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Summer 6-27-2016

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Rui-Hong Sun

*BeiHang University*, [sunnymax@foxmail.com](mailto:sunnymax@foxmail.com)

Jin-Xing Hao

*BeiHang University*, [hao@buaa.edu.cn](mailto:hao@buaa.edu.cn)

Davis Ka Chio Fong

*University of Macao*, [davisfong@umac.mo](mailto:davisfong@umac.mo)

Rob Law

*Hong Kong Polytechnic University*, [rob.law@polyu.edu.hk](mailto:rob.law@polyu.edu.hk)

Yan Yu

*RenMin University of China*, [yanyu@ruc.edu.cn](mailto:yanyu@ruc.edu.cn)

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### Recommended Citation

Sun, Rui-Hong; Hao, Jin-Xing; Fong, Davis Ka Chio; Law, Rob; and Yu, Yan, "EXPLORING THE EXPENDITURE-BASED PROFILE OF MACAO VISITORS: A CLUSTER ANALYSIS" (2016). *PACIS 2016 Proceedings*. 133.

<http://aisel.aisnet.org/pacis2016/133>

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# EXPLORING THE EXPENDITURE-BASED PROFILE OF MACAO VISITORS: A CLUSTER ANALYSIS

Rui-Hong Sun, School of Economics and Management, BeiHang University, Beijing, China,  
sunnymax@foxmail.com

Jin-Xing Hao, School of Economics and Management, BeiHang University, Beijing, China,  
hao@buaa.edu.cn

Davis Ka Chio Fong, Faculty of Business Administration, University of Macao, Macao,  
China, DavisFong@umac.mo

Rob Law, School of Hotel and Tourism Management, Hong Kong Polytechnic University,  
Hong Kong, China, rob.law@polyu.edu.hk

Yan Yu, School of Information, RenMin University of China, Beijing, China,  
yanyu@ruc.edu.cn

## Abstract

*Visitor profiling has been increasingly recognized as an important tourism marketing tool in the advent of smart tourism. There is a substantial body of literature relating to tourism market segmentation and visitor profiles. However, most of them focus on psychographic and behavioral factors. Seldom research has addressed the visitor profile based on actual expenditure during the visit. In this study, we explored the expenditure-based profile of Macao visitors using a randomly sampled dataset from a large-scale visitor profile survey supported by Macao Government Tourist Office. Utilizing self-reported actual expenditure data from 3577 visitors, we extracted six expenditure clusters of Macao visitors using a k-means clustering with silhouette analysis. The six clusters, i.e., entertainment, gambling, cuisine, shopping, both cuisine & shopping, and transit, have significant differences in expenditure preferences and expenditure levels. We also analyzed the demographic and behavior profile for each cluster. Our findings shed light on developing customized marketing strategies to the profile of each distinct expenditure cluster of Macao visitors.*

*Keywords: Visitor profile, Market segmentation, Clustering analysis, Silhouette coefficient, Expenditure preference.*

# 1 INTRODUCTION

The advent of the era of big data inevitably reshapes the tourism industry. Visitor profiling, as an important approach for recognizing and understanding target groups, will gain increasing attention from researchers and practitioners in tourism and hospitality (Huy Quan et al. 2015). It is agreed that visitor profiling and tourism segmentation help tourism organization and destination to identify common characteristics of visitors' groups and develop marketing strategies accordingly (Dolnicar et al. 2012; Wilkins 2010). However, visitor profiling is a quite challenging problem (Liu et al. 2013) and it is difficult to find a perfect solution to segment a market (Kotler et al. 2010). There is a substantial body of literature which has proposed many factors to profile visitors in many different contexts: tourism motivation; determination of tourism consumption, and choice of tourism products (Divisekera 2010), but the most frequently used factors are geographic, demographic, psychographic and behavioral (Choi et al. 2011; Konu et al. 2011). Seldom research has addressed visitor profiles based on actual expenditure during visits.

