Modeling and analysis for mobile application services: The perspective of mobile network operators

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ABSTRACT

The success of Apple's App Store has motivated many mobile network operators (MNOs) to embrace the application store. However, finding a successful strategy that provides meaningful differentiation in an increasingly competitive mobile application market is a great challenge for MNOs. This research treats the mobile application service as a two-sided market and develops a system dynamics model to understand the diffusion behavior of mobile application services. Choice-based conjoint analysis is used to collect multi-attribute preference data of end-users and developers in order to understand how they select application store service offerings in Taiwan's mobile application market. We found that under the great pressure of application stores offered by mobile platform providers, MNOs have to provide services that directly attract adoption by end-users and developers, because the cross-side network effect is not significant. MNOs need to apply a localization strategy based on their strengths while improving their store service quality by collaborating with third-party IT vendors to persuade developers and end-users to adopt their stores as another "home base". We conclude that MNOs need to not only fully exploit their resources to sense and seize emerging opportunities, but also reconfigure their resources with respect to market dynamics to rebuild their core competences for sustaining their competitive advantages.

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1. Introduction

The mobile telecommunication industry has transformed from value chains to value networks (Basole and Karla, 2011; Funk, 2009; Peppard and Rylander, 2006). Because of subscriber growth saturation and tight voice tariff competition, many mobile network operators (MNOs) have been experiencing declining average revenue per user (ARPU) (Peppard and Rylander, 2006). They have thus begun pursuing innovation in data transmission and value-added services such as news, games, video, music, and apps for end-users that can drive continued revenue growth (Funk, 2009; Kuo and Yu, 2006). However, due to the complex nature of mobile service ecosystem, MNOs do not have all the capabilities required to deliver value-added services. They face a great challenge in how to integrate a cluster of network actors (e.g., software developers, consumers) for co-creating and delivering values to the end-consumer (Funk, 2009; Kuo and Yu, 2006; Peppard and Rylander, 2006).

Initially, MNOs still dominated the market. However, the introduction of Apple's iPhone in 2007 and the launch of Apple's App Store in

July of 2008 greatly changed the mobile service ecosystem (Basole and Karla, 2012; Karhu et al., 2014). Similarly, Google launched its Android Market (renamed Google Play in March of 2012) in August of 2008. Later, Amazon and Microsoft followed suit with their own application stores as well. Though MNOs are supporting this trend by providing network infrastructure and services and receive stable revenue streams from the fast growing mobile data market, they do not retain the dominant positions in the mobile service ecosystem and competitive advantages they enjoyed in the mobile phone business (Basole and Karla, 2011; Ghezzi et al., 2015b). Most importantly, MNOs, simply providing data connectivity and bandwidth do not really create unique and long-term values to the mobile service ecosystem and lose valuable revenue opportunities with the customers (Basole and Karla, 2012). Other challenges still remain, such as a constant decline in revenues from voice traffic, increased price competition on data plans, and struggle to take a position in the content industry (Ericsson, Mobile business trend, 2015). Facing great challenges from rapid technological and market changes, MNOs need to fully utilize their assets to promote innovation and find another way to sustain or create additional revenue streams for their revenue growth. Therefore, many MNOs have launched their application stores themselves to enhance their revenue and subscriber bases, such as AT&T in US and Vodafone in Europe (Holzer and Ondrus, 2010).

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Table 1
Summary of relevant literature.

