



A Model for Predicting the Consumer Behavior Using Artificial Neural Networks (Case Study: Mobile Phone Subscribers)

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Abstract

This study tries to develop a model to predict the consumer behavior using artificial neural networks in broadcasting industry. To do so, it should be identified all the variables that can determine the consumer behavior which were based on review of literature. Artificial neural network was used to estimate consumer behavior according to independent variables. Research's Statistical population is all mobile subscribers in Urmia (a city in northwest of Iran), in which 384 mobile subscribers have chosen to survey by sampling method. For modeling and analysis of multi-layer neural network with hyperbolic tangent function of education, training has been used by the Forward algorithm that results show the importance of independent variables in predicting the dependent variable (SIM card mobile phone) to arrange the variables of price, product, rank first and third in importance and the promotion of social class ranked fifth in importance. Gender, education and marital status have the least impact on selecting the type of SIM card. The overall extension of the model obtained, 65.7 percent of the SIM card used in the test samples correctly predicted.

Keywords: Artificial Neural Networks, Consumer Behavior, Mobile Phone Subscriber

Introduction

The rapid technological development in the field of telecommunication networks in recent years provided a wide range of services to private and institutional subscribers. In this context "macro-development planners", "telecommunications service providers" and "Equipment Manufacturers" are interested to know about scientific estimates of the demand and supply of equipment investment needed (K.T. Duffy & Deno, 2001). There are many factors affecting the demand for mobile phones is one of the factors in improving the quality of mobile service is a mobile communications company. Another network modernization and upgrade it through the door to the next generation mobile technologies such as GPRS (General Packet Radio Service), EDGE (Exchanged Data rates for GSM (Global System for Mobile communications) Evolution), and 3G (Third Generation of mobile telecommunications technology). Also NGN (Next Generation Networks) and IN (Intelligent Network) issues can affect the amount of mobile applications. These factors all have the same features, and it is positive feedback. In other words, all of these factors are demand resonators and considered as "entrepreneurs". But there are other factors that impact, the negative feedback, it means, when they will escalate, decreases the demand for mobile and sales and services. However, these negative factors, and other factors should not stay away from experts that predict the demand for mobile.

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Therefore, marketers should be aware of how marketing data and other data convert to buy reaction. Consumer behavior is influenced by personal characteristics and his decision-making process and followed this article is how mobile customers and users of its services decide to buy and how marketing affects their decision. Nowadays, with the development of predictive tools, formulas, by using the best models it is possible to predict consumer behavior in buying mobile phone. Recently, a technique known as "Artificial Neural Networks", along with the predicted structural models and time-series has been used. This model is in fact taken from Brain Learning Process, Using computational speed of computers, Learn relationships - though sophisticated -between variables and uses that for predicting future values. Neural networks have no common problem that is shown mostly in classical models such as reliability and non-reliability of time series and from this point, there is no need for preparation of time series of economic variables such as the classic models for solving problems of autocorrelation, and variances are clearly not linear. In contrast, the rates predicted by econometric methods toward neural networks have a stronger statistical justification, because it can be for each of the predictions made a confidence interval. Neural Networks actually learn how to predict the future. In general, the accuracy of the neural networks is superior to linear techniques. As a general principle that is expressed by Hornik, a well-trained neural network that is never be better than a linear classifier(Hornik,et al,1989). Although artificial neural networks have their own limitations, but they have special advantages, such as the ability to learn, flexibility, adaptability, and knowledge discovery (Goonatilake, 1995).

Theoretical Principles

Consumer behavior included all mental, emotional and physical activities that individuals use them when they buy, use and throw away products for their satisfaction (Wilkes, 2000, 118). Consumer behavior is influenced by personal characteristics and his decision making process. Lifestyle of people formed by the influence of two factors which include:

External factors include cultural factors (culture, subculture, social class), social factors (group, family, role and social status), personal factors (age and stage of life, occupation, social status, style or lifestyle personality and self-concept).The internal factors include psychological factors (perception, learning, memory, motivation, emotions, and attitudes and beliefs) (Hawkins et al, 2005). Including other factors that influence the consumer behavior is marketing mix in which the most common variables at formulation marketing mix are product, price, promotion and distribution. Products (goods and services) must be consistent with the expected benefits to the customer. Price should be commensurate with the ability of buyer. This product should be available to the customer so that he can buy easily and ultimately to promotional materials will also be alerted to potential consumers of such products. In fact the concept of marketing mix makes clear the direction of organization's performance by using a series of control variables in an environment where there are many uncontrollable factors (Bennett, 1997).

