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User Experience Measurement for Travel Booking Mobile Applications Based on Confirmatory Factor Analysis

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Abstract. With the booming development of tourism, user experience measurement for travel booking mobile applications draws attention from companies and scholars, but quantitative researches are still relatively limited. This paper first acquired 30 user experience indexes of travel booking mobile applications by collecting 6314 user comments from 3 Chinese application stores and encoding these comments with grounded theory, then reduced dimensionality and calculated weights of these indexes by analyzing 303 pieces of user rating Likert scale using confirmatory factor analysis, and finally established a quantitative measurement system with 30 indexes and 9 factors for travel booking mobile applications. The measurement system is a good reflection of user opinions because its data resources were totally user evaluations and the confirmatory factor analysis had good goodness of fit.

1 Introduction

According to the 2016 Statistical Communique on China's National Economic and Social Development, there were 4.4 billion person-time domestic tourists and 3939 billion RMB domestic tourism revenue [1]. As an information-intensive industry, tourism can greatly benefit from the mobile internet to break the limitation of time and space. With the rapid development of tourism, user experience measurement for travel booking mobile applications is gaining more and more attention from companies and scholars. However, drawbacks of relevant researches lie in the comprehensiveness of indexes and the accuracy of weight calculation. This paper adopted grounded theory and confirmatory factor analysis to settle down these problems.

2 Acquisition of User Experience Indexes

Acquisition of user experience indexes was divided into two steps: (1) collecting user comments from application stores using web crawler; (2) encoding comments into user experience indexes using grounded theory.

Programmed with Python 2.7, the web crawler collected user comments from 3 Chinese application stores, including “http://www.coolapk.com/”, “https://www.wandoujia.com/” and “http://www.appchina.com/”. By February 13, 2017, 6314 text comments covering 8 travel booking mobile applications (including Qunar, Ctrip, Fliggy, Elong, Tuniu, Tongcheng, Lvmama and Mafengwo) and 3 relevant mobile applications which contain travel booking functions (including Dianping, Meituan and Nuomi) were collected after preliminary screening.

Put forward by Glaser and Strauss in 1967, grounded theory considers data collection and theory formation as a process of iterative interaction, and proposes to use systematic procedures to develop theory according to specific phenomenon [2][3][4]. Grounded theory requires extensive data collection and arrangement, and the most commonly used method of data analysis is the three-level encoding, namely open encoding, axial encoding, and selective encoding. Open encoding requires

researchers to break up and regroup the data collected in the previous period, name research phenomenon, summarize categories, and reveal the relationships between phenomenon and categories. Axial encoding requires researchers to discover the correlations between categories through methods like scenario analysis, semantic analysis, similarity analysis, difference analysis and type analysis. Selective encoding requires researchers to further develop and validate relationships between categories of different levels by means of storylines. After executing above three levels of encoding in turn, an initial user experience index system with 30 indexes (categories) was established, as shown in Table 1.

Table 1. User experience index system

Main Category	Secondary Category	Category
C1 Vision	B1 Vision	A1 Identification
		A2 Aesthetics
		A3 Information levels
C2 Service	B2 Position	A4 Positioning
		A5 Map navigation
	B3 Search	A6 Accommodation search
		A7 Traffic ticket search
		A8 Attraction search
	B4 Price	A9 Accommodation price
		A10 Air ticket price
		A11 Scenic ticket price
	B5 Booking	A12 Accommodation booking
		A13 Traffic ticket booking
		A14 Scenic ticket booking
		A15 Customized service
		A16 Payment options
	B6 Order	A17 Order tracking
		A18 Order modification and cancellation
	B7 Customer service	A19 Customer service attitudes
		A20 Customer service efficiency
	B8 Background behaviors	A21 Background behaviors
	B9 Application update	A22 Application update
C3 Trust	B10 Credit	A23 Fulfillment
		A24 Refunds
		A25 Compensations
	B11 Safety	A26 Payment security
		A27 Information security
C4 Technique	B12 Technique	A28 Resource occupancy
		A29 Application stability
		A30 Application fluency

3 Dimensionality Reduction of Indexes

Confirmatory factor analysis is a special case of structural equation model and a useful tool to validate the goodness of fit between the factor model and the data. The advantages of structural equation model include: processing multiple dependent variables simultaneously, allowing measurement errors of independent variables and dependent variables, estimating factor structure and factor relationships simultaneously, allowing measurement of greater elasticity, and estimating the goodness of fit of the whole model [5].

