Understanding Platform Loyalty in the Cloud: A Configurational View on ISV´s Costs and Benefits

Dominik Dellermann[1], Christopher Jud[2], and Fabian Reck[3]

[1] University of Kassel, Chair for Information Systems, Kassel, Germany
dellermann@uni-kassel.de
[2] University of Stuttgart, Chair for Information Systems, Stuttgart, Germany
jud@wius.bwi.uni-stuttgart.de
[3] University of Bamberg, Chair for Innovation Management, Bamberg, Germany
fabian.reck@uni-bamberg.de

Abstract. Platform-as-a-service (PaaS) providers are increasingly engaged in nurturing vibrant ecosystems of independent software vendors (ISVs) by offering standardized services. However, cloud ecosystems have also been known for its fluctuation and high rates of desertion. A currently under-researched explanation for this low traction and high rates of fluctuation may lie in the fact that ISVs face considerable costs when joining and acting on a specific platform. If these costs are too high, they can rapidly outweigh the additional value generated by the ecosystem. This study therefore explains the role of different configurations of cost-inducing factors and resource benefits in influencing an ISV´s platform loyalty. By using a configurational approach based on fuzzy-set qualitative comparative analysis (FsQCA), we display complex interactional effects of cost and benefits as causal conditions on ISVs' intention to stay in the ecosystem and thus provide valuable insights for both practice as well as theory on platform ecosystems.

Keywords: PaaS, cloud, ISV, transaction costs, FsQCA

1 Introduction

The ubiquitous provision of on-demand computing resources via the internet sets cloud computing in the spotlight of practitioners and researchers [1]. The fastest growing segment of this on-demand service delivery phenomenon is the platform-as-a-service market (PaaS). PaaS refers to an on-demand programming environment for developers of software applications, which promises to make software development more efficient [2]. IT industry leaders like Amazon Web Service (AWS) or Salesforce provide a scalable cloud platform, i.e. an expandable code base, which offers a large amount of independent third-party developers' important resources such as computing power and software databases to enable the development of applications that extend the basic functionality of the platform [3]. Such applications can be vice versa offered as software-as-a-service (SaaS) on the platform provider´s marketplace. By the numbers, Salesforce´s cloud infrastructure consists of approximately 5.5 million apps and more than 4 billion transactions a day.

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This new logic of software development in the cloud has amplified the need for innovation from an ecosystem of third-party developers, called independent software vendors (ISVs) [4]. The focus of a PaaS provider is therefore to attract ISVs to join the ecosystem and facilitate innovation as well as the generation of complementary value propositions by offering standardized cloud services to an anonymous number of ISVs [5]. However, even famous examples like Microsoft´s cloud platform Azure show that it remains challenging to gain solid traction among ISVs. Furthermore, platform ecosystems have also been known for their fluctuation and high rates of desertion [6].

A currently under-researched explanation for disloyal behavior may lie in the fact that ISVs face considerable costs when joining and acting on a specific cloud platform. If these costs are too high, they can rapidly outweigh the additional value generated by the PaaS ecosystem [7] and induce ISVs' disloyal behavior and in its strongest manifestation the abandonment of a platform. Prior studies have mainly focused on the motivational factors and the relational rents that initially motivate ISVs to join an ecosystem [8, 9]. However, the costs associated with this choice and how particularly the interplay of the benefits and costs influence the decision to stay in a PaaS ecosystem has yet to receive research attention.

Previous studies that addressed this question were primarily focusing on a technological perspective and solely on the coordination costs related to platform dependencies [6] or the lock-in effects of cloud platforms. However, to provide a more holistic analysis of costs which affect sustainable traction among ISVs, also economic dimensions need to be included as entering service partnerships with a PaaS provider might induce a cost disadvantage relative to vertically integrated structures. However, managers are willing to accept certain costs if they expect superior returns and benefits [9,10].

