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A Bayesian network approach to examining key success factors of mobile games

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ABSTRACT

As mobile game business becomes one of the most lucrative as well as fast-growing businesses, examining key success factors in this industry is of great interest. Utilizing a research method called Bayesian network, this paper models and tests interrelationship among product, marketing, consumer and competition variables. The current study surveys experts who launch many games in Korea. The three most crucial factors for successful games turn out to be targeting, awareness and consumers' willingness to pay (WTP). Many of the other factors influence the performance of games via these three factors. This paper not only investigates into the sensitivity of game performance to targeting and awareness levels but also examines the influences of product/marketing variables on consumers' first impression or willingness to pay. The findings on the roles of product or marketing factors that affect consumers' perceptions and responses, thereby competitiveness and success, will help game makers and distributors make reasonable decisions in allocating corporate resources more efficiently.

1. Introduction

The mobile game industry is growing fast. Due to rapid diffusion of mobile phones all over the world, the mobile game holds a number of exciting possibilities for new business models and growth strategies (Sharp & Rowe, 2006). The combinations of high-end devices, large developer communities, and ever-expanding retail platforms provide industry participants with various opportunities. The recent hyper-growth of the smart phone market also creates a fruitful basis for the leap of mobile games. Highlighting the significance of the mobile games is the fact that almost a third of the available titles on the application stores, such as Apple's AppStore, are games. Social network services such as Facebook also become one of the key platforms of so-called social games.

Despite the importance and popularity of the mobile games, little research explains what the key success factors are in this business. The purpose of the current study is to explore the interrelationships among various factors at product and consumer levels, thereby examining their direct and indirect effects upon the success of individual mobile games.

The structure of the paper is as follows. First, this article outlines perspectives of game-related studies as well as issues in assessment of new product performance. The following section explains a useful research method called Bayesian networks approach. The next section presents the results of an empirical analysis on mobile games using Bayesian networks model. Some of the sensitivity analysis results follow. Finally, the paper concludes with a discussion on the implications and the limitations of the present study.

2. Literature

2.1. Studies on online games

People play mobile games on cellular phones, PDAs, and other portable game devices such as Nintendo DS or PlayStation Portable. Researchers on digital games focus on online (i.e. Internet) games and give much less attention to mobile games.

Researchers divide the literature dealing with online games into two groups. One focuses on the technical side and the other takes psychological perspectives. The studies in the technical side explore the ways in making computer games more realistic with 3D rendering, sound, and visualization techniques (Rhyne, 2002). Researchers also focus on the development of platforms to increase various units and applications more effectively (Sharp & Rowe, 2006). In the studies on the psychological aspects, the concept of perceived enjoyment is important. Studies adopt a notion of flow in explaining the enjoyment of games. Scholars including Hsu and Lu (2004) apply the technology acceptance model (TAM) to predict users' acceptance of online games. In a later study (2005), the same authors further adjust TAM with perceived enjoyment, social norm and preference as antecedents of loyalty to online game communities. Kwang and Kim (2006) investigate into the factors influencing the usage and acceptance of mobile games, showing that perceived usefulness and ease of use are two major antecedents. Ha, Yoon, and Choi (2007) also

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extend TAM to include an emotion variable and measure the moderating roles of demographic variables on the acceptance of mobile games.

To the authors' knowledge, most empirical studies use data from surveys with the game users on their perceptions toward specific games. The literature on the psychological aspects of online games provides limited business implications because they lack marketing variables or product elements. Besides, studies do not reveal the interrelationships among technical aspects of a game and its users' psychological response. That is, what are the specific technical aspects of a game that may lead the users to a certain perception?

This study fills this gap by exploring the specific roles of the factors that may influence the success of mobile games. A comprehensive perspective of our study on the various aspects of mobile games will contribute to the understanding of mobile game industry and provide useful managerial implications.

2.2. New product success

New product development is one of the core functions of business. In an increasingly competitive global market, capability to develop innovative products becomes critical. Researchers trying to figure out the keys of new product success employ a multiple regression analysis, which has two limitations. First, it assumes a direct relationship between every independent variable and the dependent variable. It doesn't consider interrelatedness among independent variables. Second, multicollinearity problem frequently arises and it decreases the explanation power. As a remedy, scholars rely on a more structured approach called structural equation modeling (SEM). Although SEM is a causal modeling approach that combines cause–effect information to provide a quantitative assessment of relationships among the studied variables, it is not suitable for a diagnosis of the situation and thus has limitations in providing insights for managerial decision making. Non-linear relationships often result in poor prediction and judgment.

