Available online at www.sciencedirect.com

ScienceDirect

June 2017, 24(3): 91–96
www.sciencedirect.com/science/journal/10058885

The Journal of China Universities of Posts and Telecommunications

http://jcupt.bupt.edu.cn

Study of matching model between tariff package and user behavior

Xiao Shuochen, Ning Lianju (✉), Zhuang Wenying

School of Economics and Management, Beijing University of Posts and Telecommunications, Beijing 100876, China

Abstract

As the telecommunication market in China becomes increasingly mature, operators have begun to focus their primary effort on user management; within this focus, determining the proper tariff package for users and offering them relevant recommendations are key issues to resolve. This paper introduces a matching model that links tariff packages and users' usage behavior (e.g., the total minutes used, data usage, etc.) based on the market segmenting theory. Microsoft Visual Fox Pro 9.0 is selected as the development tool to implement the matching model, while the tariff packages and user behavior data for a city branch of China Mobile are used to validate the model.

Keywords matching model, tariff packages, user behavior

1 Introduction

The telecommunication market is becoming mature in China. According to the statistics for province-based telecommunication consumption for the third quarter 2016, published by the Ministry of Industry and Information Technology of the People's Republic of China (MIIT), the penetration rate of mobile phones in China is 95.8 mobile phones per 100 capita: 114 per 100 capita in the eastern part of China, 79.4 per 100 capita in central China and 87.7 per 100 capita. As growth in new users is slowing down, operators have begun to focus on user management. Unlike the earlier shoddy forms of competition, e.g., price-based or pre-paid awards, operators now attract users by providing various tariff packages that provide rich services.

Currently, China's telecommunication market is a buyer's market. Operators thus must segment the market based on market analysis and predictions and develop appropriate sales policies for each market segment. To segment a market is to divide it into subdivisions based on particular consumer characteristics; the most common segments are based on usage behavior, operating habits, and so on. Normally, operators select all segmented markets as their target and develop relevant tariff packages for each.

Tariff packages are developed by mobile operators according to various user requirements. They combine service types and consumption levels in a bundle so that users can maximize their benefits from the selected tariff package. In other words, a tariff package is a combination of service types and prices. For instance, the 4th generation (4G) Business Travel Tariff Package provided by Beijing Mobile includes 9 tariff packages, which cost from RMB 58 yuan per month to RMB 888 yuan per month (as illustrated in Table 1). As an example, for the RMB 58 yuan Business Travel Tariff Package, the user can make 150 min of domestic calls and consume 150 MB of data within a one month interval for a payment of RMB 58 yuan. A three-part module [1] is referred as a charging module, i.e., in a given consumption arrangement, the user prepays a monthly base, which includes a certain monthly rental fee and a certain basic consumption cost. If the user's monthly consumption overshoots the monthly base, the excess consumption will be charged according to the extended charging standard.

Received date: 02-01-2017
Corresponding author: Ning Lianju, E-mail: ninglj007@126.com
DOI: 10.1016/S1005-8885(17)60216-4

Table 1 4G Business Travel Tariff Package of Beijing Mobile

Total cost (RMB)/yuan	Domestic phone call duration/min	Domestic dataflow limit/MB
58	150	150
88	350	300
128	650	600
158	900	600
188	1 200	600
288	1 900	2 048
388	2 600	2 048
588	4 000	6 144
888	6 000	6 144

Currently, operators continually adjust and optimize their segmented markets based on their technical mastery and owned resources. In other words, operators adjust and optimize their current tariff packages and assume there must be one tariff package to fit a user's requirements. However, the user may not know which market segment he is in or which tariff package is the most suitable for him. Sometimes users are confused when selecting tariff packages, since they might not be familiar with many of them. When consumers make a tariff package selection, it can be quite difficult to determine which tariff package is the most suitable, and thus the final selection might not be the optimal one. To improve the quality of service, operators now help users to determine the optimal tariff package according to their usage behavior and inform them through relevant suggestions.