A questionnaire composed of 3 questions about user basic information and behaviors, and 30 questions about user experience index rating using Likert scale was sent out. From February 2017 to May 2017, a total of 576 questionnaires were collected, of which 303 were valid. The following questionnaires were considered invalid:

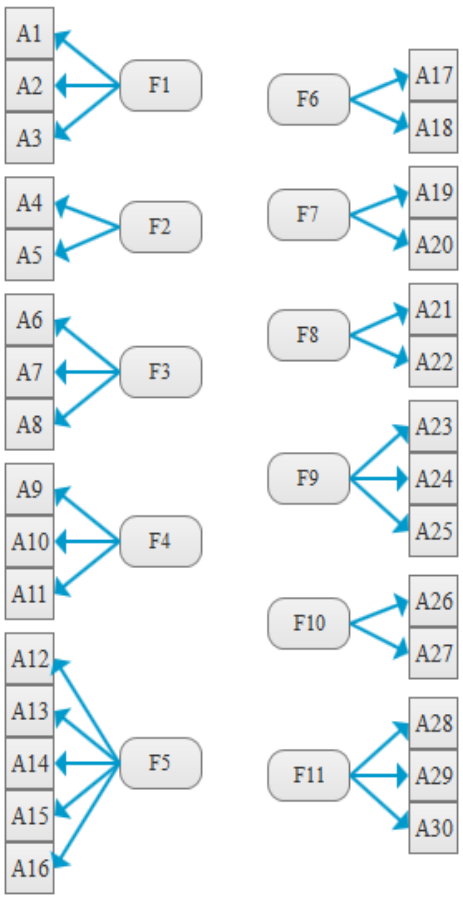
(1) Failed to complete all the questions;
(2) The response time was less than 60s;
(3) Never bought travel products or service on travel booking mobile applications;
(4) The number of questions with the same score exceeded 25;

The Cronbach's alpha was calculated to test the construct reliability of the questionnaire and its value was greater than 0.8, as shown in Table 2, which indicated the reliability was acceptable.