It is extremely difficult to predict consumer behavior. Marketers are always trying to predict the consumer behavior and provide activities and behaviors they are expected. Marketing researchers believe that behind every purchase is one important decision-making process that needs to be investigated. Steps that the buyer is going to decide what kind of products they buy is called buying decision process. In this area there are many models that this model of decision making show understandable buying behavior by consumer. The purpose of these models is to discipline and integrate components of a well-known extensive knowledge about consumer behavior, including stimulus - response model on which consumer behavior are formed on this basis that many stimulating and motivational factors with agents and marketing stimulus (means the marketing mix) enter to the consumer's black box and he shows a certain reactions from himself (kotler, 2003). In this model, in relation to marketing factors referred to marketing mix elements McCarthy's 4P model is used. But in this model in relation with non-marketing factors involved in consumer behavior is not mentioned what is the purpose of these and what is included yet. Other model in this context is comprehensive model of consumer behavior which is a mental model in which it is not included sufficient detail for predicting the behavior. According to this model, individuals form their theory of mind and life style based on effective factors like internal (mainly psychological and physical) and external (mainly social and sociological) (Hawkins et al, 2005). In the comprehensive model of



consumer behavior has been mentioned to all personal effective factors in the buying decision but has been not mentioned to the marketing factors that are the same as marketing mix as an effective factor on consumer behavior, so one of the weaknesses of this model is the lack of attention to this issue. Of the other models in relation to the consumer decision is the model of buying behavior by Howard and sheth (1969). In this model attempts to be explained how through learning, specific data in response to marketing stimuli are converted to stimulants such as buying or other behavioral responses. This is an edited version of the previous regular and systemic effort to build an attitude and a deep theory of the consumer decision making process. Howard believes the most important stimulus in determining consumer behavior is a set of information or awareness about the characteristics of goods or services (such as quality, price, having distinction, after sales service, availability). The data is transferred directly to the consumer by the product itself. The second group will include the same information that placed at the disposal of consumer through the Media (E.g. advertisements on TV). Third source of consumer information that is useful in his decision making process is information that transmitted by persons or groups that are associated with such as family, friends, social groups that he belongs or wish to belong and to which they are attached (Nabizadeh, 1996). This model also has some shortcomings but one of the most important criticisms of this theory believe that Howard knows the consumer as a reasonable being that before purchasing goods or services proceed to evaluate data within a conscious and rational process at their cognitive structures and their learning and then proceed to purchase goods. This model sees consumer as someone with the capacity to receive and applying plenty of information that have ability and comparability of different things, depending on the type, trademark, quality and other characteristics of the goods and can easily identify the data and able to select the fittest (Ibid). According to the model, we reach the conclusion that each model pointed to Part of the Factors influencing consumer behavior and they have some shortcomings. In order to compensate for these shortcomings, recent research seeks to answer a fundamental question that what important factors are influence the purchase of a SIM card. In this regard, the purpose of this study is examining and identifying effective and determinant factors on consumer behavior in determining the selected type of SIM card; obviously, the results of this research can help to the active operators in the field of mobile communication to do the necessary planning in the field of increasing their sales. In this regard, in proposed model has been tried to discuss all factors affecting the consumer behavior in four indexes of biographical features, demographic variables, psychological variables and organizational variables.

