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RESEARCH ARTICLE

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Value Cocreation for Service Innovation: Examining the Relationships between Service Innovativeness, Customer Participation, and Mobile App Performance

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Abstract

Service innovation is critical to firms' competitive advantage and, thus, firms desire to make their services increasingly innovative. However, the relationship between the innovativeness and performance of a new service is unclear. Conflicting findings and the related literature suggest that service innovativeness is multidimensional and its impact on performance could be nonlinear. However, limited research has studied these aspects, both theoretically and empirically. Furthermore, prior research has mainly considered customers as inputs to value creation, which may not capture their precise role. Drawing on service-dominant logic, we propose two dimensions of service innovativeness, namely novelty and intensity, which differentially influence the performance of a new service. We further posit that customers are part of the value cocreation process, thereby directly and indirectly affecting new service performance. The model was tested using a panel dataset of 234 mobile apps over 14 months. Results indicate important asymmetries in the impacts of novelty and intensity on mobile app performance: novelty shows a curvilinear relationship with mobile app performance whereas intensity shows a positive linear relationship. Furthermore, customer participation positively impacts mobile app performance and positively moderates the effects of intensity and novelty on mobile app performance.

Keywords: Service-Dominant Logic, Service Innovation, Mobile Apps, Innovativeness (Novelty, Intensity), Customer Participation, Service Performance

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1 Introduction

Service innovation is increasingly being considered a strategic means to sustain competitive advantage in the digital age (Barrett et al., 2015; Nambisan et al., 2017). For example, by continuously innovating, Facebook, Microsoft, and Google have maintained their competitive advantage as leading internet services companies; the iTunes Music Store service, which launched in 2003, is currently the largest digital music seller in the US (Harris, 2018). We follow Lusch and Nambisan (2015) and define service innovation as the rebundling of diverse resources to create new resources that offer value to some actors in a given context. Given that service innovation can help firms increase their value (Dotzel, Shankar, & Berry, 2013), discover novel uses of existing resources (Lusch & Nambisan, 2015), and become more responsive to customer needs (Yu & Sangiorgi, 2018), firms are eager to enhance such innovations to realize these potential benefits.

While seen as an essential strategy, implementing service innovation is less straightforward than one might anticipate, considering the difficulties in capturing its value (Foglieni & Holmlid, 2017). First,

as per service-dominant (S-D) logic, the usefulness and value of innovations are strongly dependent on customers' use (Lusch & Nambisan, 2015). Significant uncertainty exists regarding how new services would be valued by customers (Foglieni & Holmlid, 2017). Second, difficulties increase in capturing the value of new services as their novelty increases (Calantone, Chan, & Cui, 2006). In particular, highly novel services are risky because they require major changes from customers to experience their value (Foglieni & Holmlid, 2017; Stock & Zacharias, 2013). For example, new self-service technologies such as online banking were rejected in the past because customers were reluctant to learn new skills to use them and did not perceive much value from them (Curran & Meuter, 2007). More recent examples include Google Wave and Google Buzz, both of which failed to gain traction with customers (Mangalindan, 2014).

Such uncertainties and challenges heighten the importance of examining *value cocreation* with customers in service innovation in contrast to *value creation* aligned with goods-dominant logic (Vargo & Lusch, 2004; Vargo, Maglio, & Akaka, 2008). Unlike goods-dominant logic, which is applicable to product innovation, S-D logic posits that service value is cocreated between service creators and customers (Vargo & Lusch, 2004) and uniquely determined by customers' use experiences (Vargo & Lusch, 2008). Customer participation can increase the *density of resources* brought into the process of value cocreation (Lusch & Nambisan, 2015), while the *depth and width* of resource integration determine the outcome of value cocreation. For example, customers can apply their competence to create and assess the value of new services (Vargo et al., 2008). Value cocreation involves dynamic processes and activities that integrate the resources of various densities for service innovation (Lusch & Nambisan, 2015). Through interactions with service creators, customers *constantly* and *iteratively* apply their competence in the value cocreation process for service innovation (e.g., in mobile app innovation) unlike the value cocreation involved with product innovation. This alternative view suggests a need for reconceptualization and investigation of the relationship among customer participation, service innovativeness, and performance.

This need is further accentuated by inconclusive findings in the existing literature on the relationship between service innovativeness and performance. Although some studies have reported that service innovativeness improves service performance (e.g., Ordanini & Parasuraman, 2011; Sandvik, Duhan, & Sandvik, 2014), others have observed that it has no effect (e.g., Dotzel et al., 2013; Storey & Larbig, 2018). This could be because, first, these findings are often built on goods-dominant logic, which is unable to account for the unique features of value cocreation and service innovation (Foglieni & Holmlid, 2017) (i.e., customer resource integration). Second, these findings typically rely on the conceptualization of innovativeness as a single dimension (novelty), rather than viewing it in terms of two distinct aspects (McNally, Cavusgil, & Calantone, 2010) (novelty and intensity). While novelty has been recognized as an important component of innovativeness (Ordanini & Parasuraman, 2011), the other implicit component (i.e., intensity) has received little attention (Story, Boso, & Cadogan, 2015). As per S-D logic, the *width* and *depth* of resource integration should affect the outcome of service innovation (Vargo & Lusch, 2004). The *width* and *depth* of resource integration can be reflected in the *novelty* and *intensity* of service innovation respectively. Third, the mixed findings indicate a more complex relationship between the constructs than previously suggested (Storey et al., 2016), i.e., depending on *contingencies* or being nonlinear.

Overall, we aim to answer the following research question: *How do service innovativeness and customer participation affect new service performance?* Drawing on S-D logic as the overarching theoretical basis, we conceptualize service innovativeness in terms of two dimensions (i.e., novelty and intensity). Grounded on related literatures, we develop a model to explain the direct effects of novelty and intensity of service innovativeness and customer participation on new service performance. We also hypothesize that customer participation will moderate the impacts of novelty and intensity of service innovativeness on performance.

We test the proposed model in the context of the service innovation of mobile apps. Mobile apps provide a variety of services available on or accessible via mobile devices, such as mobile banking, social networking, gaming, news, mapping, location-based information, and internet surfing (Kankanhalli, Ye, & Teo, 2015; Lee & Raghu, 2014). With 64.5% of the global population using mobile phones in 2017, mobile apps generated US$88.3 billion revenue in 2016, which is projected to increase to US$188.9 billion by 2020 (Statista, 2018). Evidently, competition is intense in the mobile apps market, with vendors competing more on the basis of innovation of services than on price (Ye & Kankanhalli, 2018), thus providing an appropriate context for our study.

Furthermore, studying the services offered via mobile apps is beneficial because such services can be innovated upon continuously, with participation from customers (Ye & Kankanhalli, 2018). Specifically, mobile app development differs in several ways from other, previously studied contexts of service innovation, such as open source software (OSS). First, while OSS developers typically code specific software modules or libraries, mobile app developers tend to develop the entire app. This feature allows new apps to

be quickly distributed to users and continuously updated via app platforms (AppStore or Google Play), whereas the publication of OSS may not be controlled by individual developers and changes in OSS may take more time to be experienced by end users (Braa & Sahay, 2017; Martin et al., 2017). Second, while for mobile apps, user-needs information can be captured directly by the embedded review systems, e.g., rating and comments (Martin et al., 2017; Ruiz et al., 2017), OSS developers cannot as readily obtain information about user needs. Thus, app developers can readily access users' responses and incorporate their feedback into the app design that is reflected in the new versions of the app, instead of merely implementing bug fixes, as is typically done in OSS. This value-cocreation process in mobile apps fits well with S-D logic.

Third, OSS is not proprietary (Afuah & Tucci, 2013) whereas developers have proprietary rights to mobile apps and are able to profit from such an ownership. Additionally, the impact of customer participation (e.g., review rating) will be more important for paid apps than for free apps (Liu, Au, & Choi, 2014). Compared with free apps, users of paid apps have higher expectations in terms of use experience (Allen, 2014) and are likely to place more importance on the innovativeness of the app. Overall, paid mobile apps provide a suitable context for testing our model. The use of a panel dataset of 234 mobile apps over 14 months, fully supported the model.

This study makes three principal research contributions. First, responding to a call for research exploring the *contingencies* of the relationship between service innovativeness and service performance (Storey et al., 2016), we model and test customer participation as a moderator for the effects of service innovativeness dimensions on performance. Although transforming customers has been recognized as central to value cocreation in service innovation (Lusch & Nambisan, 2015), the role of customer participation vis-à-vis the dimensions of innovativeness (i.e., novelty and intensity) remains unclear. Moreover, in light of the mixed findings regarding the impacts of service innovativeness and customer participation (as elaborated in Section 2), we adopt S-D logic to explicate their roles in service innovation. Rather than viewing customers as external resources or inputs to service production (e.g., Storey & Larbig, 2018), we view customers' participation as an iterative and reflective learning approach to the creation of new services. Thus, our study provides insights into understanding the mechanisms behind the role of customer participation in service innovation (i.e., mobile app innovation in this study).