2 Literature review

Some scholars have researched the factors that affect users' tariff package selection possibilities.

Iyenger et al. [2] researched the impact of tariff choices. Fang et al. [3] researched the selection factors, considering impact when university students select their mobile service tariff package, based on a discrete choice model.

By combining the properties of users and mobile service tariff packages, Miao et al. [4] developed a multiple properties logit model to calculate tariff package selection possibilities based on a regression analysis. The model is evaluated based on data collected via questionnaire survey. Miao et al. also further researched this problem using the improved multinomial logit model [5].

Although the above research can help with tariff package design and optimization, these studies cannot help when a user is asked to select the appropriate tariff package.

Another research direction is to design the tariff packages by comprehensively applying user behavior theory, marketing study and data mining to develop a more reasonable tariff package. As an example, Xu et al. [6] performed a cluster analysis of users of China Telecom Co. Ltd., described the characteristics of the customer base, and designed a tariff package.

Pan et al. [7] proposed a data mining-based segmenting model, which provides insights into the characteristics of customer needs and behavior, to enable research into designing a precise tariff package.

Zhang et al. [8] proposed an optimization model for tariff package design under non-uniform package attribute levels. Zhang et al. also proposed a framework model for designing a mobile tariff package based on customer lifetime value and established a set of quantitative mobile tariff package design methods [9].

Some scholars assessed the rationality of operator tariff packages by applying hierarchical analysis. For example, Lü [10] created an evaluation index system for tariff packages considering four dimensions: the user, the enterprise, the relationship and the product. These studies seek to consistently improve the tariff package design method, so that the packages are subdivided more appropriately and rationally [10]. Su [11] used the analytic hierarchy process to build an evaluation model for mobile business packages to support the marketing management of a telecom enterprise. Still, these efforts cannot solve the problem of how to select the most suitable tariff package.

Long et al. [12] researched tariff package selection by applying a cost-volume-profit analysis that allow users to make a rough judgment.

In general, the above studies are mainly designing and evaluating of tariff package based on the choice behavior of customer and the influencing factors on the choice behavior, rather than on the use behavior of customer. In the 4G era，data traffic, instead of voice traffic, has become the most important source of revenue. Thus, non-data traffic services, such as voice traffic volume, short messaging service (SMS) traffic volume needed to be converted into data traffic volume for purpose of 'total data traffic volume billing'. This new billing mode is also in line with the general policies on facilitating faster and more affordable internet connection. In the forseeable future, the 5th generation (5G) network will be put into service. Telecom operators should lay emphasis on the difference in designing of tariff packages and billing mode method.

This paper proposes a tariff package matching method,

which guides the user to select the most suitable tariff package based on his usage behavior, especially on data traffic and total cost. The main contributions of this research include:

Provides a complete mobile tariff package matching model based on user behavior that helps users to determine the most suitable tariff package.

Develops application software that implements the matching model and can offer matching results by taking the user's usage behavior as an input parameter.

Selects 1 080 986 customers of a municipal operator and applies the matching model to determine the most suitable of 16 various tariff packages for each user.

3 Design and implementation of the matching model

3.1 Current status of the problems to be researched

1) Market segmenting and tariff package design have been completed

The 4G network has been applied in China commercially since 2014, and by the middle of 2016, the number of 4G network users was already over 618 million. Operators have adjusted their tariff packages to consider network performance, branding strategies and changing user requirements. At this point, operators have already identified unified branding strategies and established rational and systematic tariff packages adapted to various user groups. No revolutionary change is expected until the 5G network is introduced to the market in 2020.

2) Many users have not selected the most suitable tariff packages

As noted above, many users do not know which tariff package is the most appropriate for them, since they normally select a tariff package according to their experience or based on uncertain judgment. As a result, the selected tariff package often cannot match the user's expectations; in other words, the user fails to select the most suitable tariff package.

3.2 Users' usage behavior and tariff package match model

To specify the matching model clearly, several terms must first be defined. A mobile service tariff package here refers to a specific level of a billing scheme defined by the operator. For example, in Table 1, the '4G Business Travel Tariff Package' includes 9 levels, which are thus defined as 9 mobile service tariff packages.

