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Mobile-carrier Choice Modeling Framework Under Competitive Conditions

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Abstract: This paper presents a mobile-carrier choice modeling framework to analyze customer preference and understand customer choice behavior in the mobile phone market. Due to severe competitive conditions, there are few differences between the mobile phone services provided by mobile-carriers. We propose a new mobile-carrier choice modeling that takes into account incentive factors and restrictive factors as decision-making factors. A Web survey was carried out to obtain the sample data for this model. We show the model estimated from the survey data to analyze mobile-carrier choice behavior.

Keywords: choice behavior model, discrete choice analysis, mobile-carrier choice behavior

1. Introduction

The number of mobile phone customers exceeded 121 million as of July 31, 2011 in Japan [1]. Although the mobile phone market is already at a matured stage, the mobile phone market is becoming active again because of the increasing demand for smart phones, and improvement of mobile Internet technologies such as WiFi and WiMax services. The competitive condition around the mobile phone market is becoming severe. Due to the variety of pricing and discounts, it is difficult for customers to understand the differences between mobile-carriers. And once better pricing and discounts for a mobile-carrier are introduced, other mobile-carriers soon follow. And we can choose the appropriate phone among about 200 kinds of mobile phones. The number of functions is more than 100 across all models. The decision-making process and factors vary from customer to customer. The mobile-carrier choice behavior is becoming complicated and diversified. Under competitive conditions, the most important objective of a mobile-carrier is to increase the market share. Therefore, mobile-carriers require useful ways to understand the mobile-carrier choice behavior.

Recently, it is common sense that it is impossible to predict service demand using conventional techniques such as time series analysis based on the in-service usage data. Discrete Choice Analysis [2], [3] is one of the useful ways. Under the above mentioned circumstances, we should understand customer preference to construct mobile-carrier choice models. Several types of discrete choice modeling have been studied for telecommunication services in Japan [4], [5]. We have proposed service choice models to predict the service choice probability under competitive conditions on the basis of Discrete Choice Models [6], [7], [8], [9]. In general, observed variables such as charge, functions and performance are used as explanatory variables in these models. We analyzed the decision-making factors to construct a mobile-carrier choice model [10]. We classify mobile phone customers into two groups: churning customers and stable customers. Churning customers mean ones that change to other carrier. Stable customers mean ones that continue with the same carrier. Customer segmentation was carried out based on survey data for each customer group in order to clarify the decision-making factors. The results of customer segmentation suggest that we should consider incentive factors and restrictive factors as decision-making factors to construct a mobile-carrier choice model [10]. We proposed a new mobile-carrier choice model that takes into account incentive factors and restrictive factors as decision-making factors. We presented the mobile-carrier choice-behavior model estimated based on our original market research survey in CNSI 2011 [11] and ICBAKE2011 [12]. We present the detail of the model and the scenario simulation results under various conditions in this paper.

We explain the mobile-carrier choice modeling in Section 2. Section 3 describes the overview of the survey data used for mobile-carrier choice modeling. We show the estimation results of a new mobile-carrier choice model considering incentive factors and restrictive factors as decision-making factors. We demonstrate the scenario simulation results under various conditions. Finally, we conclude and discuss topics for future studies.

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2. Mobile-carrier Choice Modeling

This section gives the choice modeling to express mobile-carrier choice behavior.

2.1 Framework for Scenario Simulation (FSS)

It is impossible to analyze the demand of services or products only by using customer choice-behavior models. We proposed a *Framework for Scenario Simulation* (***FSS***) to analyze market structure and estimate service demand [6], [7], [8], [9], [10], [11], [12], [13], [14], [15]. The objective of the ***FSS*** is not to obtain a demand-forecasting result but to simulate scenarios under assumed conditions according to service changes. A scenario implies changes in market structures. Service-choice behavior results in service demand. The ***FSS*** is divided into two processes: the modeling process and demand analysis process. In the modeling process, service-choice behavior models are constructed to give choice probabilities under assumed conditions, selectable services, and service specifications. The demand analysis process has scenario functions. The scenario means a future assumed condition of the market. According to the scenario, the probability of a service being chosen is determined, and by aggregating the probabilities, the service demand is obtained for an assumed scenario. The service means mobile phone service in this paper. The object of the choice behavior is not mobile phones but mobile-carriers.