Second, this study enhances the understanding of the relationship between service innovativeness and performance by extensively examining the innovativeness construct. Rather than viewing service innovativeness as a unidimensional construct, we draw from S-D logic and conceptualize it as comprising two key dimensions, namely novelty and intensity. These dimensions have differential effects on service performance. We find that novelty and intensity have curvilinear and linear impact, respectively, on service performance, which thus advances the understanding of the mechanisms behind this relationship. Third, this study aligns with a recent call for further research on digital innovation (Nambisan et al., 2017) by investigating the relationship between mobile app innovation and app performance. Given the contextual features of mobile app innovation (i.e., rapid and frequent innovation and an embedded review system for customer participation) (Ye, Chua, & Sun, 2019), testing our research model in this context improves the understanding of innovation for such key digital services. As such, we contribute to multiple bodies of literature on service innovation, customer participation, and mobile app innovation.

2 Conceptual Background

This section first discusses our overarching theoretical foundation i.e., S-D logic. Thereafter, we describe our model constructs (i.e., service innovativeness and customer participation) and discuss the related literature.

2.1 S-D Logic

Service-dominant (S-D) logic was developed by Vargo and Lusch (2004, 2008, 2016). It conceptualizes *service* (singular) as applying specialized competencies (knowledge and skills) through deeds, processes, and performance for the benefits of another actor or the actor itself (Vargo & Lusch, 2004). S-D logic posits service as a process (i.e., *serving*) rather than an output (Lusch & Nambisan, 2015).

S-D logic views value as *value-in-use*, whether the offering is useful to customers or users (Vargo & Lusch, 2004). In particular, S-D logic focuses on the primacy of *use value* rather than the *transaction value* central to a goods-dominant logic. S-D logic proposes that value is cocreated by actors through the recombination or bundling of resources (i.e., *resource integration)* (Lusch & Nambisan, 2015). All actors (e.g., service providers and customers) in an exchange will integrate resources such as skills and competencies to create service for one another (Lusch & Webster Jr., 2011). S-D logic posits that any resource needs to be combined or bundled with other resources for its usefulness or value (Tilson, Lyytinen, & Sørensen, 2010). Service innovation is the result of recombining existing resources (Barrett et al. 2015). Furthermore, service innovation is seen as a *continuing and iterative* process with customer participation (Lusch & Nambisan, 2015), rather than as a *one-off* process, as suggested by the goods-dominant logic for product innovation.

Actors often exchange service through a service platform. Such platforms facilitate the liquefaction of resources and enhance resource integration for service innovation (Lusch & Nambisan, 2015). Knowledge and technology are key resources for service innovation that digitally enabled service platforms can liquefy (i.e., decouple from their original instantiation in physical form) and mobilize to be readily available to actors for resource integration (Normann, 2001). The *width* of resource integration refers to the types of resources that have been liquefied for integration, while the *depth* of resource integration refers to the degree of liquefaction and integration among certain types of resources. Another important aspect of value cocreation is the *density* of resources for integration (Lusch & Nambisan, 2015). *Resource density* is related to the amount of resources available for integration. Customer participation can increase resource density by providing needs-related knowledge and mixing or remixing skills (Vargo et al., 2008).

Mobile app platforms (e.g., AppStore and Google Play) can help liquefy customer inputs with embedded review systems and facilitate the integration of customer resources into service creation. Also, S-D logic suggests that interactions among actors can help share liquefied information and provide opportunities for resource integration and service innovation (Lusch & Nambisan, 2015). Mobile app platforms enable interactions between customers and application developers (Ye & Kankanhalli, 2018). In this sense, these platforms provide the conditions for customers and mobile apps developers to integrate diverse resources for service innovation.

2.2 Service Innovativeness

The notion that innovativeness is multidimensional has been mentioned in the literature (McNally et al., 2010; Storey et al., 2016; Szymanski, Kroff, & Troy, 2007). Nevertheless, most studies have focused on the degree of newness/novelty (Rubera, 2014; Sandvik et al., 2014), originality (Magnusson, Matthing, & Kristensson, 2003), or radicalness (Dotzel et al., 2013; Ordanini & Parasuraman, 2011). However, other studies have suggested that the quantity, intensity, or volume of new services should also be considered (Dotzel et al., 2013; Ordanini & Parasuraman, 2011). Service innovativeness should include the *novelty* of new services and the *intensity* of offering new services or innovating on services (Szymanski et al., 2007). Yet there is a lack of research that has done so. Although novelty is frequently defined and measured in past research, the intensity aspect of service innovativeness has been left implicit (e.g., Sandvik et al., 2014; Storey et al., 2016).

Our multidimensional conceptualization of service innovativeness is consistent with S-D logic, which posits that the *width* and *depth* of resource integration will affect the outcome of service innovation (Vargo & Lusch, 2004). In general, we suggest that the width of resource integration will be reflected in the *novelty* of service innovation while the depth of resource integration will be reflected in the *intensity* of service innovation. On one hand, novelty or newness reflects direct changes on services and is an outcome of the width of resource integration (Barrett et al., 2015; Lusch & Nambisan, 2015). On the other hand, intensity of innovation reflects the effort put in and depth of resource integration. Accordingly, we define *service innovativeness* as the degrees of the *novelty* and *intensity* of rebundling diverse resources to create new resources. The *novelty* dimension refers to the degree to which new services are discontinuous or depart from existing services. The *intensity* dimension refers to the degree to which services are frequently innovated. The practical rationale for this definition is that, as part of the requirements for novel services in a competitive mobile app market (Kankanhalli et al., 2015), service offerings need to be constantly updated to satisfy ever-changing customer needs.

Service innovativeness has been examined as an antecedent of service performance, although prior literature on the relationship has reported mixed findings. Some studies have found a positive impact of service innovativeness on performance, e.g., commercial success and strategic competitive advantage (Storey et al., 2016). Ordanini and Parasuraman (2011) observed that the novelty of new hotel services significantly increased revenue (firm performance). In a similar context, Sandvik et al. (2014) found that service novelty positively affected the market advantage of a Norwegian hotel. However, other studies did not find such impacts. For example, Dotzel et al. (2013) reported that radical service innovations and people-enabled service innovativeness do not enhance firm value; only internet-enabled service innovativeness positively affects firm value (p. 272). Kuester et al. (2013) found that service novelty is the least important factor for new service success. Through a survey of 126 service firms, Storey and Larbig (2018) observed that service innovativeness (referred as concept transformation in their study) does not affect new service success in terms of sales, market share, and financial performance.

One possible explanation for the mixed findings is that prior studies have generally relied on the conceptualization of innovativeness as a single dimension (novelty) rather than viewing it in terms of two distinct aspects (McNally et al., 2010) (i.e., novelty and intensity). As per S-D logic, innovativeness may manifest in both novelty and intensity. Yet accounting only for novelty, which could have a complex relationship to service performance, may yield inconsistent findings. Thus, another explanation for such mixed findings is the existence of a *nonlinear* relationship between service innovativeness and performance. As posited by the S-D logic that higher

novelty innovation requires more diverse and dense resources for value cocreation, a nonlinear relationship is plausible (Lusch & Nambisan, 2015). Given resource limitations, novelty will likely have a curvilinear relationship with performance. A third explanation is the existence of *contingencies* for this relationship that vary from one study context to another. One such contingency is customer participation, as customers are considered service cocreators (Yu & Sangiorgi, 2018). Customer participation can increase resource density for value cocreation, which will interact with resource integration for innovation. This notion implies that customer participation could moderate the impact of service innovativeness on new service performance (Chang & Taylor, 2016).

2.3 Customer Participation

S-D logic focuses on the primacy of value-in-use and suggests that value is uniquely determined by customers in their own use situations (Foglieni & Holmlid, 2017). In this sense, firms offer value propositions that customers can choose to accept or reject (Vargo & Lusch, 2008). In contrast, goods-dominant logic focuses on the transaction value of goods (Yu & Sangiorgi, 2018). As per S-D logic, customers are perceived as *part of value cocreation,* rather than inputs for organizational production as suggested by the goods-dominant logic (Lusch & Nambisan, 2015; Yu & Sangiorgi, 2018).

