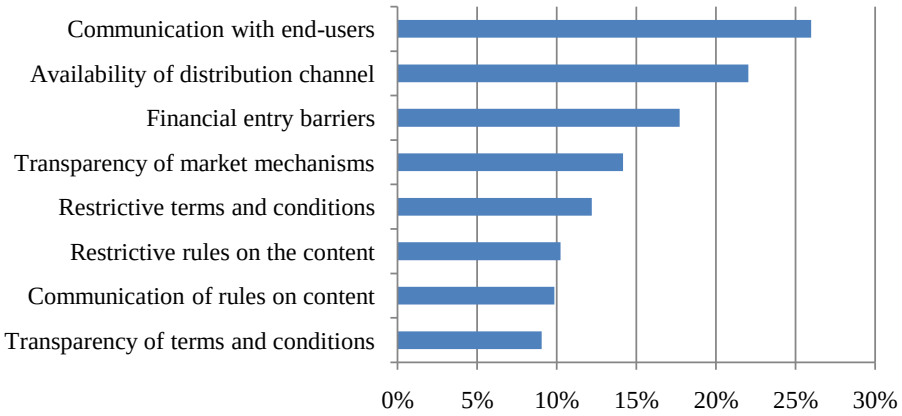

Figure 2: Ranking of Facets concerning the Distribution Channel.

The descriptive rankings of the group comparison among professional developers, amateurs and entrepreneurs are depicted in figures 3 and 4.

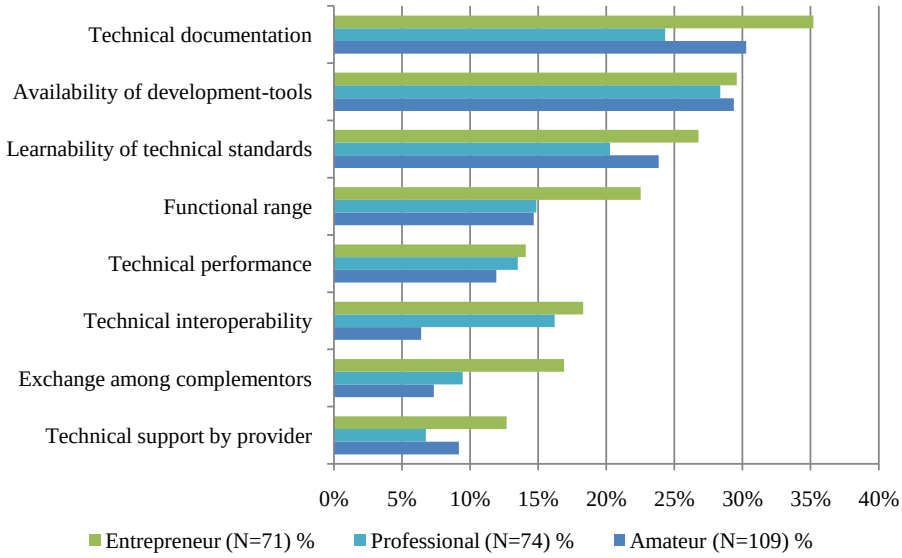

Figure 3: Comparison of Technical Facets Rankings between Amateurs, Professionals and Entrepreneurs.

Regarding the technical facets amateurs showed only little interest in the *technical interoperability* (6%), while professionals and entrepreneurs reported a significantly higher impact of this facet (16% and 18%, $p < 0.05$).

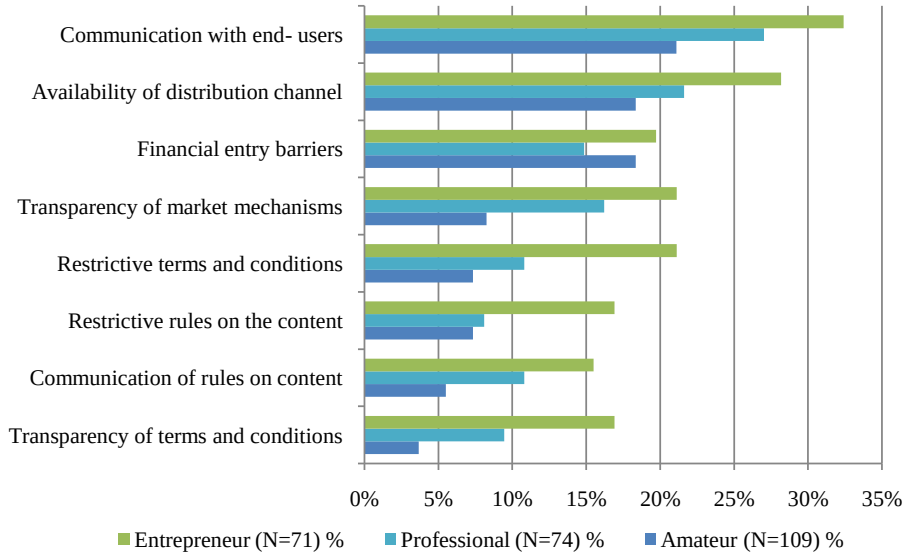

Figure 4: Comparison of Distribution Channel Facets Rankings between Amateurs, Professionals and Entrepreneurs.