2.2 Choice Behavior Modeling

Generally, a service-choice behavior model is a function expressed by various variables: individual attributes, service specifications, and other environmental constraints. Service-choice behavior modeling is the most important component of the ***FSS***. It is based on discrete choice analysis (DCA) [2], [3]. The DCA developed by McFadden [16], who won the Nobel prize in economics, enables us to construct a service-choice behavior model. The service-choice behavior model generally has four components: the decision maker, the decision-making factors, the service choice set, and the decision rules [2], [3]. The decision maker is customer n, who chooses services under various situations from his/her choice set C_n. The customer choice set C_n is a subset of universal choice set C, which consists of all Nc alternatives. The DCA model has a utility function for each alternative. The utility function U_{in} for customer n is defined as the utility obtained by choosing service i. The random utility maximization model of the decision-making process translates preferences to decisions. In the decision-making process, a customer chooses an alternative that has the highest utility.

In conventional models, observed variables such as charge, functions and performance are used as explanatory variables to express service specifications. And individual attributes like age, income, and education are used to express differences among individuals, that is, customers. In this paper, the choice set consists of three mobile carriers. "Service i" means "carrier i" as below.

The utility function U_{in} for customer n is defined as the utility obtained by choosing carrier i. U_{in} is composed of two parts as follows:

$$U_{in} = V_{in} + \varepsilon_{in} \tag{1}$$

V_{in} is called the *systematic* (or *representative*) component of utility U_{in} and is assumed to be deterministic; ε_{in} is the random part and is called the *disturbance*. Provided that the functional form for V_{in} has linear variables, V_{in} can be defined as follows:

$$V_{in} = \alpha_i + \sum_k \beta_{ik} x_{ink} \tag{2}$$

where β_{ik} ($k = 1, 2, \ldots, K$) is the coefficient denoting the weight for the value x_{ink} of decision-making factor k, and α_i denotes the carrier specific constant. Assuming that the disturbances are independent and identically Gumbel distributed (i.e., logistically distributed), the choice probability P_{in} of carrier i in choice set C_n being chosen by customer n is given by

$$\begin{aligned} P_{in} &= \text{Prob}(U_{in} \geq U_{jn},\ j \neq i,\ \forall j \in C_n) \\ &= \frac{\exp(V_{in})}{\sum_{j \in C_n} \exp(V_{jn})}. \end{aligned} \tag{3}$$

In general, a choice behavior model is constructed for a customer segment classified based on individual attributes and their preference. The coefficients denoting weights for values of explanatory variables are different in each customer segment.

The main objective of choice behavior models is not to forecast the aggregate demand, but to understand the relation among decision-making factors and customer behavior. This implies that the choice-behavior modeling is very useful to decide the priority of selectable marketing actions.

3. Overview of Results from the Survey

3.1 View Points of the Survey

The decision-making process in mobile-carrier choice behavior is divided roughly into two types of customers. One is the customer who chooses an appropriate mobile phone among all phones provided by all mobile-carriers. The other one is the customer who chooses an appropriate mobile phone among the phones provided by a predetermined mobile-carrier. We focus on the mobile-carrier choice behavior of churning customers and stable customers in this paper.

We have analyzed the mobile-carrier choice behavior by using the survey data conducted by the Mobile Marketing Data Laboratory in Japan to investigate the trend of mobile phone purchase behavior after the introduction of *Mobile Number Portability* (***MNP***) [10]. It is found that charge issues, phones or their functions to be used are related to the decision-making of churning customers. However, a model with these service-specific factors as explanatory variables of the utility function is not necessarily suitable for mobile-carrier choice modeling. There are about 200 kinds of mobile phones provided by mobile-carriers. The number of different functions is more than 100 in total. And each mobile-carrier provides more than 10 different payment schemes. It is meaningless to include all of these factors to choice models. This implies that we should consider new variables expressing customer preference factors to construct a mobile-carrier choice model. We proposed a new modeling with the following latent variables [10]:

- Brand loyalty
- Incentive factor
- Restrictive factor
- Knowledge

We designed a new survey considering incentive factors and restrictive factors.

3.2 Summary of the Survey

An original market research survey was conducted to model the choice of mobile-carrier. Sample data was collected by using the Web interview system provided by goo Research, NTT Resonant Inc. in December 2010. The total number of samples is 1,574.