1. Biographical features: age of consumers itself has affect on the concept and lifestyle as we see it in community, young people tend to use MTN (type of SIM) while older people, prefer to use MCI (type of SIM). Men and women have unique personality traits, interests, knowledge, abilities, judgment, and social status. Therefore gender has effects in consumer behavior. Married couples and single people have different needs.
2. Demographic variables: Mobile phone use in high-income consumers, most of whom are low-income and then also social class that determined by using the individual information in relation to employment, education, income level, amount of assets, type of housing area of living, type of the vehicle and its model, has effect on using the SIM card so that people with moderate to high social class prefer to benefit from permanent MCI SIM card's services. Impact of groups in recommendations and benchmarking from friends, colleagues and family to choose the SIM card is effective, so that young and teen are highly influenced by groups in selecting the type of SIM card.
3. Psychological variables: Howsoever consumers should have more faith that specific product or service is more appropriate to satisfy him, he has more motivation to achieve it (Laroch, 2010). As a result, among the psychological variables, motivation including the need for security, the need for friendly relations, the need for acceptance, approval, and need to be modeled has been recognized effective in relation of selecting the SIM card.
4. Organizational variables: Including price that has direct impact on the buyer's decision whatever SIM card price is low demand for it increases. In relation to product whatever quality of the signal, communications and data services improved demand also increases. In relation to distribution whatever waiting time is reduced and SIM card sooner reach to the consumer will has a positive impact on purchase and about advertisement whatever operator's advertisement is more attractive in relation to their facilities and provide a useful information



about their facilities, they can attract more customers. Finally, the model has been derived as figure 1.