S-D logic suggests that customer participation can increase *resource density* as *ideators* or *designers* (Lusch & Nambisan, 2015). As ideators, customers can provide needs-related knowledge and unique work context for innovation, whereas as designers, customers can help mix and match existing knowledge components or resources to configure new services (Lusch & Nambisan, 2015). Consequently, customers can directly and indirectly contribute to service innovation. However, past research has reported mixed findings on the effect of customer participation (Chang & Taylor, 2016). Ordanini and Parasuraman (2011) investigated service innovation in hotels and found that customer collaboration (i.e., customers as ideators) led to more service innovation and higher firm revenue. Similarly, Schaarschmidt, Walsh, and Evanschitzky (2018) reported the positive influence of customer interaction on service innovation in IT service firms. In contrast, through surveying 102 Spanish service firms, Carbonell, Rodriguez-Escudero, and Pujari (2009) found no direct impact of customer participation on competitive superiority and sales performance. Similarly, Chen, Tsou, and Huang (2009) reported that customer participation (as part of external partner collaboration) does not affect service delivery innovation and performance in their study of financial service firms.

Again, a plausible explanation for such mixed findings is that customer participation may have a moderating effect on the impacts of innovativeness on new service performance. This explanation is in agreement with S-D logic, which suggests that resource density will influence the effectiveness of resource integration for service innovation (Lusch & Nambisan, 2015). As customer participation can increase resource density, it is reasonable to expect that customer participation could moderate the effectiveness of resource integration for performance. Accordingly, we propose a moderating effect of customer participation.

3 Research Model and Hypotheses

Drawing on S-D logic and the related literature, we develop a model to explain service performance in terms of service innovativeness (i.e., novelty and intensity) and customer participation in the context of mobile app innovation on app platforms. The proposed model is shown in Figure 1. The dependent variable, mobile app performance is assessed through the revenue earned by the app, which is an appropriate success measure for paid apps (Liu et al., 2014).

3.1 Novelty of Service Innovativeness

Novelty of new services is defined as the degree of departure from existing services and reflects the newness in service concepts, delivery, processes, and content (Chen et al., 2009; Storey & Larbig, 2018). Previous studies have argued that novelty of services could attract new customers, enhance the competencies of performing services, and create differentiation advantage in the market (Lusch & Nambisan, 2015; Ordanini & Parasuraman, 2011). Prior research has suggested that the novelty of new services is positively related to their commercial success (Storey et al., 2016).

However, the relationship could be more nuanced than previously expected. According to S-D logic, highly novel services will need to integrate more dense and diverse resources to create value (Lusch & Nambisan, 2015). For example, high levels of novelty may require greater effort and capabilities from service producers to change their existing resource integration practices (Foglieni & Holmlid, 2017). The need for practice change could challenge the operations of service providers and reduce the performance of new services (Story et al., 2015). Hence, high levels of novelty may not benefit but adversely affect new service success. At the same time, incremental (low-level novelty) innovations are unlikely to help organizations achieve long-term competitiveness and superior performance (Lau, Yam, & Tang, 2011).

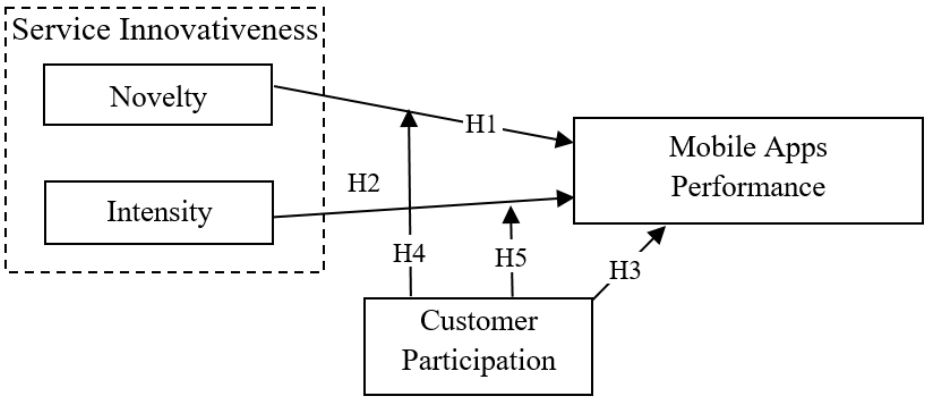

Figure 1. Research Model

Past literature on service innovation has also suggested that extremely high levels of novelty will increase the unfamiliarity and risks associated with new services (Foglieni & Holmlid, 2017). Evidently, unfamiliarity can result from a lack of information and standards to evaluate the innovation when it is very novel (Stock & Zacharias, 2013). The lack of information could hinder customer judgment and experience of the value of the new service (Yu & Sangiorgi, 2018). Furthermore, perceived risk is detrimental to the success of a new service, as customers are not then willing to accept the new service. By contrast, moderate novelty in new services would require the integration of resources that current operations can potentially accommodate. Furthermore, moderately novel services are associated with limited risks and uncertainty, as customers are familiar with the majority of service components. Overall, moderately novel services can achieve optimal performance. By combining the preceding arguments, we expect that the novelty of service innovativeness will show an inverted U-shaped relationship with service performance.

In the context of our study, we expect a similar relationship between the novelty and performance of mobile apps. Specifically, we argue that radically novel mobile apps may require greater resources from customers, which can be difficult to obtain. This requirement may discourage customers from experiencing the value of these new services. For example, new levels in *Angry Birds 2*, which require users to acquire different skills to win, were perceived as too difficult, thus resulting in customers abandoning the service (Cervantes, 2015). Therefore, highly novel mobile apps could make it challenging for the app developer to enhance customers' familiarity with the app and thereby engage them in the service experience. For example, app developers may need to expend extra effort to design on-boarding experiences for highly novel apps to assist customers in gaining familiarity with and experiencing their new features (Ledure, 2017). In contrast, moderately novel mobile apps can attract new customers and revenue by stimulating curiosity and expectations for a novel experience. Thus, we hypothesize:

H1: Novelty of service innovativeness has an inverted U-shaped (negative quadratic) relationship with mobile app performance

3.2 Intensity of Service Innovativeness

Intensity of service innovativeness is defined by the frequency of innovating and reflects the depth of resource integration. Integrating resources in depth can allow iterative improvement, which is conducive to success (Storey et al., 2016). Constantly innovating on the serving process helps update service offerings and service concepts and improves service quality, delivery, and performance (Foglieni & Holmlid, 2017). As a result, the intensity of innovativeness could attract new customers to experience the service and thus result in higher revenue.

Furthermore, intensity of service innovativeness reflects the effort put into resource integration, which is likely to improve innovation performance (Lusch & Nambisan, 2015). In the context of our study, the creation of each new version of mobile apps involves app developers and customers integrating their resources (e.g., needs-based knowledge and solution-based knowledge) for innovation (Lusch & Nambisan, 2015). Deeply integrating the extant resources could help app developers exploit innovation opportunities and produce innovations that the market favors (Sambamurthy, Bharadwaj, & Grover, 2003). Therefore, we hypothesize:

H2: Intensity of service innovativeness is positively related to mobile app performance

3.3 Customer Participation

Customer participation refers to the degree of customer involvement in providing information and feedback on specific issues related to new service (Chang & Taylor, 2016). According to S-D logic, customers contribute to the density of resources for innovation (Storey & Larbig, 2018). Increased resource density is conducive to the generation of successful new services (Schaarschmidt et al., 2018; Storey & Larbig, 2018). Customers can add to the service innovation process by applying their competencies and needs information to resource integration (Lusch & Nambisan, 2015; Storey & Larbig, 2018).

On the one hand, information about *latent customer needs and preferences* can be assimilated into service concepts and offerings through customer participation (Storey & Larbig, 2018). On the other hand, customers can increase resource density by applying their *contextual usage knowledge* to the value creation of new services (Lusch & Nambisan, 2015). Customers' understanding and appreciation of the value of new services can also be integrated into future innovation endeavors (Bayus, 2013) and enhance the success of these services (Storey & Larbig, 2018). These arguments align with previous findings that customers participate in service innovation by providing useful feedback and bring target innovations to the awareness of new customers (Di Gangi & Wasko, 2009). Thus, customer participation can increase the density of important resources (e.g., latent customer needs, preference, and contextual usage knowledge) that service producers can integrate for better service performance.