The sampling was carried out on the basis of the following requirements.

- Business customers are excluded.
- The customers are limited only to three mobile-carriers: NTT docomo, au by KDDI, and SoftBank.
- A minimum number of individuals is specified for each mobile-carrier (more than 500 individuals for NTT docomo, au, and SoftBank, respectively).
- A minimum number of individuals is required in each age category considered (more than 200 individuals in their 20s, 30s, 40s, 50s, and 60s, respectively).

Table 1 indicates the number of individuals in the sample by mobile-carrier. Distribution of individuals in the sample is different from the actual distribution in the mobile phone market shown in **Table 2**. **Table 3** indicates the number of individuals in the sample by age category. There is no requirement for samples in relation to the other demographic factors such as area, gender, income and occupation.

Table 1 Sample sizes by mobile-carrier.

Mobile Carrier	Number of Individuals
docomo	537 (34.1%)
au	516 (32.8%)
SoftBank	521 (33.1%)
Total	1574

Table 2 Actual share of mobile-carrier in July 2011.

Mobile Carrier	Number of Customers	Share
docomo	58,610,300	48.1%
au	33,460,200	27.5%
SoftBank	26,383,700	21.6%
Emobile	3,426,000	2.8%
Total	121,880,200	100.0%

Table 3 Sample sizes by age category.

Age	Number of Individuals
10s	281 (17.9%)
20s	244 (15.5%)
30s	263 (16.7%)
40s	264 (16.8%)
50s	272 (17.3%)
Over 60s	250 (15.9%)

The main contents in the questionnaire are the following:

(1) How many mobile phones (including smart phones and tablets) do you own?
(2) What were the reasons why you decided to create a contract with the current mobile-carrier?
(3) What were the reasons why you are satisfied with the current mobile-carrier?
(4) Are you thinking of changing to another mobile-carrier in the future?

It is found that about 30% customers use more than two mobile phones as the result of question (1). **Table 4** shows the decision-making factors for mobile-carrier choice. Those decision-making factors are the reasons why we decided to create a contract with the current mobile-carrier. **Figure 1** shows the share of important levels for each decision-making factor.

The characteristic of decision-making factors is summarized as below:

- Many customers are satisfied with the current mobile-carrier.
- Many customers would like to continue charge-discount-service depend on contract duration.
- Many customers get tired of changing mobile-carriers for various reasons.
- Many customers tend to choose the same mobile-carrier for the entire family.
- Carrier-specific services and contents are not so important.

This characteristic is different in each mobile-carrier. The results of questions (3) and (4) mentioned above also are different in each mobile-carrier.

4. Estimation Results for Mobile-carrier Choice Model

4.1 Choice Data and Mobile-carrier Choice Model

A lot of customers decide their behavior based on multiple decision-making factors. Costs, phones or their functions are used as the decision-making factors. However, in general, customers do not compare all combinations of services. It seems that the number of major factors is a few. Therefore a model with these service-specific factors as explanatory variables of the utility function is not necessarily suitable for mobile-carrier choice modeling.

Table 4 Decision-making factors for mobile-carrier choice.

Decision-making Factors	Meaning
Satisfaction	I am satisfied with current mobile phone.
Monthly charge	Monthly charge is low.
Carrier-specific mobile phone	I would like to use carrier-specific mobile phone.
Mobile phone service area	Mobile phone service area is wide.
Carrier-specific services and contents	Carrier-specific services and contents are attractive.
Time and effort for carrier change	I get tired of changing mobile carrier for various reasons.
Contract duration dependent service	I would like to carry over contract duration for charge discount service.
Cancelation charge	Cancelation charge is necessary to change current carrier.
Bundle service menu	Bundle service menu (tripple services, quadro services) is attractive.
Same carrier as family	Entire family is using the same carrier.
Same carrier as friends	Other friends are using the same carrier.
Mobile Number Portability	Mobile Number Portability service was introduced.
Interested person	Family or friends are working for the carrier.