We therefore propose that the interplay of transaction cost inducing hazards and resource-based benefits shape the decision of an ISV to stay loyal to a PaaS provider. As traditional regression-based net effect models are not capable to capture the complex interplay of different cost and benefit dimensions in shaping PaaS-related decision making, we apply configurational theory as theoretical lens and qualitative comparative analysis (QCA) as a way of analysis for understanding the complexities of PaaS ecosystems [11] and therefore address the following research question: *Which configurations of cost-inducing hazards and resource-based benefits maximize ISVs´ platform loyalty?*

To answer these questions, we analyze data from a survey of 42 ISVs on five leading cloud platforms by applying fuzzy set Qualitative Comparative Analysis (FsQCA) [12]. This case-oriented method enables us to analyze asymmetric and complex causal effects by extracting configurations that consistently lead to the platform loyalty [11, 13]. Our results reveal the role of cost-inducing hazards and resource benefits in influencing the loyalty of ISVs on certain cloud platforms. We therefore show that PaaS provider should balance such cost and benefit dimensions to gain solid traction among ISV and build sustainable ecosystems around their platform.

2 Conceptual Background

2.1. Platform Loyalty

A high number of complementary apps are central to the success of platform ecosystems [5]. Hence, PaaS providers are increasingly engaged in building vibrant ecosystems of ISVs around their platform [14]. For the long-term success and stability of a platform it is not only crucial to attract a large base of ISVs that produce high-quality applications but also to keep them loyal to the respective platform [15]. However, many platforms are plagued by high rates of platform desertion as ISVs stop developing applications [6], which represents the strongest manifestation of disloyalty. Further representations of disloyal behavior of ISVs might include factors like for instance showing reluctance to invest in the relation, stop curating existing applications on a specific platform or start multihoming [16]. Especially when ISVs change to rival platforms, the spillover of knowledge to competitors is a common threat to the PaaS provider that results from disloyal behavior [5]. Loyal behavior of a platform´s ISVs is a critical performance indicator. Furthermore, the ability of a PaaS provider to retain ISVs within their ecosystem is vital for success. Although previous work on developers´ loyalty on a platform in the B2C market also uses alternative explanations of platform loyalty [e.g. 17], we attempt to take an economic exchange lens, as such a perspective is especially important in the case of B2B applications. In this context, a PaaS provider should balance the effort required by the ISV to continue developing an application on the platform (i.e. cost-inducing factors) and the resource benefits offered to the ISV to stabilize the ecosystem and guarantee sustainability.

2.2 A Configurational Perspective on Platform-related Costs and Benefits

One core assumption of our study is that the influence of single factors on a specific outcome depends on the overall configuration of these factors rather than the net effects of each individual factor. Thereby, we abstain from conventional, rather reductionist variance models. Taking a configurational perspective on the conditions leading to platform loyalty is suitable for two reasons.

On the one hand, configurational approaches treat whole sets of elements as predictors rather than single variables [11]. These sets simultaneously explain the outcome of interest. Thus, one major advantage of configurational theory is its ability to explain synergetic and complementary effects [12]. This resonates well with current theoretical perspectives on the complexity of ecosystems as well as platform decisions [10]. For instance, ISVs are willing to accept cost if the benefits outweigh such. Hence, each variable in isolation may have a different effect on a decision than in combination with other elements.

On the other hand, configurations can display asymmetric relations between conditional and outcome variables rather than just symmetric ones [11]. So, configurational theory implies equifinality between different conditions and configurations [12]. Consequently, these conditions may either be sufficient or necessary causes of a dependent variable. According to both organizational [13] and information systems research [18] such notions possess superior accordance to organizational realities which are to a large part bounded to the larger context. As El-Sawy et al. [11] point out, this perspective thus particularly fits to explaining the ISV's decision to continue developing on a certain platform.

2.3. Research Framework

Fig. 1 illustrates the framework of our research. The framework comprises two facets of causal conditions for an ISV´s loyalty on a cloud platform. These two dimensions are theoretically grounded in TCT and the resource-based view. It therefore proposes that from the perspective of ISVs the configuration of four cost-inducing hazards (i.e. platform specificity; behavioral, market and technological uncertainty) and three resource benefits (i.e. technological, social and commercial capital) influences the intention of software vendors to stay in a certain PaaS arrangement.