In the context of our study, customers are able to participate in service innovation by providing comments, suggestions, and ideas regarding the design of new mobile apps. Such feedback can convey information about their latent needs, preferences, and contextual usage knowledge (Ye et al., 2019) and thereby help service producers enhance apps for greater customer acceptance and revenue. Therefore, we hypothesize:

H3: Customer participation is positively related to mobile app performance

3.4 Interactions Between Service Innovativeness and Customer Participation

As per S-D logic, value cocreation depends on resource integration and resource density (Lusch & Nambisan, 2015). In particular, resource density influences the effectiveness of resource integration for service innovation and customer participation increases the density of resources for integration and innovation (Vargo et al., 2008). Customer participation helps increase the width of resource integration by providing diverse resources. This reduces the requirement for service producers to source a wide range of resources for innovation and can hence alleviate the challenges caused by the need for novel new services. Furthermore, customers who apply their competencies in service innovation will help increase the value created. On the one hand, such participation helps reduce the effect of perceived risks and uncertainty associated with service novelty (Yu & Sangiorgi, 2018). On the other hand, it reduces the effort required by new customers to use novel services, e.g., learning new skills, as previous customers' contextual usage knowledge is integrated into new offerings (Story et al., 2015). As a result, new customers are easily able to cocreate value with new offerings. These arguments suggest that customer participation positively moderates the impact of novelty on performance.

H4: With high customer participation, the negative quadratic relationship between the novelty of service innovativeness and mobile app performance is reduced relative to those mobile apps with low customer participation

Customer participation will contribute contextual usage knowledge and preference information and hence increase the resource density residing within each new service. According to S-D logic, high resource density will facilitate the bundling of diverse resources and potentially increase the value of new resources (Lusch & Nambisan, 2015). Bundling diverse resources will increase the amount of value created in each version of a new service and hence improve its performance. In other words, deeply integrating diverse resources into the creation of a new service will increase its value (Vargo et al., 2008). With high customer participation, service creators can impart more value to each innovation. As a result, the impact of intensity on performance increases. Conversely, without customer participation, limited contextual usage knowledge and customer preference information will be included in a new service. This will reduce the value of the new service. In the context of mobile apps, when customer participation is high, resources related to customer needs, satisfaction, and preferred features abound. Bundling such resources in each version of an app is likely to increase its value, e.g., making the new app more attractive, user-friendly, and/or engaging. Based on this logic, we hypothesize:

H5: With high customer participation, the positive relationship between the intensity of service innovativeness and mobile app performance is strengthened relative to mobile apps with low customer participation.

4 Methodology

4.1 Research Setting

Our study context is the mobile app service industry. We selected the Android instead of iOS app store because the former is the most popular smartphone operating system worldwide (Smith, 2017) and is available for public access and review. It allows service producers to constantly update their applications through the platform with few constraints compared with iOS (Ye & Kankanhalli, 2018). Appszoom (www.Appszoom.com) was our research site. It offers features representative of many Android app sites and allows consumers to review and comment on the apps. Furthermore, service providers have considerable autonomy in determining frequency and content when updating mobile apps and data for the Android market can be publicly accessed on this platform. These conditions make this context suitable to validate our proposed model.

4.2 Data Collection and Operationalization

The sampling frame consisted of all 24 categories of applications on the Android platform. We selected all applications that were first published on February 1, 2011, resulting in 980 applications in total, and collected the data from these applications every month until March 1, 2012 (a total of 14 times). After removing those applications that did not survive in the market, 600 applications remained. Regarding the financial performance of mobile apps, traditional pay per download is the most common revenue source for paid app developers, as compared with in-app purchases, advertising, or subscription revenue for free-of-charge apps (Liu et al., 2014). Furthermore, the impact of customer participation (i.e., review rating) is less important for free apps than for paid apps (Liu et al., 2014). Therefore, paid apps serve as a suitable sample to test our model. As a result, we excluded free-of-charge applications and outliers and were left with a panel dataset of 3276 instances derived from 234 applications in 10 categories. During the data collection period, 1,907 new versions of these 234 applications had been published.

We operationalized the *intensity of service innovativeness* (intensity) as the *number of versions* that a mobile data service application released during the study period. This measure is similar to that used in previous literature on software innovation that typically investigates contexts in which a new version represents incremental improvement over a previous version (e.g., improving the usability or visualization) (Saxena, Deodhar, & Ruohonen, 2017). Moreover, launching software via different versions allows new features to be gradually incorporated into production (Yap et al., 2010). Since new features are carefully deployed and tested in different versions, this process helps increase usability and maintains system stability. Following this logic, we propose that each new version of an application represents a degree of innovativeness and change. For example, service producers for game applications may generate a new version by adding additional levels to the game, modifying the visualization of its look, or changing the substantive game play. Thus, the number of new versions represents the intensity of service innovation.

We measured the *novelty of service innovativeness* (novelty) by counting the *number of changes* offered in the different versions of the application. We hired two student coders to count the number of new features, characters, functionalities, levels, design, visualization, and content in the new version. They were instructed to *exclude minor changes* (e.g., bug fixing and error correction) in their counting. The overall interrater correlation was 0.95, $p < 0.001$. We used the average count number to measure the novelty of service innovativeness.

We operationalized *customer participation* as the number of customer comments to which application developers replied.[1] Comment replies indicate that application developers paid attention to the issues mentioned by the customer and intended to change the app accordingly in the future. To assess the validity of this measure, we qualitatively investigated how app developers actually interact and learn from customer comments. Sample customer comments are shown as follows:

> *…latest update includes a lot of great features! Epic Quest is a welcome addition compared to the current dead-end "story" mode ... the dedicated HOME button is intuitive ... and the extra repeat buttons are useful too! still not a fan of the current Shadowland level settings ... there's no effing way Hawkeye could take down Captain America....*
>
> *I have submitted the issue via support but I couldn't attach a screenshot of the issue, I just got a spinner for a very long time. I reported it but the support process is not very easy. I should be able to drag and drop an image onto the page. Also, I want to be able to message people on my friends list easily.*

[1] We thank one of the reviewers for suggesting this measurement. Please refer to the link below for an example. https://play.google.com/store/apps/details?id=com.zalivka.animation&showAllReviews=true

Table 1. Data Transformation

Download category	Mean coding	Ordinal coding
<50	25	1
50-100	75	2
100-500	300	3
500-1000	750	4
1000-5000	3000	5
5000-10000	7500	6
10000-50000	30000	7
50000-250000	150000	8
>250000	250000	9

The following statements are corresponding responses from the app developer:

> *We're happy to know that you like the game! If you have concerns about the game feel free to contact our Customer support team….*
>
> *We are very sad to hear that you see our game this way. We would love to hear your feedback and suggestions more so that we could improve our game in the near future. Please send us your thoughts on our Customer Service here….*
>
> *Thank you for leaving us your review and we are terribly sorry for any inconveniences. We hope new updates of this app have addressed your inconveniences. If you have any feedback regarding…, please contact our customer service....*

Qualitative evidence shows that developers do listen to customers and further solicit their detailed suggestions for future improvement. To empirically test the accuracy of this measure for customer participation, we used a sample of 20 apps and coded the customer comments of each app. We coded a comment as 1 if it provided information regarding the features that a customer likes or dislikes or any suggestions for future improvement. We coded a comment as 0 if it did not contain any useful information for improvement. On average 75.2% of customer comments contained useful information for future improvement. In addition, the number of comments that contained useful information was highly correlated with the total number of comments ($r = 0.83$, $p < 0.01$). Thus, we are convinced that this measure for customer participation is valid and useful to our study.

We measured the dependent variable (i.e., mobile app performance) by the revenue of the app (i.e., by multiplying the number of times that the application had been downloaded with its price). Given that the Android platform displays the number of downloads for each application in an ordinal manner (see Column 3 of Table 1), we used the mean of this category as the number of downloads (see Column 2 of Table 1) (Lee & Raghu, 2014).

4.3 Control Variables

We also included control variables that may affect the revenue of a mobile app, i.e., *size* of the application, *application category*, and *past experience* of the developer. *Size* of application refers to the digital space that the application will occupy in the customer's mobile phone and is measured in kilobytes. *Application category* refers to the category to which an application belongs.

Table 2. Construct Definition

Construct	Definition	Refs.
Mobile app performance	The revenue the mobile app receives in the market	Liu et al. (2014)
Intensity	The degree to which services are frequently innovated	Storey et al. (2016)
Novelty	The degree to which new services are discontinuous or depart from existing services	
Customer participation	The degree of customer involvement in providing information and feedback on specific issues related to the new service	Chang & Taylor (2016)

We used dummy variables to represent the 10 application categories. *Past experience* of the developer was measured by the *number of applications* that the developer created before the current one and the *average rating* of the developer's applications (on a scale of 1 to 5). Construct definitions are listed in Table 2, while descriptive information about all variables is listed in Table 3.

4.4 Model Specification

H4 and H5 predict moderation effects. Thus, we tested these hypotheses with two regression models. We tested for the main and moderating effects in Model 1 and Model 2, respectively. In each equation, subscript *i* represents the app and subscript *t* represents the time.