Therefore, this study aims at investigating visitors' expenditure preferences to explore their expenditure-based profiles and to provide suggestions for tourism marketing and development of tourism products in the context of Macao, which is famous for gambling tourism, using a K-means clustering method with silhouette analysis. The detailed objectives of this research are:

- To compute expenditure preferences which reflect how visitors allocate their expenditure on various goods and services consumed while visiting a destination,
- To segment the Macao visitors according to their expenditure preferences by a k-means clustering method with silhouette analysis, and
- To profile each segment after taking demographic and behavioral characteristics of visitors into consideration using cross-tabulations and chi-square tests.

The rest of this paper is organized as follows: Section 2 reviews related literature, Section 3 elaborates the employed clustering method with silhouette analysis, Section 4 describes data sources and processes, Section 5 analyses the results and describes visitors' expenditure-based profiles in detail, and Section 6 concludes the paper and points out the limitations and future research.

## 2 LITERATURE REVIEW

In this section, we briefly review the tourism expenditure literature around the key contributions of our work. As tourism revenue has become a major source of income for many countries or regions, it is necessary to study the determinants of tourism expenditure (Hung et al. 2012). Studies about tourism expenditure can be divided into three aspects: (1) why consumers spend on tourism, (2) how much they spend, and (3) which goods they purchase (Marrocu et al. 2015).

As for the first two aspects, scholars have studied for many years and achieved fruitful outputs. For example, Marrocu et al. (2015) assessed the effect of the main determinants of tourist expenditure and for the selected components of accommodation, food and beverages and other activities. Bernini and Cracolici (2015) explored demographic changes' impacts on tourism decision and tourism expenditure. Campo-Martinez et al. (2010) found that satisfaction is the biggest factor on the decision of whether to revisit a destination. Hung et al. (2012), and Abbruzzo et al. (2014) researched the major factors in expenditures and analyzed the visitors' characteristics in expenditure.

As for the third aspect, tourist consumption profile is widely used to find out which goods they purchase. Visitors' age, gender, education level, income and nationality are analysed most frequently in prior studies (Lin et al. 2015). For instance, Rastogi et al. (2015) analysed visitors' family income, satisfaction to a certain tourism pattern, service level, limitation of expenditure, the number of the old and children, and the ability of payment, which influence the recreational travel. Marrocu et al. (2015) adopted the number of visitors, travel time, accommodation and some demographic information to

character visitors. Amir et al. (2015) used CHAID method to research the differences of visitors in accommodation, diet, transportation, entertainment and shopping at home and abroad. Divisekera (2010), and Hung et al. (2012) analysed the visitors' characteristics in expenditure.

Although prior studies have done some facets of tourist expenditures, there are few researches about expenditure-based profile which can reflect visitor's preferences. Therefore, in this study, we explored the expenditure-based profile of Macao visitors using a k-means clustering method with silhouette analysis.

### 3 METHODOLOGY

#### 3.1 Expenditure Preference

To measure expenditure preference, we use the proportion of a particular expenditure category to the total expenditure as a visitor's expenditure preference towards such expenditure category. Specifically, the expenditure preference is modelled in Formula (1):

$$p_{ij} = \frac{x_{ij}}{\sum_{j=1}^g x_{ij}} \quad (1)$$

where  $p_{ij}$  is visitor  $i$ 's preference towards category  $j$ , which is the proportion of category  $j$  in the visitor  $i$ 's total expenditure.

#### 3.2 K-means Clustering with Silhouette Analysis

We employed a K-means clustering method to segment visitor based on expenditure preferences due to its simplicity and robustness. The procedure of the K-means clustering is as follows:

- Arbitrarily select  $k$  subjects as the initial clustering center from data set;
- Divide every subject into the most similar cluster based on the distance of subjects;
- Update the clustering center that is the average of the distance of every cluster; and
- If the clustering centers remain stable, the algorithm is finished; else return to the second step.