Interestingly, for the distribution channel's facets, the most significant differences occurred between entrepreneurs and the other two groups of developers (professionals and amateurs). Especially the facets regarding the *transparency of the terms and conditions* (17% vs. 9% and 4%, $p < 0.01$) and *restrictive terms and conditions* (21% vs. 11% and 7%, $p < 0.01$) were nominated significantly more often by entrepreneurs than by the other two groups.

4 Discussion

In this section, we point out the implications of our results, discuss limitations along with opportunities for further research and give a brief conclusion.

4.1 Implications

The results of our investigations allow several implications. First, in our qualitative interviews, the majority of the participating developers stated that the openness of the technical platform and the openness of the platform's marketplace are two different things that have to be considered separately. For example, mobile platforms can be quite open in terms of their technical feasibility while, simultaneously, only certain contents or functionality may be distributed in the corresponding marketplace. Vice versa, platforms that do not restrict access to their distribution channels may still fall short with regard to their technical openness, for example, in terms of their technical interoperability with other platforms. As such, the technical platform's openness and the distribution channel's openness should be considered conceptually distinct dimensions of PPO. The resulting implication for managers of smartphone software platforms is that managerial decisions concerning the vertical openness of the platform and more general the

management of complementors should always integrate both perspectives, since the isolated use of a single management lever might not lead to the desired results. A positive example of integrating both sides was given by Apple in autumn 2010. The platform provider simultaneously announced that the approval process for application will become more transparent (a facet of the distribution channel's openness) and that the policies concerning the use of third-party development tools will be relaxed (a facet of the platform's technical openness)[6].

Second, we find that in the perception of third-party developers, openness is not a unitary concept but rather the sum of multiple single facets of openness. Both, the technical platform and the distribution channel feature several fine-grained components whose attributes in sum cause the developers' perception of the platform's openness. Hence, approaches of changing the vertical platform openness can only be effective, if they involve adjusting multiple facets in a concerted action. In the case of the quantitatively investigated Android platform, the platform provider could increase the platform's vertical openness most efficiently by revising and completing the technical documentation, providing more sophisticated development-tools, and implement features that enable the complementors to exchange with end-users, since these three facets were identified as the most important ones in terms of their impact on the developers' work. Third, the results of our group comparison revealed that the different groups of developers in terms of their organizational background significantly differed in their evaluation of the openness facets' impacts. This result indicates that platform managers should differentiate which groups of complementors they want to address. For the Android platform, we found that entrepreneurs especially value openness in terms of transparent terms and conditions and fear restrictions concerning the content of their applications, because the success of their business is tightly connected to these governance issues. This is an important insight for platform managers because entrepreneurs are an especially valuable group of complementors, since their complementary applications are more likely to be innovative and hence improve the overall attractiveness of the platform.

4.2 Limitations and Further Research

Our research approach involves some limitations. First, regarding our qualitative investigations, it should be noted that owing to the limited number of observations and the non-representative selection of interview partners, the possibility to generalize the reported results and implications is limited [Yi08]. Second, our survey instrument and the respective evaluations have to be considered as a preliminary approach of a quantitative investigation, especially since the invited survey sample was limited to Android developers. However, our results should be understood as a starting point for more sophisticated research on antecedents and effects of the developers' perception of platform openness. Transferring our approach to other software-based platforms (e.g. B2B platforms like salesforce.com) and investigating the impact of perceived openness on the developers' willingness to contribute to the platform ecosystem and could be two relevant research questions in this field.

4.3 Conclusion

[6] See http://www.apple.com/pr/library/2010/09/09statement.html.

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In this paper, we introduced the concept of perceived platform openness (PPO) as an approach of investigating platform openness from third-party application developers' individual perspectives. Through a comprehensive qualitative investigation, we identified a framework of 16 openness facets, attributing either to the technical platform or the platform's distribution channel. Subsequently, the relative importance of these facets was evaluated for the Android platform by means of a quantitative survey. In doing so, our study's findings contribute to a more sophisticated understanding of platform openness in particular and platform-centric ecosystems in general and, hence, serve as an excellent starting point for further research on this topic.

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