Model 1: Ln ($Mobile\ apps\ performance_{it}$)$= \beta_1 Novelty_{i(t-1)} + \beta_2 Novelty_{i(t-1)}^2 + \beta_3 Intensity_{i(t-1)} + \beta_4 Customer\ participation_{i(t-1)} + \beta_5 Ln\ (Size_{i(t-1)}) + \beta_6 No.\ of\ applications_{i(t-1)} + \beta_7 Average\ rating_{i(t-1)} + \beta_8 Application\ category + \xi_{i(t-1)}$

Model 2: Ln ($Mobile\ apps\ performance_{it}$)$= \beta_1 Novelty_{i(t-1)} + \beta_2 Novelty_{i(t-1)}^2 + \beta_3 Intensity_{i(t-1)} + \beta_4 Customer\ Participation_{i(t-1)} + \beta_5\ Ln\ (Size_{i(t-1)}) + \beta_6 No.\ of\ applications_{i(t-1)} + \beta_7 Average\ rating_{i(t-1)} + \beta_8\ Application\ category + \beta_9 Novelty_{i(t-1)} * Customer\ participation_{i(t-1)} + \beta_{10} Novelty_{i(t-1)}^2 * Customer\ participation_{i(t-1)} + \beta_{11} Intensity_{i(t-1)} * Customer\ participation_{i(t-1)} + \xi_{it}$

where $mobile\ app\ performance_{it}$ is the revenue that application *i* has earned at time *t*; *Size* denotes the size of the application measured in kilobytes; $No.\ of\ applications_{it}$ is the total number of applications that the developer of application *i* has developed at time *t*; $average\ rating_{it}$ is the average rating score of applications that the developer of application *i* has developed at time *t*; *application category* is a dummy variable that indicates the type of each application; $intensity_{it}$ is the number of versions that application *i* has at time *t*; $customer\ participation_{it}$ *denotes* the number of comments to which the developer replied for the application *i* at time *t*. ξ_{it} is the random error term and β is a parameter vector.

Table 3. Variable Description

	Description	**Mean**	***SD***	**Min**	**Max**
Mobile app performance	Revenue that the application has earned in USD	6211.25	4356.31	5.00	14430.00
Intensity	The number of versions that each application has updated	0.58	1.47	0	13
Novelty	Coded measure of new features, functions, etc.	5.50	4.65	0	11
Customer participation (*replied comments*)	The number of customer comments to which developers replied.	0.30	1.20	0	15
Size	The digital bits of the application in KB	7883.82	11069.73	14	46377
Past experience: No. of applications	The number of applications developed by the developer	29.61	69.55	1	159
Past experience: Average rating	The average rating of all applications developed by the developer	3.38	1.32	1	5
Cat1	Application category: Adult	0.15	0.36	0	1
Cat2	Application category: Book and references	0.25	0.44	0	1
Cat3	Application category: Business	0.09	0.29	0	1
Cat4	Application category: Education	0.04	0.05	0	1
Cat5	Application category: Entertainment	0.06	0.24	0	1
Cat6	Application category: Finance	0.06	0.25	0	1
Cat7	Application category: Media and video	0.04	0.20	0	1
Cat8	Application category: News and magazines	0.08	0.27	0	1
Cat 9	Application category: Sports	0.08	0.28	0	1
Baseline	Application category: Others	0.11	0.31	0	1

Table 4. Variable Correlation

	1	2	3	4	5	6	7
1. Mobile app performance	1						
2. Intensity	0.16	1					
3. Novelty	0.23	0.43	1				
4. Customer participation	0.27	0.34	0.21	1			
5. Size	0.01	-0.18	0.18	0.01	1		
6. Past experience: No. of applications	-0.09	-0.21	-0.18	-0.21	-0.14	1	
7. Past experience: Average rating	0.20	-0.05	0.08	0.21	0.10	-0.15	1
Note: Category dummies are not included.							

4.5 Statistical Method

We performed a natural log-transformation since the data for the mobile app performance are highly skewed. Although we controlled for several important confounding factors, some unobservable application-specific factors may have confounded our results. When these factors are stable over time (e.g., the effort put in developing innovations, or developers' motivations), the fixed or random effects panel data models can be applied to account for endogeneity issues (Wooldridge, 2010).

We performed tests to select between the fixed-effects and random-efforts model. The random effects model must satisfy the assumption that the unobserved individual effects should be uncorrelated with other independent variables. Violation of this assumption produces inconsistent estimates. The Hausman test was significant (x^2 = 543.26, $p < 0.001$), indicating that the fixed effects model is preferred.

5 Analysis and Results

We used STATA 13.0 to perform the fixed-effects analysis. The descriptive statistics and correlation values of the variables are shown in Tables 3 and 4 respectively. To test for a potential multicollinearity problem, we computed variance inflation factors (VIFs). Multicollinearity can be present particularly in models that use the fixed effects and interaction effects. However, the VIFs for all variables in the analysis (including the interactions and square term) ranged from 1.4 to 2.3, ruling out this issue (Diamantopoulos & Siguaw, 2006).

5.1 Hypothesis Testing

We first estimated a random effects model of mobile app performance on control variables. Table 5 shows that among the control variables, the average rating of all applications by the developer is significantly related to mobile app performance. This result suggests that highly rated developers are likely to develop new services with better performance.

We next estimated a fixed effects model of mobile app performance on the main and interaction effects of customer participation and service innovativeness. To test the interaction effects, we mean centered the independent and moderating variables. Column 2 in Table 5 shows that the *novelty of service innovativeness* has an inverted U-shaped relationship with mobile app performance (β_1 = 0.311, $p < 0.001$; β_2 = -0.115, $p < 0.01$), providing support for H1. Additionally, *intensity of service innovativeness* has a positive linear relationship with mobile app performance (β_3 = 0.232, $p < 0.01$). Thus, H2 is also supported.

Column 3 of Table 5 shows that *customer participation* positively affects mobile app performance (β_4 = 0.134, $p < 0.001$), indicating that H3 is supported. Column 4 of Table 5 shows that *customer participation* positively moderates the curvilinear relationship between *novelty of service innovativeness* and *mobile app performance* (β_{10} = 0.134, $p < 0.01$). This finding suggests that H4 is supported. Figure 2 depicts the interaction plot for H4. Further, we found a positive moderation effect of customer participation on the linear relationship between *intensity of service innovativeness* and *mobile app performance* (β_{11} = 0.264, $p < 0.01$). Thus, H5 is also supported.

5.2 Robustness Checks

We tested the robustness of the results in several ways. First, we estimated our models using *downloads* instead of *revenue* to measure the dependent variable (i.e., mobile app performance). For the mean-coding downloads (see Table 1), we use the fixed effects model. For the ordinal-coding download (see Table 1), we use the ordered logistic regression method (Jaccard, 2001). Our results shown in Table 6 (Columns 1 and 2) remain substantively the same. Furthermore, the results are consistent with our results in Table 5. This result suggests that our findings are robust to the different measures of the dependent variable.

Table 5. Data Analysis Results

Independent variables	***DV*= Ln (Mobile app performance)**			
	1	**2**	**3**	**4**
Intensity $_{i(t-1)}$		0.232**	0.226**	0.221**
Novelty $_{i(t-1)}$		0.311***	0.307***	0.288***
Novelty $_{i(t-1)}^2$		-0.115**	-0.121***	-0.105***
Customer participation $_{i(t-1)}$			0.134***	0.113**
Intensity $_{i(t-1)}$ * Customer participation $_{i(t-1)}$ [a]				**0.264****
Novelty $_{i(t-1)}$ * Customer participation $_{i(t-1)}$ [a]				0.041
Novelty $_{i(t-1)}^2$ * Customer participation $_{i(t-1)}$ [a]				**0.134****
Ln (Size)	0.09	-0.04	-0.07	-0.12
Past experience: No. of applications	0.08	0.06	0.07	-0.11
Past experience: Average rating	0.34**	0.28**	0.19**	0.14*
Fixed effects	No	Yes	Yes	Yes
R^2	0.008	0.134	0.146	0.182
Number of observations	3276			

Notes: Significance level: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

[a]Variables are mean centered.