1) Parameter descriptions

Tariff package cost: given M tariff package, each package includes n services. The kth billing suite is described as $T_k(i_1, i_2, ..., i_n),\ k = 1, 2, ...,\ M(M, n \in \mathbb{Z})$, where $i_l, l = 1, 2, ..., n$ indicates the component item, which represents the total cost and each service. For instance, for a given tariff package including domestic phone calls, domestic data, and SMS limits.

The above expression can represent the m tariff package by n dimensional vectors, thus establishing $n \times m$ alternative spaces.

User data: assume there are N user bills, the pth user's bill is $U_p(h_1, h_2, ..., h_n),\ p = 1, 2, ..., N(N, n \in \mathbb{Z})$, where N is the number of total users and $h_j, j = 1, 2, ..., n$, indicates the service items included in the user's tariff package, which maps to i_l one by one.

2) Data normalization

Because the components of the tariff package have various units, with very different potential ranges of measurement, for the matching model to provide significant results, the data of each component should be normalized before feeding it into the model.

In this paper, the data are mapped to the range of 0~1 using a normalization formula to eliminate the influence of dimension on the analytical result. Max and min represent the maximum and minimum values of the sample data, respectively. For the different datasets, the [0,1] normalization method is specified below.

Data for the services included in the tariff package:

$$i'_{lr} = \frac{i_{lr} - \min\limits_{k} i_{lk}}{\max\limits_{k} i_{lk} - \min\limits_{k} i_{lk}};\quad r \neq k \tag{1}$$

where i_{lr} indicates the lth service of the rth tariff package.

Data for the services utilized by the user in practice:

$$h'_{jq} = \frac{h_{jq} - \min\limits_{p} h_{jp}}{\max\limits_{p} h_{jp} - \min\limits_{p} h_{jp}};\quad q \neq p \tag{2}$$

where h_{jq} indicates the jth service data of the qth user.

3) Model expression

In this paper, the distance method is used to define the degree of matching between the user and the tariff package. The distance is defined by the norm method as follows:

The distance between user $U_p(h_1,h_2,...,h_n)$ and tariff package $T_k(i_1,i_2,...,i_n)$ with norm α is defined as:

$$D_{pk}=\sqrt[\alpha]{\sum_{j=l=1}^{n}(h'_{jp}-i'_{lk})^{\alpha}} \quad (3)$$

Then, the distances from the pth user to the kth various mobile tariff packages are: D_{p1}, D_{p2}, …, D_{pk}.

When $D_{pk}=\sqrt[\alpha]{\sum_{j=l=1}^{n}(h'_{jp}-i'_{lk})^{\alpha}}$, we identify tariff package $T_k(i_1,i_2,...,i_n)$ as having the minimum distance from user $U_p(h_1,h_2,...,h_n)$; thus, it is the most suitable for user $U_p(h_1,h_2,...,h_n)$.

3.3 Software implementation

To implement the matching model, Microsoft Visual Fox Pro 9.0 is selected as the development tool. The developed software takes users' consumption data as the input parameters and calculates the optimized tariff package based on the input data.

Windows XP and Windows 7 x86/x64 are the supporting operating systems. A total of 100 MB of free memory is required to ensure that the software runs smoothly. Currently, the software can support importing up to 500 000 rows of data at a time.

4 Evaluation

The paper takes data for 1 080 986 users and 16 tariff packages from a city branch of China Mobile to evaluate the matching model. Combined with sample selection, the main parameters are as follows:

Tariff package variable $T_k(i_1,i_2,i_3),k=1,2,...,16$. In which, i_1 for total cost of the suit, i_2 stands for domestic call minutes, i_3 stands for domestic data.

User variable $U_p(h_1,h_2,h_3),p=1,2,...,1\ 080\ 986$. In which, h_1 stands for total cost billed, h_2 stands for domestic call minutes billed, h_3 stands for data billed.