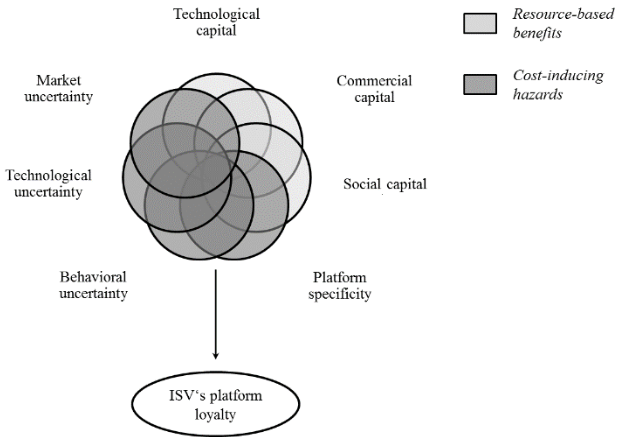

Figure 1. Research framework

The probably most prominent theoretical approach to explain boundary decisions associated with interfirm exchange (e.g. outsourcing decisions) is Transaction Cost Theory (TCT) [19 - 21]. TCT defines the costs of economic exchange (i.e. search and information costs; investments in social relations; opportunity costs) within the boundaries of a specific system (i.e. market or hierarchies) [22]. From TCT´s perspective developing applications on cloud platforms therefore might induce a cost disadvantage relative to vertically integrated structures of software development [7]. In the PaaS context, the required transactions for using an on-demand programming environment to develop software applications always create costs. According to TCT such costs mainly arise from two cost-inducing hazards: uncertainty and its sub-dimensions as well as specificity [23]. We therefore use these dimensions as cost predictors for platform loyalty.

Platform specificity: The specificity of a certain cloud platform represents the first hazard for ISVs. Platform specificity refers to the software migration between different PaaS providers [24] as well as the value of ISV´s assets within alternative PaaS relations [23]. For instance, cloud platforms require investments in relation-specific knowledge to participate in the ecosystem and capitalize from the access to complementary resources [20]. Apart from requirements to adapt software applications that are locked-in by specific APIs or for instance proprietary data storage implementations, high investments requirements create dependencies with the PaaS provider. This increases switching costs making it difficult for the ISVs to leave the actual cloud ecosystem and move to another platform [16].

Uncertainty represents the second cost-inducing hazard for ISVs. This TCT dimension is defined as the absence of complete information, which in turn leads to an ISV's inability to predict its surroundings accurately [25]. The uncertainty dimension can be subdivided in the volatility of market conditions (e.g. market, demand, and competitive environment), technological requirements (e.g. technological volatility) as well as the behavior (e.g. opportunism) of the PaaS provider [23].

Market uncertainty: Market conditions are crucial contextual conditions for ISVs. By developing complementary apps upon a platform, software vendors typically attempt to occupy a specific niche market [13]. Unpredictable user demand, substitute software products or changes in the competitive environment therefore increase the costs of ISVs.

Technological uncertainty: The second dimension of uncertainty in PaaS relations spans the difficulties to accurately predict the technological requirements. Particularly in the context of cloud platforms the quality of the service offering is hard to forecast. Furthermore, technological complexity and changes of specifications like for instance interfaces are frequently the most significant sources of uncertainty [7].

Behavioral uncertainty: Contrary to technological or market uncertainty, which is not directly related to the PaaS provider, behavioral uncertainty arises from the complexity of service performance evaluation. The platform provider for instance might follow its individual and act opportunistically [19]. ISVs therefore need to monitor the PaaS provider to detect opportunistic behavior like for instance exploiting resources or poaching in the ISV's niche [9].

From a resource-based perspective however, an ecosystem offers relational rents by providing the access to resources [26]. When ISVs decide to join an ecosystem, advantages or benefits need to be gained to make the commitment to a platform attractive [27, 28]. There are various forms of motives which drive ISVs to join and stay in an ecosystem. Most of them are related to getting access to a certain resource as technical or commercial resources. Kude et al. [9] grouped motives into three categories: technological capital, commercial capital and social capital.