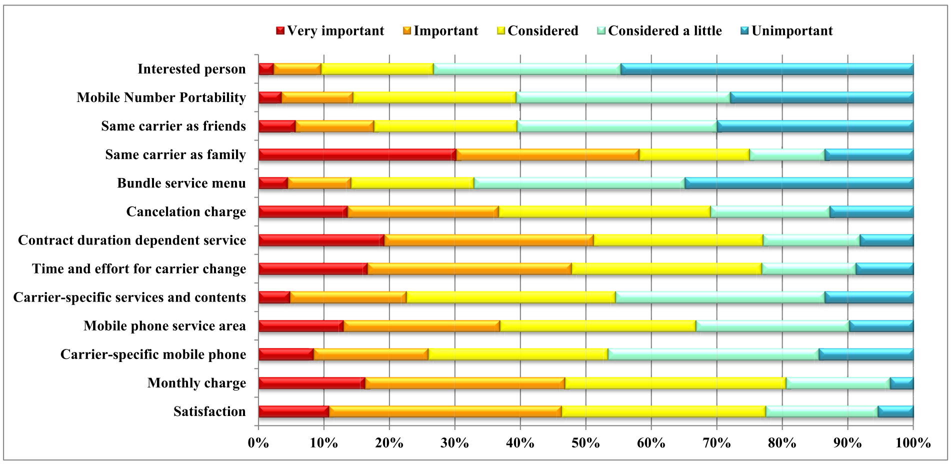

Fig. 1 Important levels for decision-making factors.

Table 5 Description of explanatory variables in mobile-carrier choice model.

No.	Variables	Definition
1	**Monthly charge: X,000 yen**	Monthly charge becomes cheap by X,000 yen.
2	**Phone discount: X0,000 yen**	Purchase price of mobile phone is discounted by X0,000 yen.
3	**Service period: X months**	Monthly fixed charge becomes free for X months.
4	**Cancelation charge**	Dummy variable is equal to 1 if new carrier supports cancelation charge required to change current carrier, 0 otherwise.
5	**Mail service**	Dummy variable is equal to 1 if mail address can be carried over, 0 otherwise.
6	**Contract duration**	Dummy variable is equal to 1 if discount that depends on contract duration can be carried over, 0 otherwise.

We proposed a new model with only six factors as incentive factors and restrictive factors related to the current mobile phone market [11], [12]. The decision maker n is a residential customer. The customer choice set C_n consists of three major mobile-carriers in Japan: *docomo*, *au*, and *SoftBank*. Each alternative, that is, each carrier has several variables x_{ink} as decision-making factors shown in Eq. (2). A simple multinomial Logit model is used for estimating the mobile-carrier choice model. The *systematic* component V_{in} of utility U_{in} for three carriers is specified as follows:

$$V_{in}=\alpha_i+\sum_{k=1}^{6}\beta_k x_{ink}. \quad (i = 1, 2, 3) \tag{4}$$

Table 5 shows the explanatory variables of the choice model. The explanatory variables mean the decision-making factors for choosing a mobile-carrier. This model has three charge factors which customers can understand the difference easily. The other three factors are restrictive factors for churning customers. If the value of the cancelation charge variable is equal to 1, the variable is an incentive factor for churning customers. If the value is equal to 0, the variable is a restrictive factor for churning customers. Two variables: mail service and contract duration mean the same. These six explanatory variables in the proposed mobile-carrier choice model means realizable or realized marketing actions. Although "same carrier as family" is the most important factor as shown in Fig. 1, the proposed model does not include the factor.

We asked participants which mobile-carrier they would like to choose among the three carriers providing the assumed service menu in our survey. The alternatives are the three mobile-carriers defined in Section 3.2. Each carrier has a predesigned service menu that consists of six variables shown in Table 5. **Table 6** shows a sample of choice data that consists of the choice result (the selected carrier) and the value set of service menus. In this example, it is shown that *SoftBank* is chosen among the three carriers. Our sample comprises 1,574 observations.

Table 6 Choice data example.

No.	Explanatory Variables	*au*	*docomo*	*Softbank*
1	Monthly charge: X,000 yen	2	0	2
2	Phone discount: X0,000 yen	2	0	2
3	Service period: X months	12	0	12
4	Cancelation charge	0	1	1
5	Mail service	0	1	0
6	Contract duration	0	1	1
	Choice			○

Table 7 Estimation results of mobile-carrier choice model.

