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The effect of service rollout on demand forecasting: The application of modified Bass model to the step growing markets

Stevan Velickovic [a,*], Valentina Radojicic [b], Bojan Bakmaz [b]

[a] Department of Postal and Banking Technologies, ICT College of Vocational Studies, Belgrade, Serbia
[b] Department of Telecommunications Traffic and Networks, Faculty of Transport and Traffic Engineering, University of Belgrade, Serbia

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ABSTRACT

The purpose of this research is to develop a new forecasting model for gradual development of telecommunications network infrastructure. If technical support service is not provided in the whole territory, then the service cannot be simultaneously offered to the market. Therefore, the adoption process is performing in steps, following the systematic process of the infrastructure development. We propose the step growing market model with variable market potential, based on the fundamental Bass diffusion model. This model uses market segmentation and the simulation of various market scenarios in order to indicate effective service rollout. Demand forecasting is required in order to dimensioning of required network resources. Moreover, this model offers the insight into the operator's compromises regarding decisions in the network investment. The resulting plan is a network deployment strategy that defines temporal sequence of network layouts. Thus, the upgrade plan indicates which investments are indispensible at each point of time.

1. Introduction

In order to achieve business success, many companies have turned their attention to the development of tools that will assist them in making strategic decisions. Business forecasting should be an integral part of management activities, while timely and proper business decisions are the primary goals of the forecasting process (Radojicic, 2003).

Diffusion theory has been widely applied in order to forecast the adoption of new service/product (Carey and Moss, 1985; Chandrasekaran and Tellis, 2007; Crawford and Di Benedetto, 2014), while the Bass model is one of the more well-known models widely used for analyzing and forecasting in marketing researches and other disciplines (Bass, 1969; Meade and Islam, 2006). One of the characteristic assumptions of the basic Bass model relates to the size of the market potential, whose value is determined at the time of introducing the new service/product and remains constant along the whole diffusion process.

This paper proposes a new service forecasting model for the markets with the gradual infrastructure development. Based on the fundamental Bass model, it has a significant impact on business decisions, because it provides an insight on market adoption and determines whether or not to move forward with the new service/product. The model considers variable market potential that depends on the technical capabilities related to some new telecommunications services/products. The availability of territory infrastructure is increasing during the time according to the infrastructure investment necessity. These investments make influence to the market potential by creating conditions for more users to adopt new services/products. The application of the model is adequate in cases when the number of potential users over time follows the step-growth function. Accordingly, we named this model, the step growing market model. The applications of the proposed model are especially convenient in a certain categories of the new telecommunications services/products, which require previous ability to fulfill the technical standards for the traffic area.

The reminder of the paper is organized as follows. The next section presents the fundamental principles of diffusion theory and provides a comprehensive literature overview concerning models with a variable market potential based on modifications of the basic Bass model. Third section presents a new diffusion model, which is applicable to the step growing markets. This section explains the theoretical background of the proposed model as well as the specific cases where the application of this model is recommended. The last section gives the numerical example and comparison between the Bass model and the step growing market model. Finally, some conclusions are given.

2. Diffusion models with variable market potential — literature review

The fundamental Bass model describes a new service adoption process by observing the interaction between the existing and the potential users. The probability of current purchase by someone who is still on the market is a linear function of the number of previous buyers (Bass, 1969). This model has three key parameters: the parameter of innovation or external influence (p), the parameter of imitation or internal influence (q) and the market potential (m). The parameter q reflects the

* Corresponding author at: Zdravka Celara 16, 11000 Belgrade, Serbia.
E-mail address: stevan.velickovic@ict.edu.rs (S. Velickovic).

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influence of those users who have already adopted a new service/technology (i.e. "word of mouth" communication from previous adopters — WoM effect), while p captures the influence that is independent from the number of adopters (i.e. external communication).The effect of mass media refers to those users who are interested in services/products that are the latest and the best. Advertisement heavily influences this segment of the market and creates users awareness and service presence. The effect of verbal transmission of experience is stronger in terms of reflecting the dynamics of the new service adoption.

The latter models mainly represent the modifications of the existing ones. As the most significant modifications, the following models can be considered: model with marketing variables (Robinson and Lakhani, 1975), generalized model that takes into account the diffusion of successive generations of observed technology (Norton and Bass, 1987), generalized model that observes the adoption process of innovations at various stages in different countries (Eliashberg et al., 1989). Many other models also present modifications of the Bass diffusion model (Meade, 1984; Mahajan and Peterson, 1985; Mahajan et al., 1990; Mahajan et al., 1993; Baptista, 1999; Mahajan et al., 2000; Meade and Islam, 2001).

Models with dynamic market potential are considered in the open literature since the 1970s and they can be generally classified into two different approaches. Some works introduce a variable structure of market potential, modifying the residual market, and exclude an intervention on WoM effects (Mahajan and Peterson, 1978; Kamakura and Balasubramanian, 1988; Horsky, 1990; Mesak and Darat, 2002). Other contributions allow both modifications and WoM effects considerations, (Sharif and Ramanathan, 1981; Rao, 1985; Jain and Rao, 1990; Parker, 1992, 1993; Kim et al., 1999; Centrone et al., 2007; Goldenberg et al., 2010).