Although the K-means clustering method is popular, the number of clusters must to be known ahead. Prior studies, for example, Rousseeuw (1987), Lleti et al. (2004), Covoes and Hruschka (2011), and Thanh et al. (2015), have adopted silhouette coefficient to solve the problem. Silhouette coefficient, as defined in Formulas (2) and (3), is a distinguishing method combined with condensation and separation degrees, which can distinguish the superiority of clustering.

$$sw_i = \frac{b_i - a_i}{\max(a_i, b_i)} \quad (2)$$

$$\overline{sw} = \frac{1}{n} \sum_{i=1}^n sw_i \quad (3)$$

This method divides data into clusters firstly,  $a_i$  represents the average of distance between data  $i$  and the other data of the same cluster,  $b_i$  represents the minimal average of distance between data  $i$  and the other data in the other clusters,  $sw_i$  represents the silhouette width of data  $i$ ,  $\overline{sw}$  represents the average of the  $n$  clusters' silhouette width, which is between -1 and 1. 1 represents the best result of clustering, -1 means the worst clustering. We can get the best number of clusters while the silhouette coefficient is biggest.

### 4 DATA

In this study, we profiled Macao visitors using a randomly sampled dataset from a large-scale visitor profile survey supported by Macao Government Tourist Office. The questionnaire used in the survey was developed through several rounds interview with government officials and practitioners, as well

as focus group among visitors to Macao. The target population of the survey was adult visitors (aged above 18) completing at least 80% of their current trip to Macao. The survey was conducted at the border gate, outer harbor, Taipa harbor, and the airport of Macao. Due to the purpose of this study, we focus on items relevant to expenditure, including the spending amount of local transportation, diet, shopping, meeting and exhibition, shows in casino, shows out of casino, attractions, gambling, as well as the total expenditure. Table 1 demonstrates the measurement scales and response format for each item.

Variables of the Study	Type of Variable and Measurement Scale	Values
a. Expenditure variables		
<i>Eight expenditure items</i>	Interval;	$\geq 0$
b. Behavioral variables		
<i>Stay overnights</i>	Nominal; dummy	Yes = 1; No = 0
<i>Annual visits</i>	Ordinal; categorical	1-3 = 1; 4-6 = 2; over 6 = 3
c. Demographic variables		
<i>Age</i>	Ordinal; categorical	18-24 = 1; 25-34 = 2; 35-44 = 3; 45-54 = 4; 55-64 = 5; over 65 = 6; Refused to answer=7
<i>Gender</i>	Nominal; dummy	Male = 1; Female = 0
<i>Income</i>	Ordinal; categorical	MOP 2999 or less=1; MOP 3,000-7,999=2; MOP 8,000-14,999=3; MOP 15,000-79,999=4; MOP 80,000 or more=5; Refused to answer=6

Table 1. Measurement Scales and Response Format for Each Variable.

During the data cleaning phase, we found 171 records had missing value of expenditure and 1 record with outliers. Accordingly, we finally got 3577 valid records.

## 5 RESULTS AND DISCUSSION

We used R to programme and to conduct k-means clustering with silhouette analysis. We firstly obtained the relationship of silhouette coefficient and the number of clusters as shown in Figure 1.

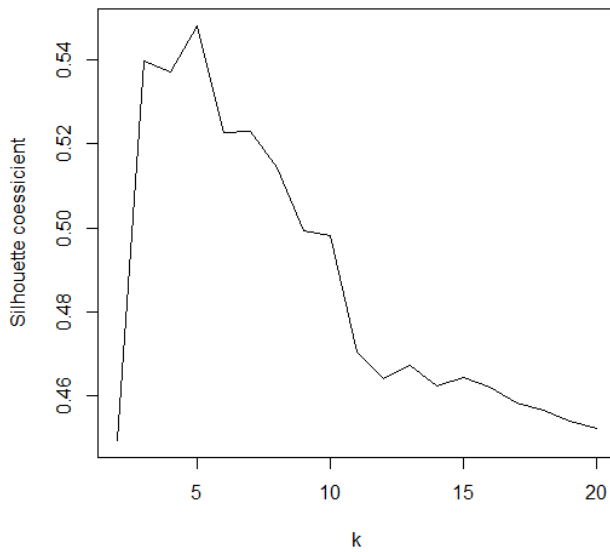


Figure 1. Relationship of silhouette coefficient and the number of clusters.

The horizontal axis represents the number of clusters, the vertical axis stands of the silhouette coefficient. The number of clusters,  $k$ , is between 2 and 20, we repeated 30 times and obtained the relationship of  $k$  and silhouette coefficient. Figure 1 shows that the clustering performs the best while  $k = 6$ , therefore, this study segments visitors into 6 clusters.