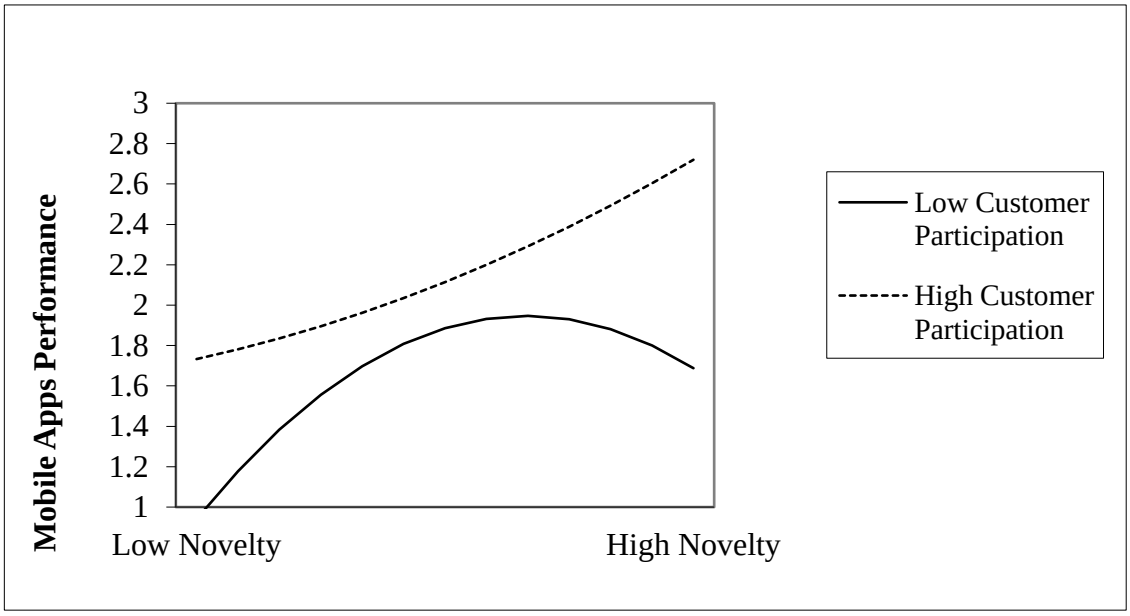

Figure 2. Interaction Plot for Novelty of Service Innovativeness and Customer Participation

Table 6. Robustness Checks

Independent variables	**Downloads (mean coding)**	**Downloads (ordinal coding)**	**Ln (mobile app performance)**
	Fixed effects (1)	**Logistic regression (2)**	**2SLS (3)**
Intensity $_{i(t-1)}$	0.062***	0.175**	0.240**
Novelty $_{i(t-1)}$	0.011	0.105	0.232**
Novelty $_{i(t-1)}^2$	-0.102**	-0.184**	-0.184***
Replied comments $_{i(t-1)}$	0.053**	0.118**	0.104***
Intensity $_{i(t-1)}$ * Replied comments $_{i(t-1)}$ [a]	0.122**	0.181**	0.176***
Novelty $_{i(t-1)}$ * Replied comments $_{i(t-1)}$ [a]	0.013	0.019	0.065
Novelty $_{i(t-1)}^2$ * Replied comments $_{i(t-1)}$ [a]	0.111***	0.195**	0.185**
Ln (Size)	-0.007	-0.010	-0.142
Past experience: no. of applications	-0.002	-0.005	-0.201
Past experience: average rating	0.062*	0.115*	0.272*
Application category: Adult		-0.042	0.002
Application category: Books and references		-0.125	-0.231
Application category: Business		0.242	0.024
Application category: Education		-0.652	-0.112
Application category: Entertainment		-0.581	**0.455***
Application category: Finance		**-2.184***	0.250
Application category: Media and video		**0.774***	-0.237
Application category: News and magazines		**0.208***	-0.283
Application category: Sports		-0.510	-0.334
R^2	0.141	0.271	0.430
Log-likelihood		-1482.21	
Number of observations	3276		

Notes: Significance level: *p < 0.05; **p < 0.01; ***p < 0.001.

[a] Variables are mean centered.

Table 7. Granger Causality Test

	Dependent variables				
	Performance	**Intensity**	**Novelty**	**Novelty^2**	**Customer participation**
Performance	-	1.14	2.20	1.24	2.13
Intensity	3.52*	-	4.63**	2.25	2.21
Novelty	3.99*	1.96	-	3.01	1.02
Novelty^2	3.92*	1.85	2.14	-	1.63
Customer participation	4.33**	1.78	1.02	1.56	-

Notes: Results reported are the *F*-statistic with the *p*-value denoted in stars (*p < 0.05; **p < 0.01; ***p < 0.001). Granger causality test is performed with three lags when AIC is lowest.

Second, we estimated our equations using a random-effects panel model in addition to the application category dummies. Column 2 of Table 6 shows that *finance* applications are less downloaded than the baseline category (*other applications*) while *media and video* and *news and magazines* are more downloaded than the baseline – although these are not significant in Column 3. Column 3 of Table 6 shows that *entertainment* applications perform significantly better than other categories of applications in terms of revenue.

Third, we identified the instrumental variables to address potential endogeneity issue.

The first instrumental variable is IV (intensity)$_{i(t-1)}$ = $\frac{1}{n_k}\left[\sum_{i,t,k}^{n_k}\left(V_{i(t-1)}\right) - V_{i(t-1)}\right]$, where i is the application ID, k is category, t is time. n_k is the total number of the applications in the k category of application. $V_{i(t-1)}$ is the number of versions of the i application at j time. IV (intensity)$_{i\ (t-1)}$ refers to the average number of versions published by all applications excluding the current application in the same category. It could indicate the market's change rate of versions in the same category of application. This may affect the number of versions the application updated through peer influence effects but not its performance.

The second instrumental variable is IV (*replied comment*)$_{i(t-1)}$ =$\frac{1}{n_k}\left[\sum_{i,t,k}^{n_k}\left(C_{i(t-1)}\right) - C_{i(t-1)}\right]$, where i is the application ID, k is category, t is time. n_k is the total number of applications in k category of application. $C_{i(t-1)}$ is the number of comments of i application replied to at $t-1$ time. This measure refers to the average number of comments replied to by all applications excluding the current application in the same category, which may affect the number of comments that the current application received through the similarity effect but not its performance. We used these two instrumental variables and conducted 2SLS. Findings in Column 3 of Table 6 are consistent with those in Column 4 of Table 5, suggesting the robustness of our findings.

Lastly, we conducted the Granger causality test (Granger, 1969). The results shown in Table 7 suggest that the independent variables (*intensity and novelty of service innovativeness* and *customer participation*) Granger-cause mobile app performance. The reverse causality to the dependent variable was not found. Interestingly, we found that *intensity* will Granger-cause *novelty*. This finding is understandable; as explained in our methodology section, new versions are likely to bring new features and functions to mobile apps.

6 Discussion and Implications

Creating and capturing the value of service innovation is important for firms to sustain competitive advantage in the market (Lusch & Nambisan, 2015). Past literature has affirmed that service innovativeness is crucial for service success (Storey et al., 2016). However, the question of how, precisely, service innovativeness contributes to service performance remains (Dotzel et al., 2013). Furthermore, S-D logic suggests that the customer is part of value creation, instead of an input, as indicated in goods-dominant logic (Vargo et al., 2008). This distinction suggests a need for further investigation regarding how customers can cocreate value of service offerings. This need is heightened by the mixed findings of the impacts of customer participation (Chang & Taylor, 2016) or service innovativeness on service performance, suggesting the possibility of contingencies and a more complex relationship. The current study extends existing literature by differentiating the two dimensions of service innovativeness and proposing a more nuanced model in which the dimensions have differential relationships with service performance that are contingent on customer participation. The model was tested using objective data from mobile apps at a popular Android app site.

Consistent with our proposed model, novelty of service innovativeness showed an inverted U-shaped relationship with mobile app performance while customer participation had a positive linear relationship with mobile app performance. Furthermore, customer participation was found to positively moderate the curvilinear relationship between novelty of service innovativeness and mobile app performance. As hypothesized, we also found a linear relationship between intensity of service innovativeness and mobile app performance. As proposed, we found that customer participation positively moderates this linear relationship. Thus, the results indicate full support for our research model.

6.1 Research Contributions

Theoretically, our study contributes to the extant research in several ways. First, this study extends existing literature on service innovativeness (Berry et al., 2006; Dotzel et al., 2013) by conceptualizing it in terms of two distinct dimensions (i.e., novelty and intensity) and explaining the differential impacts of each dimension. The findings indicate important asymmetries regarding the effects of novelty and intensity of service innovativeness on mobile app performance (curvilinear vs. linear relationships). Our model proposes that the two dimensions of service innovativeness influence service performance in unique ways, which is more nuanced than what prior research has suggested (Dotzel et al., 2013; Storey et

al., 2016). While novelty and intensity are both important to mobile app performance, the mechanisms of influence and their effects differ. This finding expands our understanding of how specifically service innovativeness contributes to service performance, as compared to earlier unidimensional conceptualizations.