No.	Variables	Value	t-value	p-value
1	Monthly charge: X,000 yen	0.428	7.11	0
2	Phone discount: X0,000 yen	0.0114	0.22	0.82
3	Service period: X years	0.0801	8.36	0
4	Cancelation charge	1.17	13.01	0
5	Mail service	1.28	11.9	0
6	Contract duration	1.33	12.02	0

4.2 Estimation Results

We used an estimator BIOGEME Version 1.8 [17] to estimate the coefficients of the mobile-carrier choice model. The estimation results are presented in **Table 7**, except for the alternative constants. Alternative constants are shown by bar graph in **Fig. 2**. In this model, we set 0 for the alternative constant of *SoftBank*. The alternative constant of the carrier implies the brand loyalty. t-value is an estimator and is the test statistic based on the t-distribution. In general, the absolute value of the t-value of more than 1.96 indicates that the variable is significant for the estimated model when the sample size is large. p-value is also an estimator for the test statistic. p-value of less than 0.05 indicates that the variable is significant for the estimated model. The results show

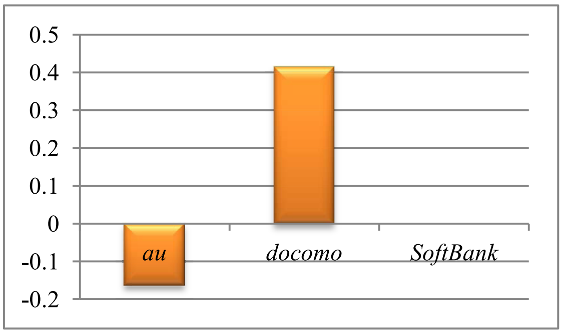

Fig. 2 Alternative constants of mobile-carrier choice model.

Table 8 Simulation results in Case I.

No.	Explanatory Variables	*au*	*docomo*	*Softbank*
1	Monthly charge: X,000 yen	0	0	0
2	Phone discount: X0,000 yen	0	0	0
3	Service period: X months	0	0	0
4	Cancelation charge	0	0	0
5	Mail service	0	0	0
6	Contract duration	0	0	0
	Choice Probability (%)	25.27	45.01	29.72

that all variables except phone discount are valid in this model.

4.3 Simulation Results

We demonstrate the scenario simulation results under various conditions. Under these scenarios, it is assumed that a customer is thinking about the purchase of a new mobile phone among all phones provided by three mobile-carriers defined in Section 3.2. The mobile-carrier choice probabilities as the scenario simulation results are shown by using the estimated model.

Until now, the major sales strategy in the mobile phone market is to offer charge discounts or phone-price discounts. These discount schemes are incentive factors for customers. The explanatory variables No.1 to 3 in Table 5 expresses these incentive factors.

If a customer cancels the service earlier than the predetermined period, that is, the minimum use period, the customer should pay the cancelation charge. In general mobile-phone services such as mail service cannot be carried over, if the customer changes the current mobile-carrier. So far, charge-discount service depending on contract duration was unable to carry over. Currently *SoftBank* announces that the charge-discount service depending on contract duration can be carried over even if the customer changes the current mobile-carrier. The explanatory variables No.4 to 6 in Table 5 expresses restrictive factors for customers, if the value of the variable is 0. In other words, these variables are incentive factors for customers who would like to change to a new mobile-carrier, if the value of the variable is 1.

(1) Case I

Table 8 shows the mobile-carrier choice probabilities for the scenario in which all of conditions are the same. In other words, there is no merit in this scenario. The results indicate the brand loyalty effect for the mobile-carrier choice behavior.

(2) Case II

The sales strategy of *au* and *SoftBank* is the same in this scenario. This scenario expresses the following conditions.

Table 9 Simulation results in Case II.

No.	Explanatory Variables	*au*	*docomo*	*Softbank*
1	Monthly charge: X,000 yen	1	0	1
2	Phone discount: X0,000 yen	2	0	2
3	Service period: X months	12	0	12
4	Cancelation charge	0	0	0
5	Mail service	0	1	0
6	Contract duration	0	0	0
	Choice Probability (%)	26.76	41.77	31.47

Table 10 Simulation results in Case III.