In order to view the clustering results, we adopted multidimensional scaling (MDS) to reduce dimensions. The clustering result based on expenditure preferences is illustrated in Figure 2.

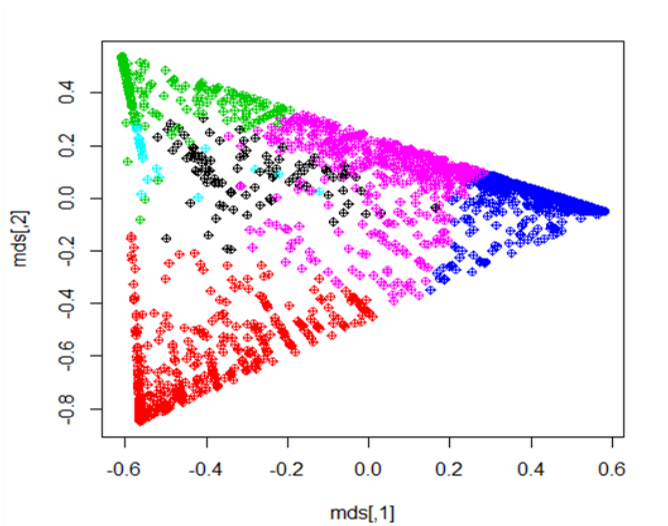


Figure 2. Clusters based on the expenditure preferences.

Figure 2 shows the generated 6 clusters with different colours. As we can see, 4 clusters have centralized distribution and the other 2 clusters are distributed. As Konu et al. (2011) indicate, mean values can be useful for the description of the six clusters as illustrated in Table 2. The first cluster can be called *Visitors for Entertainment* because their expenditures are quite diversified and they have no special preferences. The second cluster corresponds to *Visitors for Gambling* due to their clear preferences to gambling expenditures ( $p_3=0.7938$ ). The third cluster consists of *Visitors for Cuisine*. Visitors in this group have preferences to diet ( $p_2=0.8006$ ). The fourth cluster includes *Visitors for Shopping* because their dominated expenditure is shopping ( $p_3=0.8971$ ). The fifth cluster can be

named *Visitors for Both Cuisine & Shopping* because they are interested in both of them ( $p_2=0.3238$  ,  $p_3=0.5452$ ). Finally, the sixth cluster is emerged from *Visitors for Transit* because local transportation expenditure makes up most of the total expenditure ( $p_1=0.9600$ ). Kruskal-Wallis chi-squared values and corresponding  $p$ -values for each expenditure categories demonstrate the validity of the six clusters.

	Cluster1 Entertainment (n=97)	Cluster 2 Gambling (n=521)	Cluster 3 Cuisine (n=528)	Cluster 4 Shopping (n=1357)	Cluster 5 Cuisine& Shopping (n=808)	Cluster 6 Transit (n=266)	Kruskal -Wallis $\chi^2$
Transportation	0.0783	0.0134	0.1302	0.0203	0.0702	0.9600	1220.9
Diet	0.2594	0.0595	0.8006	0.0678	0.3238	0.0330	2565.8
Shopping	0.1309	0.1267	0.0554	0.8971	0.5452	0.0041	3168.5
Meeting or exhibition	0.0402	0.0001	0.0002	0.0002	0.0032	0	119.57
Shows in casino	0.3168	0.0034	0.0024	0.0032	0.0082	0	864.56
Shows out of casino	0.0784	0.0022	0.0015	0.0009	0.0086	0.0005	113.83
Attractions	0.0742	0.0012	0.0063	0.0018	0.0050	0.0019	105.02
Gambling	0.0217	0.7938	0.0034	0.0087	0.0359	0.0006	2713.9

Notes: All statistics are significant at  $p$ -value < 0.001

Table 2. Macao Visitor Segments based on Expenditure Preferences.