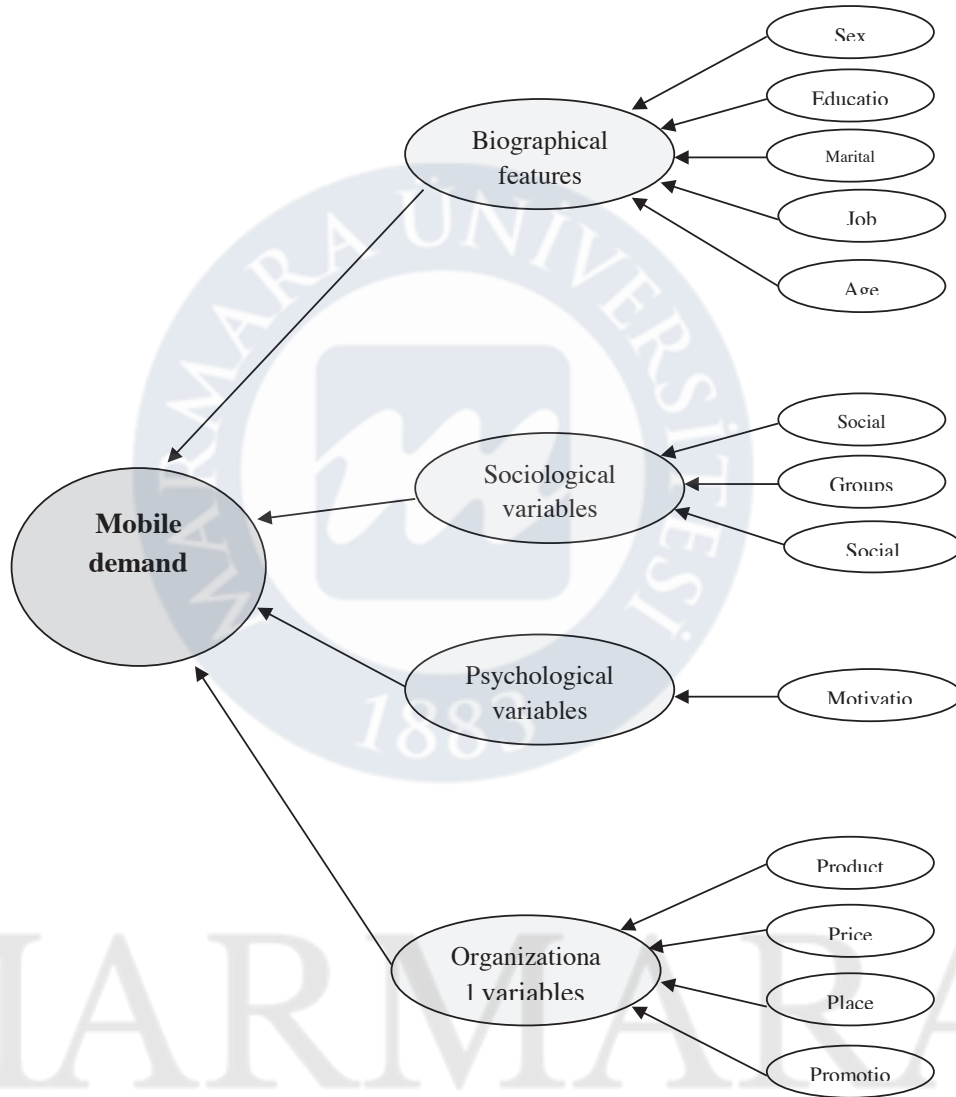


Figure 1. Research Model

MATERIALS AND METHODS

The research method used in this study from the view of objective is practical and due to study of cause and effect relationships it is a cause research. Statistical community of present research is all mobile phone subscribers are in Urmia. Sampling in this study is the available sampling. The size of sample considered unlimited, because the population is not clear. Since for determining the sample by using mentioned equation the variable trait variance is required, therefore with use an 30 semiconductor sample variance is calculated and the sample size has been determined.

To determine the sample the following formula is used: $n = (Z^2 * \sigma^2) / ME^2$

Where:

Z = Z value (e.g. 1.96 for 95% confidence level)

σ = Population standard deviation

ME= Margin of Error (the margin of error expresses the maximum expected difference between the true population parameter and a sample estimate of that parameter)

In above formula by placing $\epsilon = 0.08$, $\sigma = 0.8$, $Z_{\alpha/2} = 1.96$ the sample size is obtained 384.



A questionnaire containing 46 questions was drafted that at the first three questions is determined the type of SIM card and the year of buying and proceed to Question 10 is determined the features of the person's biography who is responded to questions. Questions 11 to 29 are examined demographic and psychological variables and finally of questions 30 to 46 were evaluated the organizational variables. In order to obtaining validity of the questionnaire, in addition to obtaining opinion of experienced professors from universities in the field of management, marketing, research methods and statistics were consulted with manager of Mobile Communication province of Western Azarbyjan and five senior experts in the area of mobile communications and the validity of questionnaire also confirmed by them. Durability of questions is calculated by using Cronbach's alpha coefficient technique. In this study, Durability of Questions has been tested for each of the variables, according to Cronbach's alpha coefficient was calculated at 0.72, we conclude that the question have acceptable durability. According to scale of variables and their distribution, ANN toolbox is used to predict the consumer behavior on selecting the type of SIM card for mobile phon. Neural Networks are lacking common problems of classical modeling such as reliability and non reliability of time series. In this sense, it doesn't require preparation for time series of economic variables like the classic modeling for resolving the problems of autocorrelation, linear and variances. Neural Networks are superior to the linear techniques in terms of accuracy and are able to learn complex relationships between variables and used that for predicting future values. For predicting we have used multi-layer perception method, for this purpose initially we were divided the data into two groups of "training sample" and " testing sample " and were placed 70% of people the training samples (270 cases) and 30% of people in the tested samples (105 cases). Data recorded included the training of the neural network are used in education. Testing sample is an independent set of stored data that are used to find the error which occurred during the education and this will prevent the training too much. In this network, we have used a hidden layer of hyperbolic tangent activation function. Due to the small sample the type of training which is selected is batch.

RESULTS

In the output of the neural network weight of each independent variable is specified in predicting dependent variable that network data in the Table 1 and summarizes of the results from analysis of neural network models are shown in the Table 2.