Technological capital: By technological benefits we refer to access to technological resources that an ISV gains by joining a cloud ecosystem. These are for instance the PaaS provider's ability to supply integrated systems and its capability to innovate these systems [29]. First, the benefits from integrated systems arise for instance if the products and solutions offered by the ISVs offer only a small solution-space. Hence, this single solution gains value through the interoperability with a larger system of modules. Cloud ecosystems offer various technological resources like Applications Programming Interfaces (API), Software Development Kits (SDK) or Integrated Development Environments (IDE) [30]. Such resources allow the ISV to individually develop extending applications. Another benefit from the technological point of view is the availability of standards and technologies which are offered or hosted by the platform [9].

Commercial capital: Commercial capital refers to the PaaS provider´s or the whole cloud ecosystem´s marketing capabilities as well as its service and distribution networks. Especially, if ISVs have limited internal capabilities to heavily invest in marketing activities and to set up distribution networks, the access to such forms of commercial capital is crucial [31]. When partnering with huge platform providers like for instance Salesforce, ISVs can benefit from marketing and distribution capabilities to increase the awareness among many potential users by providing access to broad markets [32] or leverage highly visible cloud ecosystems to gain attention for own products. Distribution channels are for example AppStores. This kind of phenomenon also can be found in the domain of Enterprise Software where SAP or Microsoft offer respective features on their platforms. Using the possibilities of AppStores, ISVs can offer their solutions to end-users without the need to set up own distribution channels.

Social capital: Social capital refers to the PaaS provider´s reputation that is often aligned with the brand of this particular firm [32]. As ISVs are frequently unknown due to the limited reputation, customers might suspect the quality as well as reliability of their value propositions services. Nevertheless, such trustworthiness is a crucial topic in the software industry since the quality of SaaS offerings as well as the knowledge and experience of the vendor is difficult to assess a priori [9]. If a platform has reputation, e.g. AWS's reputation to produce and sell high-class products, ISVs may benefit from this reputation. A reputation can lead among others to a premium in prices. Furthermore, social benefits include the use of communities where ISVs can exchange information with other ISVs or ask for support in case of problems during the development of applications [17].

3 Research Methodology

3.1 Fuzzy-set QCA

Data analysis was done via FsQCA. This set-theoretic approach emphasizes the effects of the whole rather than its pieces. Hence, the method explicitly acknowledges that research cases are multidimensional. FsQCA thereby draws on measures of consistency and coverage to evaluate the predictive power of single configurations towards the outcome of interest. The first indicator, consistency, is analogous to correlation estimates in statistical methods. This value's meaning is the degree to which cases of a certain configuration agree in leading to a given outcome [12]. The second indicator, coverage, displays the degree to which a configuration accounts for the instances of an outcome. Hence, these values are analogous to R-square in regression analysis. FsQCA detects configurations with adequate consistency and coverage values in three steps which are: a) calibration, b) construction of truth tables, and c) truth table analysis [12].

Calibration represents the first step. This step is necessary because set-theoretic analysis is based on the degree of memberships of cases in a certain set of conditions (here, e.g. membership in the group of firms with high social capital). Thus, to obtain such so called fuzzy set membership scores all construct measures must be transformed to a scale ranging between 0 and 1 with 0 indicating full non-membership, 1 indicating full membership and 0.5 representing the crossover point [33]. Analogous to the calibration approach by Fiss [13], the observed maximum and minimum values within our sample for all variables specify full membership and full non-membership. The calculated scale midpoint (median of observed values) is the cross-over point. The fuzzy set memberships scores for each case were calculated via the calibration procedure in the FsQCA software program (version 2.5 [34]), with the three above mentioned values as calibration benchmarks.

The *construction and refinement of truth tables* represents the second step of analysis. In this context, a truth table is a matrix of all possible configurations of predictor conditions (in our case, 32 rows; in general, 2k, where k is the number of conditions observed [12]). Subsequently, the requirements of FsQCA demand a refinement of this truth table. The refinement procedure draws on two criteria to asses each possible configuration: frequency and consistency. The frequency criterion captures if and how many empirical cases exist which have a membership score of more than 0.5 and thus display membership in the configuration of interest more than non-membership. The standard threshold for frequency in medium-sized samples is 1 meaning that every configuration that exists in the empirical dataset will be part of the analysis [33]. The consistency criterion captures if a truth table row consistently leads to an outcome. This value should outreach .8, at least [12]. We choose a rather conservative threshold of .9 within this work.