Based on the clustering results, we continue to profile each segment after taking demographic and behavioral characteristics of visitors into consideration by using cross-tabulations and chi-square tests. Previous evidence suggests that age, gender, and income are important variables for describing segments (Bieger and Laesser 2002; Ekinci and Chen 2002; Kazeminia et al. 2013; Lima et al. 2012; Park and Yoon 2009; Perdue 2004). In addition, we incorporated behavioral characteristics of Macao visitors, i.e., Stay overnight and annual visits, to describe the above segments. Drawn from Table 3, we can find that Visitors for Entertainment take a small percentage of the Macao tourism market. Visitors for Gambling and Diet both occupy about 15 percentage of the whole market. Visitors for Shopping are the dominant visitor segment, which makes up 37.9 percentage. Finally, Visitors for Transit occupy approximately 7.4 percentage. The detail of each cluster is described as follows.

- Cluster 1: visitors in cluster 1 can be recognized as entertainment focused. Although it is a small cluster, its' features are bright and it has gradually become a special group that cannot be ignored. Their hobbies vary and they are relatively well-distributed. Among their preferences, they like shows, shopping and cuisine best. Young and middle-aged visitors are the main force. Considered the income, most of them are low and middle-level. As for expenditure, most of them spend less than 2999 MOP (75.3%) and the average expenditure is only 2334.27 MOP. Visitors in this cluster prefer to stay overnights in Macao and visit less frequently (2.65).
- Cluster 2: visitors in cluster 2 can be recognized as gambling focused. Among their preferences, they like gambling best ( $p_8=0.7938$ ). They are most young and middle-aged and the majority are male. Their level of income and expenditure is well-distributed and their average expenditure is 43396.44 MOP which is the most among all the clusters. Majority of them choose to stay overnights (82.7%), visit more frequently (3.39).

	Cluster1 97(2.7)	Cluster2 521(14.6)	Cluster3 528(14.8)	Cluster4 1357(37.9)	Cluster5 808(22.6)	Cluster6 266(7.4)	$\chi^2$
Age							49.272(25)
18-24	16(16.7)	65(12.8)	94(18.4)	204(15.5)	166(20.8)	49(18.7)	
25-34	44(45.8)	193(38.1)	186(36.4)	518(39.4)	290(36.4)	112(42.7)	
35-44	25(26.0)	155(30.6)	120(23.5)	346(26.3)	190(23.8)	62(23.7)	
45-54	8(8.3)	61(12.1)	67(13.1)	153(11.6)	93(11.7)	17(6.5)	
55-64	3(3.1)	25(4.9)	29(5.7)	67(5.1)	47(5.9)	13(5.0)	
>=65	0(0)	7(1.4)	15(2.9)	26(2.0)	11(1.4)	9(3.4)	
Gender							27.167(5)
Male	52(53.6)	305(58.5)	279(52.8)	656(48.3)	395(48.9)	161(60.5)	
Female	45(46.4)	216(41.5)	249(42.7)	701(51.7)	413(51.1)	105(39.5)	
Income level (MOP)							71.695(20)
2999 or less	13(17.3)	56(15.3)	73(19.7)	202(21.5)	139(23.7)	42(23.5)	
3,000 - 7,999	32(42.7)	91(24.9)	97(26.2)	269(28.7)	198(33.8)	45(25.1)	
8,000 - 14,999	14(18.7)	84(23.0)	87(23.5)	204(21.7)	122(20.8)	36(20.1)	
15,000 - 79,999	13(17.3)	113(30.9)	106(28.6)	242(25.8)	124(21.2)	55(30.7)	
80,000 or more	3(4.0)	22(6.0)	7(1.9)	21(2.2)	3(0.5)	1(0.6)	
Expenditure level (MOP)							1189.6(20)
2999 or less	73(75.3)	105(20.2)	485(91.9)	702(51.7)	616(76.2)	263(98.9)	
3,000 - 7,999	19(19.6)	120(23.0)	28(5.3)	356(26.2)	144(17.8)	1(0.4)	
8,000 - 14,999	5(5.2)	81(15.5)	10(1.9)	124(9.1)	28(3.5)	2(0.8)	
15,000 - 79,999	0(0)	149(28.6)	4(0.8)	155(11.4)	19(2.4)	0(0)	
80,000 or more	0(0)	66(12.7)	1(0.2)	20(1.5)	1(0.1)	0(0)	
Average expenditure	2334.27	43396.44	1513.30	8876.22	2939.63	249.02	140840(5)
Stay overnights							282.89(5)
No	37(38.1)	90(17.3)	226(42.8)	371(27.3)	268(33.2)	191(71.8)	
Yes	60(61.9)	431(82.7)	302(57.2)	986(72.7)	540(66.8)	75(28.2)	
Annual visits							47.799(10)
1-3	80(83.3)	404(79.7)	388(75.5)	1113(84.3)	661(83.5)	179(70.2)	
4-6	11(11.5)	59(11.6)	79(15.4)	135(10.2)	82(10.4)	41(16.1)	
>6	5(5.2)	44(8.7)	47(9.1)	73(5.5)	49(6.2)	35(13.7)	
Average visits	2.65	3.39	3.51	3.11	3.03	4.47	