Second, the results indicate a curvilinear relationship between novelty of service innovativeness and mobile app performance. This suggests that the service innovativeness-performance relationship is more complex than previously thought. In addition, service innovativeness is not always beneficial for service success. This finding and the underlying theorization help expand our understanding of the consequences of service innovativeness beyond linear assessments and offer an explanation for real-life cases suggesting that increasing innovativeness eventually generates diminishing returns for new services (Hruska, 2016). The finding of the curvilinear relationship between novelty and performance thus advances our understanding of the nature of this relationship and adds to the existing literature on service innovation (e.g., Dotzel et al., 2013; Lusch & Nambisan, 2015).

Third, our results add to the research on customer participation (e.g., Chang & Taylor, 2016; Storey & Larbig, 2018) by exploring the direct and indirect impacts of customer participation on mobile app performance. We view customer participation as part of the creation of new services rather than an input. Although the direct impacts that we observed for customer participation on service performance are consistent with those in existing studies (Chang & Taylor, 2016), we further extend the literature on customer participation by identifying and explaining the interaction effects of customer participation and service innovativeness. Our model and results suggest that the beneficial effect of service innovativeness on service performance depends on the degree of customer participation in the innovation process. Extensive customer participation helps new services generate superior performance benefits from increased innovativeness. Evidently, our model validates the idea that customers can contribute to the process of value creation, instead of serving as antecedents of service innovation, as previously postulated (e.g., Schaarschmidt et al., 2018; Storey & Larbig, 2018). Moreover, although the impacts of novelty and intensity on service performance differ, customer participation across the board enhances such impacts.

Fourth, our findings serve as an empirical validation of the relevant aspects of S-D logic (Vargo & Lusch, 2004, 2016) by testing the impact of customer participation and service innovativeness. This study further adds to the S-D logic literature by applying it to the context of mobile apps, which is an unexplored context. Our results indicate that S-D logic provides more insight into the impacts of service innovativeness on mobile app performance than previously realized. This enriches the existing literature on mobile apps (e.g., Lee & Raghu, 2014) and can be used for future research in this area. In addition, S-D logic increases the understanding of the role of customers in service innovation. Instead of viewing customer participation as an input, we find that customers iteratively participate in the process of service innovation and help improve the impacts of innovativeness on performance. This adds to the existing literature on service innovation (e.g., Berry et al., 2006; Dotzel et al., 2013), which has primarily relied on the goods-dominant logic.

6.2 Practical Implications

Practically, our study provides guidelines to management on deriving value from innovative mobile apps. First, we suggest the importance of service innovativeness in influencing mobile app performance. Our results indicate that neither highly novel nor low-novelty services attain superior performance. This finding suggests that service firms should consider customers' current knowledge of new services before they develop highly innovative services. Service firms should also inform and train their customers regarding the new value proposition offered by innovative services. Specifically, they could inform customers by advertising the new value propositions to them. They could also provide trial versions of mobile apps for customers to gain the necessary skills before they assess their value (Hughes, 2011).

Second, our results also indicate that customer participation is vital for mobile app performance. Service firms should solicit feedback from customers regarding the limitations of the current versions. They should cultivate practices that encourage customers to participate in the development of mobile apps (Ye et al., 2019). Such practices include inviting customers to comment on the applications and offering incentives for them to provide feedback, such as longer time for free use of the app.

Third, our findings also show that customer participation moderates the influence of service innovativeness on mobile app performance. This suggests that customer input should be included in the process of new service design and be incorporated into new versions of mobile apps. Thus, service firms should encourage customers to provide feedback on the current version of mobile apps applications and include comments in the new versions. Also, the results suggest a particularly crucial role of customer participation in mitigating the downside effects of service novelty and enhancing the effects of innovation intensity. Overall, mobile app developers should actively include customers in the process of value creation.

6.3 Limitations and Future Research

The findings of this study should be interpreted in light of its limitations. First, we measured customer participation by counting the number of comments that received replies, i.e., comments that attracted the attention of developers and were critical to the creation of mobile apps. However, there is the possibility that some comments may not be adopted in new versions of the application. Future research should conduct other investigations (e.g., experiments) to examine how such comments will affect developers' creation of mobile apps.

Second, we examined the influence of two key variables, namely customer participation and service innovativeness, on mobile app performance. Future research should explore the influences of additional, e.g., environmental or app developer, variables on mobile app performance. For example, researchers could examine the influence of competition intensity, environmental dynamism, or app developer type, on mobile app performance. Also, alternative theories could explain other aspects of mobile app performance. For example, word-of-mouth theory (Chevalier & Mayzlin, 2006) could be employed to understand the influence of peer ratings on mobile app performance.

Third, we acknowledge that we did not correct for market trend endogeneity.[2] Given our focus on service innovativeness rather than market trends or market orientation, this was beyond the scope of this paper, but would be a worthwhile topic for future research (Song et al., 2018). Furthermore, it would be useful to study the effect of survival of a mobile app in the market, since apps that do and do not survive may evolve along different trajectories (Liu et al., 2014). Fourth, since we measure mobile app performance by multiplying downloads and price, this mainly accounts for purchases by new customers and is unable to capture the revenue from in-app purchases. This is acceptable in our case, as in-app purchases were only introduced for Google Play apps in March 2011 (Chu, 2011) after we started our data collection. Nevertheless, future research should collect revenue data directly from developers (e.g., via surveys) and retest to assess whether the current findings will hold.

7 Conclusion

Considering the importance of capturing the value of new services, practitioners have expressed substantial concerns about what contributes to the success of new services (Storey et al., 2016). However, there are gaps in our understanding of how firms can promote service innovation, especially for mobile apps. To this end, we developed a theoretical model based on S-D logic to explain the impact of customer participation and service innovativeness (both novelty and intensity) on mobile app performance. Our findings indicate that novelty of service innovativeness has an inverted U-shaped relationship with mobile app performance, while customer participation directly and interactively affects mobile app performance. Intensity of service innovativeness has a positive relationship with mobile app performance, while customer participation positively moderates this relationship. These results add to the extant research on service innovation, S-D logic, and mobile apps. They also offer insights to practitioners on how to innovate to improve mobile app performance.

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[2] We thank one of the reviewers for raising this point.

References

Afuah, A., & Tucci, C. L. (2013). Value capture and crowdsourcing. *Academy of Management Review, 38*(3), 457-460.

Allen, S. (2014). Monetizing your mobile app: pay per download. http://www.accella.net/knowledgebase/monetizing-your-mobile-app-pay-per-download/

Barrett, M., Davidson, E., Prabhu, J., & Vargo, S. L. (2015). Service innovation in the digital age: key contributions and future directions. *MIS Quarterly, 39*(1), 135-154.

Bayus, B. (2013). Crowdsourcing new product ideas over time: An analysis of the Dell Ideastorm community. *Management Science, 59*(1), 226-244.

Berry, L., Shankar, V., Parish, J. T., Cadwallader, S., & Dotzel, T. (2006). Creating new markets through service innovation. *Sloan Management Review, 47*(2), 56-63.

Braa, J., & Sahay, S. (2017). The DHIS2 open source software platform: Evolution over time and space. In L. A. G. Celi, H. S. F. Fraser, V. Nikore, J. S. Osorio, & K. Paik (Eds.), *Global health informatics: Principles of eHealth and mHealth to improve quality of care.* The MIT Press.

Calantone, R. J., Chan, K., & Cui, A. S. (2006). Decomposing product innovativeness and its effects on new product success. *Journal of Product Innovation Management, 23*(5), 408-421.

Carbonell, P., Rodriguez ‐ Escudero, A. I., & Pujari, D. (2009). Customer involvement in new service development: An examination of antecedents and outcomes. *Journal of Product Innovation Management, 26*(5), 536-550.

Cervantes, E. (2015). Angry Birds 2 review: How does it compare to the original? https://www.androidauthority.com/angry-birds-2-review-631029/

Chang, W., & Taylor, S. A. (2016). The effectiveness of customer participation in new product development: A meta-analysis. *Journal of marketing, 80*(1), 47-64.

Chen, J.-S., Tsou, H. T., & Huang, A. Y.-H. (2009). Service delivery innovation: Antecedents and impact on firm performance. *Journal of Service Research, 12*(1), 36-55.

Chevalier, J. A., & Mayzlin, D. (2006). The effect of word of mouth on sales: Online book reviews. *Journal of Marketing Research, 43*(3), 345-354.

Chu, E. (2011). In-app billing on android market: ready for testing. https://android-developers.googleblog.com/2011/03/in-app-billing-on-android-market-ready.html

Curran, J. M., & Meuter, M. L. (2007). Encouraging existing customers to switch to self-service technologies: Put a little fun in their lives. *Journal of Marketing Theory and Practice, 15*(4), 283-298.