In the third and final step, FsQCA analyzes the refined truth tables based on Boolean algebra, respectively counterfactual analysis, to be more specific. This step of analysis draws on the Quine-McCluskey algorithm which strips away factors that are inconsistently present or absent concerning the outcome [13]. By doing so, the algorithm excludes conditions that are no essential part of a sufficient configuration for the respective outcome. The result of this procedure encompasses two distinct solutions: the parsimonious solution and the intermediate solution. In the parsimonious solution, all simplifying assumptions derived from counterfactuals are included. In contrast, the intermediate solution only includes simplifying assumptions based on easy counterfactuals. Because of this dual algorithm, the intermediate solution necessarily represents a subset of the parsimonious solution, so that all conditions appearing in the parsimonious solution appear in the intermediate solution but not vice versa [12]. If a condition appears in the parsimonious solution, it passed a more thorough reduction procedure. In other words, the data provides particularly strong empirical evidence for the causality in this case. This condition thus displays a causal core of a configuration, while the periphery includes all conditions present in the intermediate solution [13].

3.2 Data Collection and Sample Description

Our sample consists of 750 firms equally distributed and randomly drawn among the ISVs of five market leading cloud platforms (i.e. Microsoft Azure, Oracle Cloud Platform, Amazon Web Services, SAP HANA, and Salesforce Force.com). There were two reasons for choosing exactly these platforms. First, all are instituted by established players and have shown an adequate amount of traction of their ISVs. Therefore, they can provide sufficient benefits for ISVs. Second, due to their high level of power imbalance they are perfectly suited for analyzing asymmetric third-party relationship and the corresponding costs related to that imbalance.

A web-crawling approach randomly collected sales contact data from the platforms´ app stores. This approach is congruent with previous surveys of third-party innovators [30]. Recipients were asked to forward the questionnaire to high-level executives (C-level; IT executives) as key informants who completed an online questionnaire containing the constructs of interest. We furthermore ensured confidentiality and anonymity to the participants.

In total, we obtained N=42 valid cases in which the data was complete. The resulting response rate of 5.6% is common in such settings. Non-response bias might still be an issue, so we compared responses of early and late respondents [35]. T-tests not reveal any significant differences ($p > 0.05$), hence we are confident to reject the presence of non-response bias in our study.

ISVs in our study were distributed among all five platforms (Microsoft Azure: 9; Oracle Cloud Platform: 4; Amazon Web Services: 2; SAP HANA: 9; and Salesforce Force.com: 18). Most of our respondents were high-level executives (C-level: 71.4%; BU executives: 19%). Participants in our sample indicated that they are highly experience in this topic (>10 years: 83.3%) and were experts in the context of our survey (95.2%).

3.3 Measurement Validation

To ensure validity we applied measures that were already developed and validated in prior studies in TCT [36 - 38]. For the benefit dimension, we developed scales based on the constructs of [9]. When necessary, we adapted scales slightly to the platform context. All items were rated on seven-point Likert scales. Through a pilot study with managers in the software industry, we pretested and refined our measurement instrument to ensure that each of them was clearly and unambiguously phrased.

Construct	Number of Items	MEAN	Standard Deviation	Loadings Range	Cronbach's Alpha	Composite Reliability	AVE
Outcome Variable							
Platform loyalty Adapted from [17]	3	5.65	1.36	.974	.941	.974	.949
Causal Conditions							
Platform specificity Adapted from [36]	4	4.99	1.41	.725-.931	.861	.907	.711
Market uncertainty Adapted from [37, 38]	4	4.61	1.62	.856-.952	.916	.941	.799
Technological uncertainty Adapted from [37, 38]	4	3.83	1.69	.785-.963	.925	.942	.804
Behavioral uncertainty Adapted from [37]	4	3.77	1.65	.848-.963	.894	.919	.743
Technological capital Following [9]	3	5.99	.97	.728-.954	.855	.900	.774
Commercial capital Following [9]	3	5.61	1.40	.796-.911	.834	.910	.751
Social capital Following [9]	3	5,62	1.36	.784-.941	.852	.912	.776