Using Bayesian networks (BN) approach can overcome the limitations. The methodology numerically expresses the strength of relationships among variables in terms of probabilistic distributions and automatically calculates the probabilities associated with changes in variables resulting from the input of new evidence. BNs are applicable not only to examining empirically validated model (which is possible by using SEM) but also to developing a model at the hypothetical variable level. BNs are suitable for modeling non-linear relationships, thereby allowing more accurate interpretation and prediction. (Gupta & Kim, 2008). This paper tries to model and test causal relationships among various factors using BNs to analyze their direct and/or indirect effects on the success of mobile games.

3. Research method

3.1. Bayesian networks

Machine learning is an innovative computer-based method extracting patterns from data and performing optimization tasks that can assist managers' decision making and forecasting. Association rules, decision trees, neural networks, genetic algorithms, etc. and are useful in learning new knowledge when researchers have observable data but do not know the model structure (Cui, Wong, & Lui, 2006). As one of these methods, a BN can represent the complex relationships among the elements and makes inroads into management research such as modeling strategic planning of new products (Cooper, 2000) or consumer complaint behavior (Blodgett & Anderson, 2000). Cui et al. (2006) model consumer responses to direct marketing using BNs and compare the results against those of neural networks, classification and regression tree (CART), and latent class regression. BNs have distinct advantages over the other methods in accuracy of prediction, transparency of procedures, interpretability of results, and greater explanatory power. The findings provide a strong support to BNs as a robust tool for modeling marketing problems and a tool for assisting managers' decision making. A BN is a directed acyclic graph in which the arcs connecting nodes reflect the conditional probabilities of outcomes, given the range of factors and assumptions considered. The influence diagrams, or webs, are the visual schemes of BNs. The conditional probability outputs provide managers with the capability to predict the future and to answer diagnostic 'what-if' questions about possible actions. The construction of a BN and subsequent exploitation generally follows a sequence of actions as below (Galan, Matias, Rivas, & Bastante, 2009).

Firstly, the network structure is defined by an expert in the application domain or by means of an estimate derived from the data (structure learning). A combined approach includes some a priori information in the learning algorithm to restrict the relationships permitted between the variables. The learning algorithms use either techniques for searching in the space of possible structures, trying to maximize a model selection criterion (e.g., K2 by Cooper & Herskovits, 1992; BDeu criterion by Heckerman, Geiger, & Chickering, 1995) or statistical independence tests to determine conditioned independence relationships (e.g., the PC algorithm by Spirtes, Glymour, & Scheines, 1993).

The conditional independence between some variables of the network enormously simplifies the calculation of joint distribution from (1) to (2) in the case of Fig. 1:

$$P(X1, X2, X3, X4) = P(X4|X1, X2, X3) \cdot P(X3|X1, X2) \cdot P(X2|X1) \cdot P(X1) \quad (1)$$

$$P(X1, X2, X3, X4) = P(X4|X2, X3) \cdot P(X3|X1) \cdot P(X2) \cdot P(X1) \quad (2)$$

Secondly, parameter learning process estimates the parameters of the joint distribution. Methods typically used at this stage — depending on the characteristics of the problem (i.e., degree of noise, incomplete data, etc.) — are Bayesian estimates, maximum likelihood estimation, the expectation-minimization algorithm, or any combination of these.

3.2. Data collection

Asia is the biggest market in terms of industry revenue with almost 40% market share of mobile games, and Korea is one of the major players. This study use survey data from Korean market to

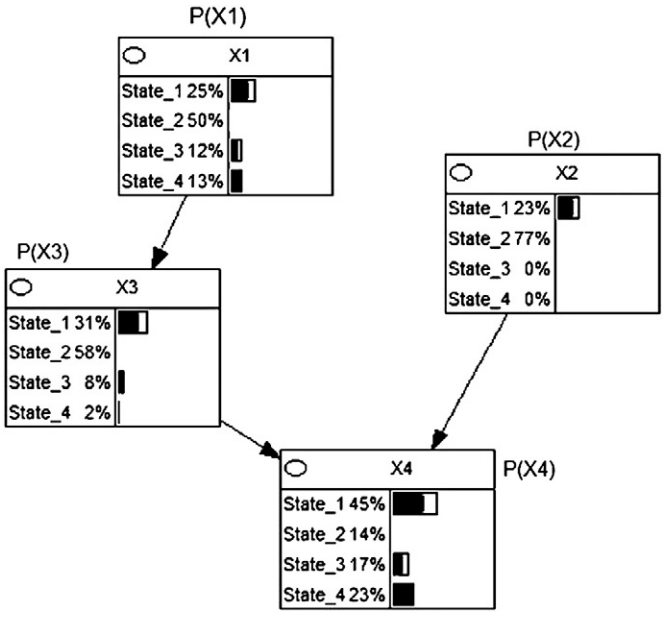

Fig. 1. A dependence structure of a Bayesian network.