Di Gangi, P. M., & Wasko, M. (2009). Steal my idea! Organizational adoption of user innovations from a user innovation community: A case study of Dell ideastorm. *Decision Support Systems, 48*(1), 303-312.

Diamantopoulos, A., & Siguaw, J. A. (2006). Formative versus reflective indicators in organizational measure development: A comparison and empirical illustration. *British Journal of Management, 17*(4), 263-282.

Dotzel, T., Shankar, V., & Berry, L. L. (2013). Service innovativeness and firm value. *Journal of Marketing Research, 50*(2), 259-276.

Foglieni, F., & Holmlid, S. (2017). Determining service value: exploring the link between value creation and service evaluation. *Service Science, 9*(1), 74-90.

Granger, C. W. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica: Journal of the Econometric Society, 37*(3), 424-438.

Harris, M. (2018). The History of the iTunes Store. https://www.lifewire.com/itunes-store-history-2438593

Hruska, J. (2016). Woman wins $10,000 judgment against Microsoft for forced Windows 10 upgrade. https://www.extremetech.com/computing/230794-woman-wins-10000-judgment-against-microsoft-for-forced-windows-10-upgrade

Hughes, J. (2011). *iPhone & iPad apps marketing*. QUE Publishing.

Jaccard, J. (2001). *Interaction effects in logistic regression.* SAGE.

Kankanhalli, A., Ye, H., & Teo, H. H. (2015). Comparing potential and actual innovators: An empirical study of mobile data services innovation. *MIS Quarterly, 39*(3), 667-682.

Kuester, S., Schuhmacher, M. C., Gast, B., & Worgul, A. (2013). Sectoral heterogeneity in new service development: An exploratory study of service types and success factors. *Journal of Product Innovation Management, 30*(3), 533-544.

Lau, A. K., Yam, R., & Tang, E. (2011). The impact of product modularity on new product performance: Mediation by product innovativeness. *Journal of Product Innovation Management, 28*(2), 270-284.

Ledure, E. (2017). Onboarding: Building a first-time experience that makes users stick around. https://blog.prototypr.io/onboarding-building-a-first-time-experience-that-makes-users-stick-around-39e3155c467d

Lee, G., & Raghu, T. S. (2014). Determinants of mobile apps' success: Evidence from the app store market. *Journal of Management Information Systems, 31*(2), 133-170.

Liu, C. Z., Au, Y. A., & Choi, H. S. (2014). Effects of freemium strategy in the mobile app market: An empirical study of google play. *Journal of Management Information Systems, 31*(3), 326-354.

Lusch, R. F., & Nambisan, S. (2015). Service innovation: A service-dominant logic perspective. *MIS Quarterly, 39*(1), 155-175.

Lusch, R. F., & Webster Jr., F. E. (2011). A stakeholder-unifying, cocreation philosophy for marketing. *Journal of Macromarketing, 31*(2), 129-134.

Magnusson, P. R., Matthing, J., & Kristensson, P. (2003). Managing user involvement in service innovation. *Journal of Service Research, 6*(2), 111-124.

Mangalindan, J. P. (2014). Google's 8 biggest flops. *Fortune*. Retrieved from http://fortune.com/2014/04/28/googles-8-biggest-flops/

Martin, W., Sarro, F., Jia, Y., Zhang, Y., & Harman, M. (2017). A survey of app store analysis for software engineering. *IEEE Transactions on Software Engineering, 43*(9), 817-847.

McNally, R. C., Cavusgil, E., & Calantone, R. J. (2010). Product innovativeness dimensions and their relationships with product advantage, product financial performance, and project protocol. *Journal of Product Innovation Management, 27*(7), 991-1006.

Nambisan, S., Lyytinen, K., Majchrzak, A., & Song, M. (2017). Digital innovation management: Reinventing innovation management research in a digital world. *MIS Quarterly, 41*(1), 223-238.

Normann, R. (2001). *Reframing business: When the map changes the landscape*. Wiley.

Ordanini, A., & Parasuraman, A. (2011). Service innovation viewed through a service dominant logic lens: A conceptual framework and empirical analysis. *Journal of Service Research, 14*(1), 3-23.

Rubera, G. (2014). Design innovativeness and product sales' evolution. *Marketing Science, 34*(1), 98-115.

Ruiz, I. M., Nagappan, M., Adams, B., Berger, T., Dienst, S., & Hassan, A. (2017). An examination of the current rating system used in mobile app stores. *IEEE Software, 33*(6), 86-92.

Sambamurthy, V., Bharadwaj, A., & Grover, V. (2003). Shaping agility through digital options: Reconceptualizing the role of information technology in contemporary firms. *MIS Quarterly*, 27(2), 237-263.

Sandvik, I. L., Duhan, D. F., & Sandvik, K. (2014). Innovativeness and profitability: An empirical investigation in the Norwegian hotel industry. *Cornell Hospitality Quarterly, 55*(2), 165-185.

Saxena, K. B. C., Deodhar, S. J., & Ruohonen, M. (2017). *Business model innovation in software product industry*. Springer.

Schaarschmidt, M., Walsh, G., & Evanschitzky, H. (2018). Customer interaction and innovation in hybrid offerings: Investigating moderation and mediation effects for goods and services innovation. *Journal of Service Research, 21*(1), 119-134.

Smith. (2017). Android now the world's most popular operating system. https://www.csoonline.com/article/3187011/mobile-wireless/android-is-now-the-worlds-most-popular-operating-system.html

Song, P., Xue, L., Rai, A., & Zhang, C. (2018). The ecosystem of software platform: A study of asymmetric cross-side network effects and platform governance. *MIS Quarterly, 42*(1), 121-142.

Statista. (2018). Worldwide mobile app revenues in 2015, 2016 and 2020. https://www.statista.com/statistics/269025/worldwide-mobile-app-revenue-forecast/

Stock, R. M., & Zacharias, N. A. (2013). Two sides of the same coin: How do different dimensions

of product program innovativeness affect customer loyalty? *Journal of Product Innovation Management, 30*(3), 516-532.

Storey, C., Cankurtaran, P., Papastathopoulou, P., & Hultink, E. J. (2016). Success factors for service innovation: a meta-analysis. *Journal of Product Innovation Management, 33*(5), 527-548.

Storey, C., & Larbig, C. (2018). Absorbing customer knowledge: how customer involvement enables service design success. *Journal of Service Research, 21*(1), 101-118.

Story, V. M., Boso, N., & Cadogan, J. W. (2015). The form of relationship between firm-level product innovativeness and new product performance in developed and emerging markets. *Journal of Product Innovation Management, 32*(1), 45-64.

Szymanski, D. M., Kroff, M. W., & Troy, L. C. (2007). Innovativeness and new product success: Insights from the cumulative evidence. *Journal of the Academy of Marketing Science, 35*(1), 35-52.

Tilson, D., Lyytinen, K., & Sørensen, C. (2010). Research commentary—Digital infrastructures: The missing IS research agenda. *Information Systems Research, 21*(4), 748-759.

Vargo, S. L., & Lusch, R. F. (2004). Evolving to a new dominant logic for marketing. *Journal of Marketing, 68*(1), 1-17.

Vargo, S. L., & Lusch, R. F. (2008). Service-dominant logic: continuing the evolution. *Journal of the Academy of Marketing Science, 36*(1), 1-10.

Vargo, S. L., & Lusch, R. F. (2016). Institutions and axioms: an extension and update of service-dominant logic. *Journal of the Academy of Marketing Science, 44*(1), 5-23.

Vargo, S. L., Maglio, P. P., & Akaka, M. A. (2008). On value and value cocreation: A service systems and service logic perspective. *European Management Journal, 26*(3), 145-152.

Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data*. MIT Press.

Yap, K.-K., Sherwood, R., Kobayashi, M., Huang, T.-Y., Chan, M., Handigol, N., . . . Parulkar, G. (2010). *Blueprint for introducing innovation into wireless mobile networks.* Paper presented at the Proceedings of the second ACM SIGCOMM workshop on Virtualized infrastructure systems and architectures.

Ye, H., Chua, C., & Sun, J. (2019). Enhancing mobile data services performance via online reviews. *Information Systems Frontiers, 21*(2), 441–452.

Ye, H., & Kankanhalli, A. (2018). User service innovation on mobile phone platforms: investigating impacts of lead userness, toolkit support, and design autonomy. *MIS Quarterly, 42*(1), 165-187.

Yu, E., & Sangiorgi, D. (2018). Service design as an approach to implement the value cocreation perspective in new service development. *Journal of Service Research, 21*(1), 40-58.

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