No.	Explanatory Variables	*au*	*docomo*	*Softbank*
1	Monthly charge: X,000 yen	1	0	1
2	Phone discount: X0,000 yen	2	0	2
3	Service period: X months	12	0	12
4	Cancelation charge	0	0	1
5	Mail service	0	1	0
6	Contract duration	0	0	1
	Choice Probability (%)	5.92	9.24	84.84

- Monthly charge becomes less by 1,000 yen, if the customer changes mobile-carrier to *au* or *SoftBank*. Monthly fixed charge becomes free for 12 months.
- The purchase price of a mobile phone is discounted by 20,000 yen, if the customer buys the phone provided by *au* or *SoftBank*.
- There is no merit concerning monthly charge and price, if the customer buys a new *docomo*'s phone.
- The cancelation charge required to change the current mobile-carrier is paid by the new mobile-carrier.
- Mail address cannot be carried over except for *docomo*, if the customer changes the current mobile-carrier.
- Charge-discount service depending on contract duration cannot be carried over, if the customer changes the current mobile-carrier.

The simulation results in Case II are shown in **Table 9**. The choice probability of *docomo* is more than 10% larger than those of the other carriers although the sales strategy of *au* and *SoftBank* is very powerful in this scenario. It is found that the restrictive factor, that is, mail service, strongly influences the choice-behavior.

(3) Case III

SoftBank announces that the charge-discount service depending on contract duration can be carried over, if a customer changes from other carriers to *SoftBank*. There is an advertising campaign such as cancelation-charge support service recently. Therefore, this scenario implies realistic conditions. This scenario is the same as that in Case II except the following conditions:

- *SoftBank* pays the cancelation charge required to change the current mobile-carrier, if a customer changes from other carriers to *SoftBank*.
- Charge-discount service depending on contract duration can be carried over, if a customer changes from other carriers to *SoftBank*.

The simulation results in Case III are shown in **Table 10**. The results express that the restrictive factors are very important for the mobile-carrier choice behavior.

Table 11 Percentage of stable customers.

Current Carrier	Percentage of Stable Customers
docomo	69.6%
au	54.8%
Softbank	42.6%

4.4 Consideration on Customer Segmentations

This mobile-carrier choice-behavior modeling is an effective way to decide the priority of selectable marketing actions. The six explanatory variables in the proposed mobile-carrier choice model means realizable or realized actions. It is very important to analyze customer segmentations and to collect the survey data considering the segmentations in order to improve the accuracy of the proposed model. In general, the variety of mobile-carrier choice-behavior depends on not the difference of demographics attributes but the difference of preferences by customers. Special choice-data samples are required to construct the segment-dependent models. Due to the limitation of budget for conducting market surveys, a common model is constructed based on the samples for the questionnaire used in this paper. **Table 11** shows the percentage of stable customers in the survey mentioned in Section 3. It is found that more than half of the customers would like to continue their contract with the same carrier regardless of the conditions of the other carriers. This implies that we should consider these customer segments in order to construct better mobile-carrier choice models.

5. Conclusion

We proposed mobile-carrier choice modeling to analyze customer preference and understand customer choice behavior in this paper. We constructed a new mobile-carrier choice model that takes into consideration incentive factors and restrictive factors as decision-making factors. It is shown that these factors of the choice model estimated by using the survey data are effective in analyzing mobile-carrier choice behavior.

Decision-making factors for choosing a mobile carrier vary from customer to customer. It is difficult to understand the actual market structure by using the model constructed by a common set of decision-making factors for all customers. We should consider the difference of preference by customers. There are two ways to express the difference. One is constructing a model with individual attributes as explanatory variables of the utility function as shown in Eq. (2). The other one is constructing models for customer segments divided on the basis of the difference in customer preference. In order to improve the accuracy of the proposed model, we should carry out the customer segmentation based on customer's decision-making characteristic, and construct the model for each customer segment. We are studying the special questionnaire-survey to construct the segment-dependent models.

Various types of changes occur every month in the mobile phone market. These include the launch of new phones, the introduction of new services, change of charge menu and so on. Due to severe competitive conditions in the mobile market, there are a few differences in relation to fees and phones among mobile phone services provided by mobile-carriers. When our survey data was collected, the effect of *iPhone* did not appear clearly. However, the effect of *iPhone* by *au* appeared recently. We will consider the *iPhone* factor when collecting new survey data.

And we will consider additional factors such as service quality, brand loyalty and inertia. As further study, we will construct a model using latent variables based on additional factors.

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