Table 1. Construct measures

We assessed reliability, convergent validity (see Table 1) to ensure that all values exceed the recommended threshold, supporting the notion of scale reliability. Furthermore, the AVE’s square root exceed the shared variance between a single construct and all other constructs within model, reflecting discriminant validity [39]

We additionally conducted Harman’s one-factor test [40] to assess for common method bias. The unrotated factor solution resulted in 5 factors explaining 80% of the variance (31 percent was the largest variance explained by one factor). Thus, common method bias is unlikely to be a problem.

4 Results

The results of the FsQCA reveal several patterns that explain how different configurations of cost-inducing hazards and resource-based benefits result in high or low levels of ISV´s loyalty. High levels of loyalty indicate a high intention to stay in the ecosystem while low loyalty indicates a high intention to leave. We extracted this pattern by comparing structures of different configurations [13]. Figure 2 shows the configurations resulting from FsQCA. Black circles indicate the presence of a condition, crossed-out circles indicate the absence of a condition, large circles indicate core condition, and small circles indicate peripheral conditions. Blank spaces indicate a condition may be either present or absent.

	Solutions for intention to stay					Solutions for intention to leave				
	1a	1b	1c	1d	1e	1	2	3a	3b	3c
Hazards										
Platform specifity		●	●	⊗	●	⊗	●	⊗	⊗	●
Behavioral uncertainty	⊗		●	⊗	●		⬤	⬤	⬤	⬤
Technological uncertainty	⊗	●		⊗	⊗	●	⊗		⊗	●
Market uncertainty	⊗	●	●	●	●	⊗	●	⊗	●	●
Benefits										
Technological capital	⬤	⬤	⬤	⬤	⬤	⨂	●	⨂	⨂	⨂
Commercial capital	●	●	●	⊗	⊗	⊗	⨂	⨂	⨂	⨂
Social capital	●	●	●	⊗	⊗	⊗	⊗	⊗	⊗	⊗
Consistency	.99	.92	.91	.95	.91	.95	.97	.94	.99	.94
Raw coverage	.47	.44	.39	.28	.23	.43	.32	.46	.38	.39
Unique coverage	.18	.04	.01	.03	.01	.02	.04	.06	.01	.02
Overall solution consistency			.91					.94		
Overall solution coverage			.73					.69		

Notes: Black circles indicate the presence of a condition, circles with “x” indicate its absence. Large circles indicate core conditions, small ones indicate peripheral conditions. Blank spaces indicate may be either present or absent.

Figure 2. Solutions for high and low platform loyalty

4.1 Configurations for High Platform Loyalty

We identified five different configurations that result in a high intention of the ISV to stay, which underlines the equifinality of achieving a certain outcome. Consistency for configurations ranges from 0.91 to 0.99 representing the degree to which these configurations of causal conditions result in high platform loyalty. Raw coverage, which describes the importance of a certain configuration in explaining the intended outcome, range from 0.23 to 0.47. The overall solution consistency shows these five solutions can consistently result in high platform loyalty with 89%. The overall solution coverage indicates that the extent to which these seven configurations cover high likelihood of risk cases is 76%. We compared the five configurations that result in high platform loyalty to extract four strong patterns:

- **I.** In platform ecosystems that offer high benefits and low levels of behavioral and environmental uncertainty, ISVs have a high level of platform loyalty no matter if the amount of investment in platform-specific resources is high or low (1a).
- **II.** Technological capital is a necessary condition for ISVs to stay in an ecosystem. Its presence is required to create platform loyalty (1a,b,c,d,e).
- **III.** ISVs are willing to accept all forms of uncertainty as well to heavily invest in platform-specific resources when all three benefits are prevalent (1b,c).
- **IV.** If the ecosystem does not offer social and commercial capital to the ISV, the combination of technological capital and technological stability is required (1d,e).