Notes: All statistics are significant at  $p < 0.001$

Table 3. Cross-Tabulations and Chi-Square Tests per Segment.

- Cluster 3: visitors in cluster 3 can be recognized as cuisine focused. They prefer cuisine among their hobbies. Tourists from mainland (49.2%) and Hong Kong (34.7%) make up most. There is an



interesting finding that their income is well-distributed, but their expenditure is most under 2999 MOP and average expenditure is only 1513.30 MOP. They visit Macao frequently.

- Cluster 4: visitors in cluster 4 can be recognized as shopping focused. They like shopping the best. Most of them are young women. Although their income is well-distributed, their expenditure' distribution is not same. Half of them spend less than 2999 MOP, and the other spend more. Their average expenditure is relatively high (8876.22 MOP).
- Cluster 5: visitors in cluster 5 can be recognized as both cuisine & shopping focused. That is to say, their favorite activities are cuisine and shopping. Although it is a portfolio, it has different expenditure habit. Its' average expenditure is higher than cluster 3 and lower than cluster 4. Most of tourists spend less 2999 MOP (76.2%).
- Cluster 6: visitors in cluster 6 can be recognized as transit focused. They spend most on the local transportation. They are young and middle-aged, and most of them are male. Their income has no difference compared with the other groups, but their expenditure is markedly different from them. Majority of them spend less than 2999 MOP (98.9%) and the average expenditure is only 249.02 MOP. Most of them choose to leave at night (71.8%). They visit Macao the most frequently (4.47).

## **6 CONCLUSIONS, LIMITATIONS AND FUTURE RESEARCH**

In this study, we explored the expenditure-based profile of Macao visitors using a K-means clustering method with silhouette analysis. Six visitor segments based on their expenditure preference have emerged as entertainment, gambling, diet, shopping, diet & shopping, and transit. Although Macao has become known worldwide as the "Monte Carlo of the Orient", our results show that the majority segment of Macao visitors is shopping instead of gambling. Visitor segment for gambling takes the leading position in terms of expenditure levels not expenditure preference. In addition, we find that no visitor segment has been found to focus on expenditure on meeting and exhibition, as well as attractions. It implies potential development directions for Macao tourism. Therefore, understanding visitors expenditure-based profile is helpful to customizing destination marketing policies and strategies.

With the coming age of smart tourism, visitor profiling and market segmentation are facing great opportunities and challenges. On one hand, the big data generated from smart tourism can help us portray more accurate visitor profile for precision marketing. On the other hand, we need new models and algorithms to process tourism big data for visitor profiling. Tourism big data is not limited to survey data, but all kinds of data including text, image, social network, and others. Therefore, the current visitor profiling study can be extended by considering more expenditure categories and data samples. We will also try to do longitudinal profiling study and compare different models for visitor profiling. To make up the subjectivity of questionnaire, we will try to crawl online visitor activities and make effective methods to automatically extract visitor profiles.

### **Acknowledgements**

Yan Yu and Jin-Xing Hao are the corresponding authors of the paper. The data file was received from the Institute for the Study of Commercial Gaming, University of Macao, Macao. We would like to acknowledge the supports from projects funded by National Science Foundation of China (Nos. 71101005, 71331007, 71471011, 71420107025, 71531001), Beijing Natural Science Foundation (Nos. 9142010, 9142011), Beijing Social Science Foundation (No. 13JGC092), and Fundamental Research Funds for the Central Universities of BeiHang University.

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