Table 1. Network Information

Input Layer	Factors	1	sex
		2	Education
		3	Marital status
		4	job
		5	Place
	Covariates	1	age
		2	Social Base
		3	Social class
Hidden Layer(s)	Number of Units Rescaling Method for Covariates Number of Hidden Layers Number of Units in Hidden Layer 1a Activation Function	4	Group
		5	motivation
		6	Product(service)
		7	price
		8	promotion
		31	Standardized
		1	Hyperbolic tangent
		4	Simkart
Output Layer	Dependent Variables Number of Units Activation Function Error Function	1	Softmax
		3	Cross-entropy

Excluding the bias unit



Table 2. Model Summary

Training	Cross Entropy Error	202.965
	Percent Incorrect Predictions	31.5%
	Stopping Rule Used	1 consecutive step(s) with no decrease in error ^a
	Training Time	00:00:00.078
Testing	Cross Entropy Error	84.161
	Percent Incorrect Predictions	34.3%

Dependent Variable: Simkart

a. Error computations are based on the testing sample.

Also, table 3 shows the importance of each one of the independent variables for predicting the dependent variable.

Table 3: Independent Variable Importance

Independent Variable	Importance	Normalized Importance
Sex	.019	9.3%
Education	.046	22.6%
Marital Status	.047	23.1%
job	.058	28.7%
Place	.094	46.8%
Age	.056	27.9%
Social Base	.076	37.8%
Social Class	.092	45.5%
Groups	.060	29.5%
Motivation	.053	26.3%
Product	.119	58.9%
Price	.202	100.0%
Promotion	.079	39.1%

According to the weight given to the independent variables, resulting model from neural network analysis is capable in the training samples to correctly estimated 85.5% demand for permanent SIM1, 51.8% demand for credit SIM2 card and 57.4% demand for SIM3. In general, the training samples correctly predicted 68.5%. In testing sample is correctly estimated that 83.6% demand for permanent SIM1 card, 33.3% demand for credit SIM 2card and 65.7% demand for SIM3 card. The results are shown in Table 4.

Table4. Classification

Sample	Observed	Predicted			
		SIM1	SIM2	SIM3	Percent Correct
Training	SIM1	106	11	7	85.5%
	SIM2	25	44	16	51.8%
	SIM3	12	14	35	57.4%
	Overall Percent	53.0%	25.6%	21.5%	68.5%
Testing	SIM1	46	7	2	83.6%
	SIM2	9	6	3	33.3%
	SIM3	3	12	17	53.1%
	Overall Percent	55.2%	23.8%	26.0%	65.7%

Dependent Variable: Simkart

Conclusions

Assael and Xue believe that the decision to buy services and products is function of three factors, consumer, products and position. So the consumer according to goods and services (marketing mix) and a situation in which it is located (situational factors) gained information and evaluates product and then choose the goods by the influence of these two factors. On the other hand, Zajas and Crowley also described that the brand, recommendations of friends and experienced people in order to reflect the individual's personality is effective factors. Yu-Ho Cho also has declared that the reputation of brand and price can influence consumer choice. According to the results of previous research, in this study also on buying a SIM card by consumer marketing mix has the greatest impact and biographical characteristics (gender, education, marital status, age, and occupation) has minimal impact. According to the importance of independent variables in predicting the dependent variable (type of mobile phone sim) respectively, price, product, distribution, rank first to the third in importance and the promotion



after the social class in the fifth grade are important. Sex, education and marital status have the least impact on the chosen SIM. Models of artificial neural networks are able to predict 65.7% of the samples to estimate correctly.

Among the independent variables, sex has minimal impact and the price has the greatest impact on the demand for mobile phones; in order to these results, it is suggested to the active operators of mobile communications that for increasing the demand for buying SIM cards, it is necessary to reduce the price of SIM cards. On the other hand, among other marketing mix variables promote has minimum impact on the demand for mobile phones. According to this theory, due to the impact of advertising on sales, we conclude that active operators in the field of mobile have a very weak advertising and it's essential to study this technically and take action to strengthen the publicity of their SIM till from this way increase sales of SIM cards and related services . Product Variable among the 13 independent variables that influence the demand for mobile located on the second place and it shows that the diversity of services, proper conversations quality, and affordable signal coverage and update data services provided by operators has a great importance in attracting the customers. After all what is recommended is that operators attempt to increase the quality of conversations, signal coverage and data services and be diligent to enhance their value in building services.

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