The size of the market potential is probably the most critical element in forecasting matters. From the mathematical point of view, there are different assumptions governing the shape of the market potential. In some cases it is exogenously determined as a function of observed variables (Mahajan and Peterson, 1978; Kalish, 1985; Kamakura and Balasubramanian, 1988; Jain and Rao, 1990; Parker, 1992, 1993; Horsky, 1990; Kim et al., 1999). Some efforts are necessary for the correct specification of the main drivers (e.g., price, number of households with special facilities, number of competitors, number of retailers, threshold probabilities, etc.) and suitable transformation in order to obtain a reasonable correspondence with the adoption process scale. In some papers, market potential is presented as the exponential function of time (Sharif and Ramanathan, 1981; Meyer and Ausubel, 1999; Centrone et al., 2007), while a dynamic market potential is introduced by Guseo and Guidolin (2009).

In order to develop forecasting models for different market scenarios, the authors present the total market or the market potential in different ways. Therefore, the total population in a social system is presented as an influential factor for market potential (Mahajan and Peterson, 1978). Also, the market potential can be presented as a function of population growth (Sharif and Ramanathan, 1981). There exist models that assume market potential as a function of price and number of adopters (Kalish, 1985), and models where the price of product has an effect on overall market potential (Jain and Rao, 1990). There is a model assuming that an increase in the number of retailers will affect the whole market (Jones and Ritz, 1991). In addition, model that can forecast the technology replacement with population growth used for the variable market potential is proposed by Kreng and Wang (2009).

The model in which the market potential is a function of time-varying exogenous and endogenous factors such as socioeconomic conditions, population changes, and government or marketing actions can be found in Mahajan and Peterson, (1978). In addition, a non-uniform influence model that allows the parameter of imitation to be time varying is proposed by Easingwood et.al. (1983).

Some authors present discrete form of diffusion model applicable on step growing markets (Velickovic, 2011) and later basic continuous numerical form of model with step function (Velickovic and Radojicic, 2012). To the best of our knowledge, there are no other modifications of Bass model that take into account the gradual development of a network infrastructure to enable the acceptance of a new service/product. Under such circumstances, it is necessary to develop an appropriate model where the potential market follows the infrastructure development.

3. A modification of bass model to the step growing markets

If technical support for services/products does not exist across the whole territory, then the services/products cannot be offered to the whole market at the same time. Therefore, the adoption process is performing in steps, following the technologically provided territories. This paper proposes a new diffusion model applicable on markets with the systematic and gradual infrastructure development. According to this, the proposed model enables service demand forecasting for various possible development scenarios. Additionally, the cost benefit analysis is given.

Considering the results of the previous researches (Velickovic, 2011; Velickovic and Radojicic, 2012), some theoretical changes are conducted by introducing new assumptions into the model and by upgrading it into the multi-phase model for the simulation of new service adoption in various market scenarios depending on the infrastructure development. The proposed model becomes part of the multi-phase planning model for telecommunications service rollout. The model application requires prior market segmentation, parameter evaluation, development planning, optimal activation sequence of traffic areas and simulation in order to generate effective diffusion of service with the gradual infrastructure development. This model can be used as a prospective tool for planning and simulation of telecommunications service gradual rollout.

It is expected, that the number of potential users of telecommunications services/products are changing according to the dynamics of building network infrastructure to provide a certain service/product (e.g., dynamics of laying optic cables, construction of base stations for mobile systems, etc.). Further, it can be assumed that the whole traffic territory consists of smaller sub-territories different areas with certain socio-demographic and geographic features. These sub-territories are then becoming technically equipped step-by-step, in order to support a certain service/product. This has a direct impact on the number of potential users as well as on the shape of diffusion curve. Therefore, each sub-territory will have a slightly different diffusion process with a different time to market. Thus, the market potential is introduced as a discrete step function:

$$m(t) = \begin{Bmatrix} m_1, & \tau_1 \leq t < \tau_2 \\ m_1 + m_2, & \tau_2 \leq t < \tau_3 \\ \cdots & \\ \sum_{i=1}^{n} m_i, & t \geq \tau_n \end{Bmatrix}, \tag{1}$$

where $m_i\,(t)$ represents the market potential of sub-territory i, $\tau_1, \tau_2, \ldots, \tau_n$ are time to market of new telecommunications service in sub-

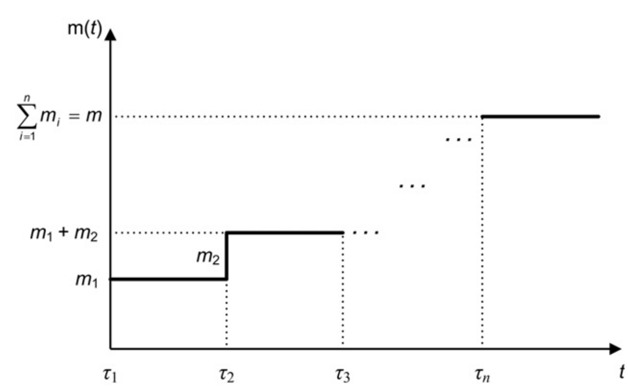

Fig. 1. Step growing market potential.