The Euclidean distance is used, so parameter $\alpha=2$. Table 2 shows 20 users selected from the total as a sample and the normalized bill value.

Table 2 Bill value of the sampled user list

Customer ID	Sampled data			Standardized data		
	Total cost (RMB)/yuan	Call duration (RMB)/yuan	Data (RMB)/yuan	Total cost (RMB)/yuan	Call duration (RMB)/yuan	Data (RMB)/yuan
7612********6434	80.61	329.5	95.235 3	0.095 7	0.390 4	0.017 6
7609********8625	40.23	117.0	66.266 6	0	0.055 2	0
7605********2243	57.33	82.0	180.175 7	0.040 5	0	0.069 1
7612********5339	224.01	647.0	384.744 1	0.435 5	0.891 2	0.193 1
7604********5840	274.05	104.5	912.726 5	0.554 1	0.035 5	0.513 2
7612*********5641	138.00	386.5	371.296 8	0.231 7	0.480 3	0.184 9
7603********6342	164.04	165.5	1 113.808 5	0.293 4	0.131 7	0.635 1
7608********5428	265.67	149.5	1 464.231 4	0.534 2	0.106 5	0.847 6
7608********5182	338.57	113.5	1 715.604 4	0.707 0	0.049 7	1.000 0
7606********7786	188.00	716.0	564.814 4	0.350 2	1.000 0	0.302 3
7612********6567	462.22	209.0	1 255.948 2	1.000 0	0.200 3	0.721 3
7609********7243	88.00	101.5	386.443 3	0.113 2	0.030 8	0.194 1
7600********7481	221.03	110.0	1 158.708 9	0.428 4	0.044 2	0.662 4
7612********4518	161.62	173.5	1 105.444 3	0.287 7	0.144 3	0.630 1
7612********3842	104.25	305.5	569.516 6	0.151 7	0.352 5	0.305 1
7612********9733	88.00	199.0	487.921 8	0.113 2	0.184 5	0.255 7
7608********6628	61.85	112.5	177.486 3	0.051 2	0.048 1	0.067 4
7608********6698	88.14	97.0	276.580 0	0.113 5	0.023 7	0.127 5
7610********4294	190.6	270.5	516.231 4	0.356 3	0.297 3	0.272 8
7612********0518	152.15	125.0	478.977 5	0.265 2	0.067 8	0.250 2

The 16 tariff packages being used in this provincial branch are as Table 3:

Table 3 Tariff package list

Package number	Monthly base (RMB)/yuan	Call duration in package/min	Data in package/MB
1	8	30	0
2	18	0	100
3	28	50	100
4	38	50	300
5	48	50	500
6	58	100	500
7	88	220	700
8	138	500	1 024
9	158	500	2 048
10	238	1 000	2 048
11	268	1 000	3 072
12	338	2 000	3 072
13	458	3 000	4 096
14	588	4 000	6 144
15	608	3 000	11 264
16	688	4 000	11 264

After calculation by the matching model, the most suitable tariff package for each of the sampled users is as Table 4:

Table 4 The matching result

Customer ID	The matched tariff package number	In-service tariff package number
7612********6434	7	5
7609********8625	6	4
7605********2243	4	4
7612********5339	8	7
7604********5840	8	7
7612*********5641	8	8
7603********6342	8	7
7608********5428	8	8
7608********5182	9	8
7606********7786	9	8
7612********6567	8	8
7609********7243	6	7
7600********7481	8	8
7612********4518	8	7
7612********3842	7	7
7612********9733	7	7
7608********6628	6	5
7608********6698	6	6
7610********4294	7	9
7612********0518	6	6

The user behavior of 1 080 986 users is selected to perform the matching according to their behaviors based on the module. The matching result indicates that 302 676 users' current tariff package are not optimized selection and should shift their consumption suit. Among the 302 676 users, local telecom operator randomly selected 30 000 people and recommended suitable tariff package to them. Ultimately, 20 550 users accepted the proposal to replace the tariff package.