4.2 Configurations for Low Platform Loyalty

Furthermore, we identified five distinctive configurations that exceed minimum consistency threshold and result in a low level of platform loyalty. Consistency for configurations ranges from 0.94 to 0.99. Raw coverage ranges from 0.32 to 0.46. These five solutions can consistently result in low platform loyalty with 94% and cover 69% of cases with this outcome. Comparing the five configurations reveals three further important patterns:

- **V.** In cases where technological uncertainty is high and ISVs are not provided with sufficient technological capital by the platform, their loyalty diminishes (1)
- **VI.** Especially when behavioral uncertainty is high and commercial capital is not provided by the ecosystem the ISVs´ loyalty to the ecosystem suffers (2; 3a,b,c).
- **VII.** Although technological capital is present, high behavioral uncertainty, market uncertainty and platform-specificity outweigh technological benefits resulting in a low level of platform loyalty (2).

4.3. The Role of Cost-inducing Hazards and Resource-based Benefits in Maximizing Platform Loyalty

Out of these seven patterns derived from the comparison of configurations that lead to high and low platform loyalty, we can reveal holistic insights of the interplay of cost-inducing factors and resource benefits in influencing the intention of a third-party developer to stay in the ecosystem or to leave it. Based on the commonalities among the pattern we identified three holistic findings to explain the loyalty of complementors.

First, technological capital is a necessary condition for ensuring platform loyalty among the ISV's. In all our sample cases, which displayed high levels of loyalty, the ISV perceived access to valuable technological resources which help it provide and innovate its systems and software products. The results strongly indicate that without the superiority of the technological capital provided via the ecosystem, gaining strong traction among ISVs is hardly likely. Thus, platform owners must ensure ISV's access to technological resources to ensure their loyalty.

Second, technological still does not suffice for predicting platform loyalty. In situations of high behavioral uncertainty, volatile market environments, highly specific needs of platform-related investments and the absence of further benefits like commercial and social capital, ISV may display low levels of loyalty even if they can access technological capital. Hence, the presence of technological capital is a necessary but not sufficient condition for high levels of platform loyalty.

Still, combinations of technological capital with other cost- or benefit-related factors prove to be collectively sufficient [33] for ISV's loyalty. Excluding the rather trivial solution 1a covering cases in which ISV perceiving high benefits with low hazards from this discussion, the results demonstrate two main paths to high platform loyalty (Patterns III and IV). One the one hand, the absence of technological uncertainty in combination with technological capital is sufficient for ISV's loyalty (solutions 1d,e). This finding highlights the importance of the appropriation of resources over access to them [41]. If technological specifications in the platform remain stable, profiting from accessed technological capital is much easier so that ISVs can obtain value from the ecosystem. On the other hand, in situations of high uncertainty and highly specific investments to the platform, technological capital does not suffice alone (solutions 1b,c). In these cases, ISV's loyalty is only secured, if they are also provided with commercial and social capital. Hence, in situations where profit from technological capital is not guaranteed, ISVs want further benefits from the ecosystem. As there are circumstances under which technological capital both alone and in combination with the other two benefits leads to high loyalty, these two paths are equifinal.

Third, in contrast to technological capital, commercial and social capital seem to be of different importance. The solution table for low platform loyalty demonstrates that for low levels of loyalty, commercial and social capital are absent. As a converse argument, the presence of both commercial and social capital is a sufficient condition for high platform loyalty. Hence, commercial and social capital can enhance technological capitals effects for platform loyalty but seem to be rather substitutable add-ons in the eyes of ISVs.

Fourth and finally, while cost-inducing hazards play a role in predicting ISV's loyalty towards an ecosystem, there is none which cannot be overcome by the provision of technological, commercial and social capital. Behavioral uncertainty seems to play a quite important role. In four of the five paths leading to low levels of loyalty, the ISV sees the platform owner as a key source of risk. This result highlights the outstanding importance of the platform owner in ensuring ISVs traction to the ecosystem. The other three hazards represent rather peripheral conditions which are partially interchangeable concerning their effect on platform loyalty. The permutations of the main solutions for high (1a,b,c,d,e) and low platform loyalty (3a,b,c) stem from different merely inconsistent combinations of these. So, these factors play rather minor roles in causally explaining platform loyalty.