Research stream	Description	Supporting literature
Mobile app ecosystem	• Mobile service ecosystem has experienced a great value transformation. • Companies involved in different mobile ecosystem system selected quite different collaborative and competitive strategies for growing their market share. • Competitive differentiation and segmentation strategies and a continuous process of interactions and learning from users will become increasingly critical for different app store platforms.	Feijóo et al. (20090, Müller et al. (2011), Basole and Karla (2011), Basole and Karla (2012), Cuadrado and Duenas (2012), Karhu et al. (2014)
MNO perspective	• MNOs has lost their dominant position. • MNOs should continue to provide network services and closely work with other actors to enhance user experiences via more integrated and consistent services and apps. • MNOs may use app stores for their subscribers to buy new smartphones along with more advanced service packages. • MNOs should develop new core competences based on a selected strategy; e.g., "smart pipe", "value network orchestrators", or "innovation coordinators".	Chen and Cheng (2010), Kimbler (2010), Gonçalves (2010), Holzer and Ondrus (2010), Ghezzi et al. (2015b), Ghezzi et al. (2015a)
End-user perspective	• Both quantity-related and environment-related facilitators all influence app discoverability, which affects end-user satisfaction. • Performance expectancy, effort expectancy, facilitating conditions, hedonic motivation, and habit significantly relate with behavioral intention to use mobile apps, habit is a more predominant predictor. • Easiness is the key factor influencing continuance intention of mobile app use, while human connection and social utility are more important than entertainment. • eWOM plays an important role in mobile apps downloads. External eWOM by third-party informediaries plays an important role in paid apps downloads.	Hong et al. (2008), Kim (2012), Kang (2014), Song et al. (2014), Hew et al. (2015), Oh et al. (2015)
Developer perspective	• Freelance developers adopted a mobile platform because of their calculative and affective commitments. • Broadening app offerings across multiple categories is a key determinant for success in app marketplace. Other factors include free app offers, high initial ranks, investment in less-popular categories, continuous quality updates, and high-volume and high-user review scores. • Efficiency is the main value creation driver, while lock-in and novelty yield mixed results depending on the app category. • There has been lack expert participation in the design of health care apps for general public. The security issues should be adopted by developers.	Holzer and Ondrus (2011), Hsieh and Hsieh (2013), Dye and Scarfone (2014), Lee and Raghu (2014), Hyrynsalmi et al. (2014), Dhillon and Mahmoud (2015)

Taiwan's mobile operators have also faced the same challenges. Several local operators have launched content services based on the operator-centric model since 2005. However, the lack of attractive content and software integration support held revenue from the mobile content value-added services to <10% of ARPU in 2008 (Chen and Cheng, 2010). After the end of 2009, three major local operators began copying Apple's App Store by building their own online marketplaces subsequently. However, similar to most MNOs in other countries, they have yet to perceive any notable success and still struggle to keep up. Hence, the challenge for MNOs is to find a successful strategy and provide meaningful differentiation in an increasingly competitive mobile app market (Ghezzi et al., 2015b; Gonçalves, 2010; Holzer and Ondrus, 2010; Wang, 2014).

This research treats the mobile app service as a two-sided market (Eisenmann et al., 2006; Parker and Van Alstyne, 2005; Rochet and Tirole, 2003), where end-users on one side of the market and developers on the other side exchange apps and the utility on the one side of the market increases with the number of participants on the other side (Hagiu, 2014; Heitkoetter et al., 2012; Holzer and Ondrus, 2011). As the number of developers increases resulting in the growth of apps, the store will attract more end-users. Similarly, as the number of end-users increases for the store, the number of developers attracted to this store will also increase, due to a larger number of potential customers. This is called an indirect network effect (Basu et al., 2003) or more accurately called a cross-side network effect that distinguishes network benefits crossing distinct markets (Eisenmann et al., 2006). A system dynamics (SD) methodology (Sterman, 2000), which is a mathematical modeling technique to understand the dynamics of complex systems, is used to capture the characteristics of two-sided market in the mobile app ecosystem in order to analyze the dynamic diffusion

behavior of mobile app services. Since the diffusion of mobile app services is mainly affected by the adoption intentions of main players of the ecosystem, such as developers and end-users, it is important to understand their preferences for the different service offerings of application stores (Schmidt and Gary, 2002; Zhang et al., 2011). Choice-based conjoint (CBC) analysis (Green and Srinivasan, 1990; Raghavarao et al., 2010) is used to collect the multi-attribute preference data of end-users and developers and analyze their relative preferences and tradeoffs among different service offerings. Taiwan's mobile app market is the subject of the study, because of the data gathering convenience. This research thus investigates two key questions: (1) what store attributes are more important to Taiwan's end-users or developers in adopting the service offerings of an application store? (2) What strategies can be used to improve Taiwan's MNO's mobile app services in order to sustain their growth?

The proposed methodology that integrates SD and conjoint analysis can enhance insight into the problem structure and increase understanding of dynamic diffusion patterns of mobile app services. Further, SD simulation models can be built to help Taiwan's MNOs evaluate appropriate strategies for improving their competitive advantages.

This paper is organized as follows. Section 2 reviews the literature on mobile app services. Section 3 presents the developed system dynamics model. The case study and strategies suggested as well as simulation results are discussed in Section 4. Finally, Section 5 concludes the paper.

2. Literature review on mobile app services

Fast growing mobile app market has attracted many researchers' attentions in recent years. Since the mobile app service is complicated and involves various network actors working together to co-produce service