5 Summary and expectations

This paper proposed a model to match tariff packages based on user behavior that can help users to determine out the most suitable tariff package according to their usage behavior.

To evaluate the model, the author implemented the model with VFP 9.0 and tested it using data provided by a city branch of China Mobile.

As the research is now in its primary phase, further studies and improvements are expected. For example, various services (e.g., domestic phone call duration, domestic data, etc.) from a tariff package should be weighted to make the model more meaningful. In addition, a matching method should be invented for new users who have no behavior data records. What is more, according to the matching results, a performance appraisal scheme should be established to measure the effect of new matched tariff packages on customer satisfaction, loyalty, and profitability. Thus, further studies are required.

References

1. Qu X L. Research on the development strategy of telecom tariff packages in China. Price: Theory and Practice, 2010(5): 71−72 (in Chinese)
2. Iyengar R, Jedidi K, Essegaier S, et al. The impact of tariff structure on customer retention, usage, and profitability of access services. Marketing Science, 2011, 30(5): 820−836
3. Fang Y B, Ye P. Research on behavior of choosing a tariff plan in telecom industry based on discrete choice model. Chinese Journal of Management, 2014, 11(12): 1864−1870 (in Chinese)
4. Miao Y H, Tang J F. Behavior prediction of telecom consumers' choice with packages based on MNL: empirical research. Journal of Systems and Management, 2013, 22(2): 168−176 (in Chinese)
5. Miao Y H, Tang J F, Zhang T J. Behavior prediction of telecom consumers choice with packages based on improved MNL model considering reference dependent. Systems Engineering, 2013, 31(6): 78−82 (in Chinese)
6. Xu H, Qian G Y. Data mining in market segmentation and tariff policy design: a telecommunication case. Proceedings of the 2009 Asia-Pacific Conference on Information Processing: Vol 1, Jul 18−19, 2009, Shenzhen, China. Piscataway, NJ, USA: IEEE, 2009: 328−331
7. Pan Y X, Ye Y H, He R L. Precise suite design method based on data mining for telecom industry. Journal of Intelligence, 2011, 30(6): 123−125 (in Chinese)
8. Zhang T J, Luo X G, Cai L Q, et al. Optimization model for mobile billing suite based on customer choice analysis. Systems Engineering: Theory and Practice, 2014, 34(2): 444−450 (in Chinese)
9. Zhang T J, Cai L Q, Luo X G, et al. Framework model of telecom suite design based on customer lifetime value. Systems Engineering, 2012, 30(2):

15–21 (in Chinese)
10. Lü Z G. Research on evaluation model and evaluation index system of tariff package. Guangdong Communication Technology, 2007, 27(7): 67–71 (in Chinese)
11. Su Z X. Study on the evaluation of telecom operator's mobile service package based on AHP method. Telecom Engineering Technics and Standardization, 2015, 28(4): 50–53 (in Chinese)
12. Long Y T, Liu B H, Guan J L. The tariff package selecting model base on cost-volume-profit analysis. Economic Research Guide, 2014(14): 273–275 (in Chinese)

(Editor: Wang Xuying)