5 Discussion and Conclusion

Our study describes the interplay of cost-inducing hazards and resource benefits of PaaS offerings in explaining platform loyalty. By comparing different configurations that result in high and low platform loyalty, we identified seven patterns that describe the role of cost-inducing hazards and resource benefits in shaping ISVs´ platform loyalty. By drawing on configurational theory and applying FsQCA we can provide a much more fine-grained perspective on the complex causality associated with our dependent variable, platform loyalty. In doing so, we contribute to theory on platform ecosystems and ISVs loyalty in various ways.

First, we introduce the concept of hazards related to transaction costs to this phenomenon and evaluate their role in weakening or strengthening ISVs loyalty. Thereby, we find that especially behavioral uncertainty serves as a key cause of low levels of loyalty while the other hazards play a rather peripheral role. Still, also behavioral uncertainty is accompanied by the absence of at least two of the resource benefits, so that only in combination with them behavioral uncertainty is a sufficient cause of disloyalty. These two insights advance theories on platform loyalty by a) outlining the platform owner's behavior as a key driver of platform-related costs in addition to previously identified cost drivers such as e.g. the management of technological dependencies [6] and b) indicating that while also highly loyal ISVs may face high levels of hazard and consequentially high transaction costs access to valuable resources outweighs these costs. Hence, our findings support a notion of ISVs loyalty to be driven by opportunity-seeking rather than risk-avoiding motives. This gives hints that the issue ISVs loyalty to platform ecosystems might hold important contextual differences compared to traditional business partnerships like for instance between outsourcing contractors [20, 21] or service providers and customers [42]. Further research might specify these differences and examine why these exist.

Second, drawing on configurational theory and applying FsQCA allows us to capture asymmetrical causal relationships and thus shed light on how the effects of distinct resource-based benefits on ISVs platform loyalty differ. Thereby, we provide a more differentiated view than previous studies [e.g. 3, 8, 9, 42] on how resource benefits motivate platform loyalty. Our analysis reveals that technological capital is a necessary condition for high loyalty, while commercial and social capital are collectively sufficient conditions. In other words, platform owners do not remain loyal if they do not perceive clear benefits on the technology side but were loyal in all the cases within our sample where all technological, commercial and social capital were high. These findings indicate a preference hierarchy of ISV. They may join and stay on the platform mainly with the goal of enhancing their own technological capabilities by the architectural features the software platform offers. If the platform's technological features are stable, the ISV will stay loyal even if cost-inducing hazards are high. Commercial and social capital are rather valued if such stability is not given and may partially compensate in this case. This fact challenges the findings of previous studies that were focusing on network effects as the main (and sometimes only) driver of platform traction [43, 44] We suppose future research on ecosystems to analyze why ISVs are rather technology-driven. Furthermore, it would be interesting to investigate if these perceptions and preferences match with value opportunities in ecosystems or rather indicate strategical "blind spots" of the ISVs which hinder them from benefiting more from commercial resources and network linkages gained through platform membership.

On the practical side, implications of our research show the impact of different influencing factors on if ISVs remain on a platform or leave. This is particularly important for offering cloud services like PaaS, which are rather addressing a mass market then providing customized service value proposition. We therefore provide insights on how such standardized PaaS offerings should balance cost-inducing hazards and benefits to gain solid traction among a huge number of anonymous ISVs. The different configurations derived from FsQCA may serve as a blueprint for PaaS providers in designing their ecosystems of third-party software development.

However, this work is not without limitations. Although FsQCA is particularly suitable for medium sample size (n=5-50) an increased sample size probably cloud enhance the insights and generalizability of our results. Second, we did not include platform characteristics in the analysis of our empirical data so far. However, the characteristics and the explicit value proposition of the single PaaS providers vary. For instance, SAP HANA´s in memory data base is a very specific service offering compared to the other platforms in our sample. We therefore intend to include such platform characteristics in the further progress of our study. Third, this study includes a potential selection bias as the respondents of the survey that are still on the platform might over represent loyal ISVs. To proceed this study, attempt should therefore point towards gathering data from ISVs, who already left the platform, to gain more robust results.

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