From p. 82

7. Parat K, Dennison C. A floating gate based 3D NAND technology with CMOS under array. Proceedings of the 2015 IEEE International Electron Devices Meeting (IEDM'15), Dec 7–9, 2015, Washington, DC, USA. Piscataway, NJ, USA: IEEE, 2015: 3.3.1–3.3.4
8. Larcher L, Padovani A, Pavan P, et al. Modeling NAND flash memories for IC design. IEEE Electron Device Letters, 2008, 29(10): 1152–1154
9. Kirisawa R, Aritome S, Nakayama R, et al. A NAND structured cell with a new programming technology for highly reliable 5 V–only flash EEPROM. Proceedings of the 1990 Symposium on VLSl Technology, Jun 4–7, 1990, Honolulu, HI, USA. Piscataway, NJ, USA: IEEE, 1990: 129–130
10. Bez R, Camerlenghi E, Modelli A, et al. Introduction to flash memory. Proceedings of the IEEE, 2003, 91(4): 489–502
11. Lee C H, Kang C, Sim J, et al. Charge trapping memory cell of TANOS (si-oxide-SiN-Al2O3-TaN) structure compatible to conventional NAND flash memory. Proceedings of the 21st IEEE Non-Volatile Semiconductor Memory Workshop, Feb 12–16, 2006, Monterey, CA, USA. Piscataway, NJ, USA: IEEE, 2006: 54–55
12. Masuoka F, Asano M, Iwahashi H, et al. A 256K flash EEPROM using triple polysilicon technology. Proceedings of the 1985 IEEE International Solid-State Circuits Conference, Feb 13–15, 1985, Coral Gables, FL, USA. Piscataway, NJ, USA: IEEE, 1985: 168–169
13. Tanakamaru S, Doi M, Takeuchi K, et al. Error-prediction analyses in 1X, 2X and 3X nm NAND flash memories for system-level reliability improvement of solid-state drives (SSDs). Proceedings of the 2013 IEEE International Reliability Physics Symposium (IRPS'13), Apr 14–18, 2013, Monterey, CA, USA. Piscataway, NJ, USA: IEEE, 2013: 3B.3.1–3B.3.6
14. Tanaka H, Kido M, Yahashi K, et al. Bit cost scalable technology with punch and plug process for ultra high density flash memory. Proceedings of the 2007 IEEE Symposium on VLSI Technology, Jun 12–14, 2007, Kyoto, Japan. Piscataway, NJ, USA: IEEE, 2007: 14–15
15. Katsumata R, Kito M, Fukuzumi Y, et al. Pipe-shaped BiCS flash memory with 16 stacked layers and multi-level-cell operation for ultra high density storage devices. Proceedings of the 2009 IEEE Symposium on VLSI Technology, Jun 16–18, 2009, Kyoto, Japan. Piscataway, NJ, USA: IEEE, 2009: 136–137
16. Jang J, Kim H S, Cho W, et al. Vertical cell array using TCAT (terabit cell array transistor) technology for ultrahigh density NAND flash memory. Proceedings of the 2009 IEEE Symposium on VLSI Technology, Jun 16–18, 2009, Kyoto, Japan. Piscataway, NJ, USA: IEEE, 2009: 192–193
17. Tanaka T, Helm M, Vali T, et al. A 768 Gb 3 b/cell 3D-floating-gate NAND flash memory. Proceedings of the 2016 IEEE International Solid-State Circuits Conference (ISSCC'16), Jan 31–Feb 4, 2016, San Francisco, CA, USA. Piscataway, NJ, USA: IEEE, 2016: 142–143
18. Seo M S, Lee B H, Park S K, et al. Novel concept of the three-dimensional vertical FG NAND flash memory using the separated-sidewall control gate. IEEE Transactions on Electron Devices, 2012, 59(8): 2078–2084
19. Whang S J, Lee K H, Shin D G, et al. Novel 3-dimensional dual control-gate with surrounding floating-gate (DC-SF) NAND flash cell for 1 Tb file storage application. Proceedings of the 2010 International Electron Devices Meeting (IEDM'10), Dec 6–8, 2010, San Francisco, CA, USA. Piscataway, NJ, USA: IEEE, 2010: 29.7.1–29.7.4
20. Jeong W, Im J W, Kim D H, et al. A 128 Gb 3 b/cell V-NAND flash memory with 1 Gb/s I/O rate. IEEE Journal of Solid-State Circuits, 2016, 51 (1): 204–212
21. Kim C, Cho J H, Jeong W, et al. A 512 Gb 3 b/cell 64-stacked WL 3D V-NAND flash memory. Proceedings of the 2017 IEEE International Solid-State Circuits Conference (ISSCC'17), Feb 5–9, 2017, San Francisco, CA, USA. Piscataway, NJ, USA: IEEE, 2017: 202–203

(Editor: Wang Xuying)