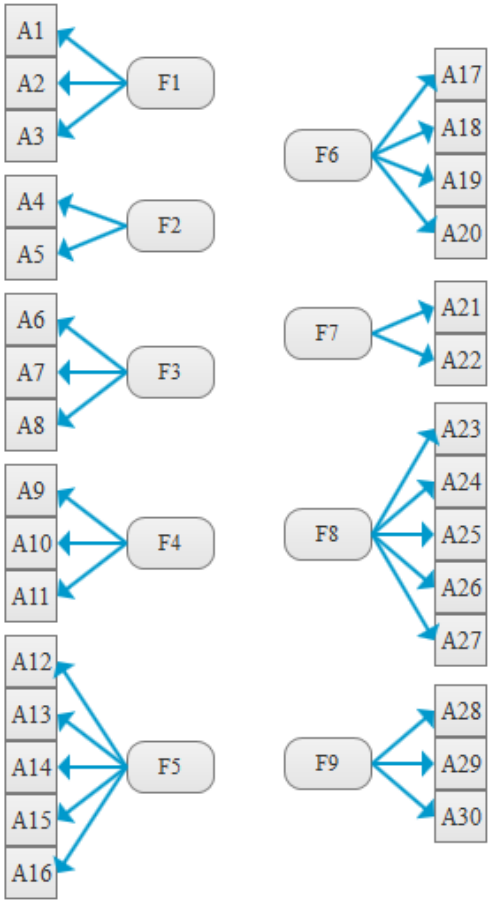
Table 2. Reliability statistics

Cronbach's alpha	Number of measurement items
0.905	30

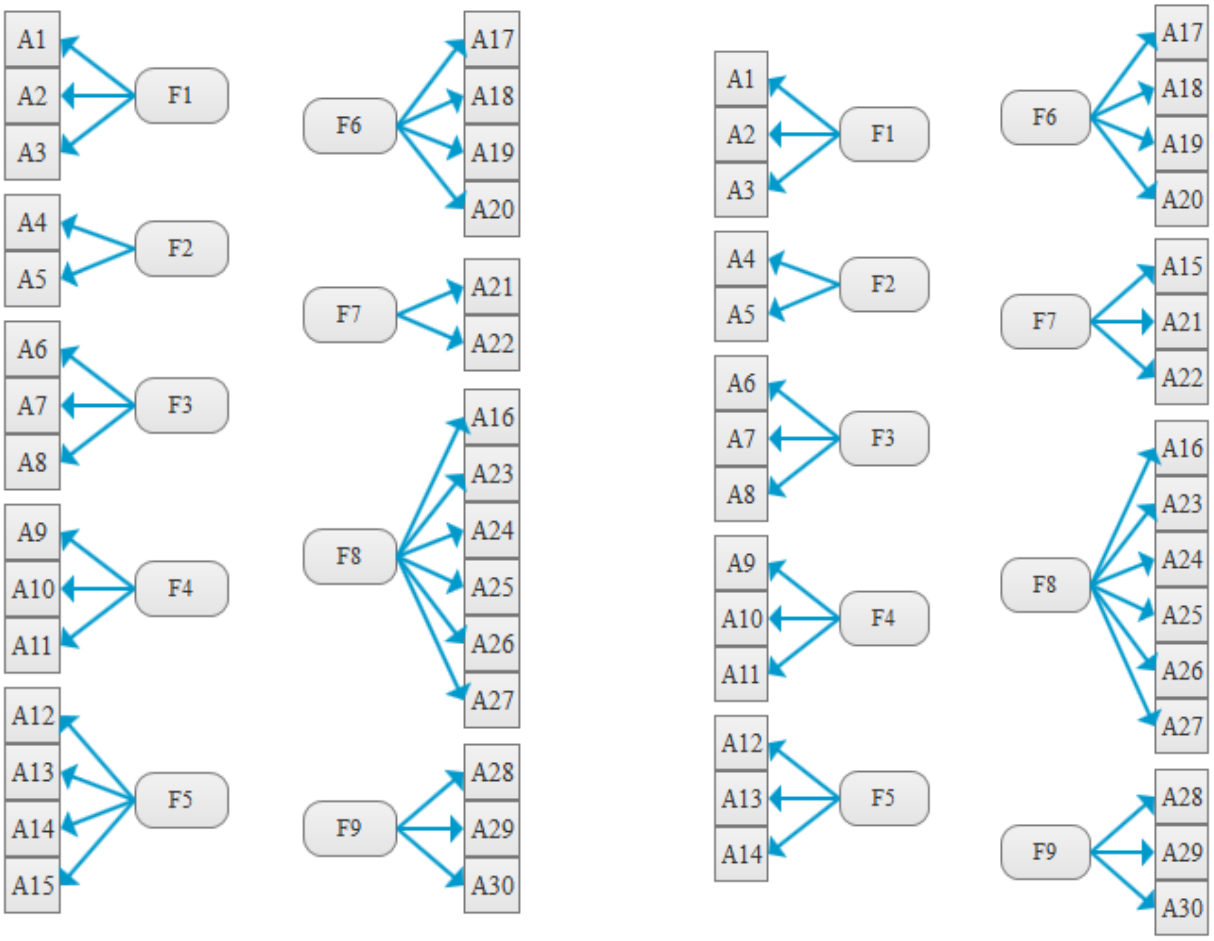
A correlation matrix obtained from the 303 pieces of user rating Likert scale was used to conduct confirmatory factor analysis. Based on the result of grounded theory, 4 models were proposed and tested for fitting successively, as shown in Figure 1 (a) (b) (c) and (d).



(a) Model 1



(b) Model 2



(c) Model 3 (d) Model 4

Fig.1. Models proposed for confirmatory factor analysis

After confirmatory factor analysis, Model 4 turned out to have the best goodness of fit, as shown in Table 3. The goodness of fit of the model would be acceptable if RMSEA < 0.080, NNFI > 0.90 and CFI > 0.90.

Table 3. Goodness of fitting

χ^2	df	RMSEA	NNFI	CFI
1024.28	350	0.080	0.93	0.94
1084.17	369	0.081	0.93	0.94
1044.52	369	0.080	0.93	0.94
970.47	369	0.074	0.94	0.95

Compared to the result of grounded theory, differences were as follows:

(1) Users tended to separate A15 Customized service and A16 Payment options from other booking operations (A12-A14);

(2) Users tended to induce order operations (A17 and A18) and customer service (A19 and A20) into one factor. The possible reason was that users treated them both as after-sale service;

(3) Users tended to induce A16 Payment options, credit (A23-A25) and safety (A26 and A27) into one factor. The possible reason was that for users, payment was strongly related to trust, instead of simply related to booking operations;

(4) Users tended to induce A15 Customized service, A21 Background behaviors and A22 Application update into one factor. The possible reason was that users were not satisfied with these functions or had weak desire to use them because it was found from user comments and index ratings that they were not satisfied with these functions and rated them with low importance.

4 Measurement System

The factor loads of indexes were calculated in confirmatory factor analysis. After normalizing the factor loads, the weights of the indexes in the measurement model were obtained. The final quantitative user experience measurement system with 30 indexes and 9 factors for travel booking mobile applications was established, as shown in Table 4.

Table 4. User experience measurement system

Factor	Index	Weight
F1 Vision	A1 Identification	0.37
	A2 Aesthetics	0.30
	A3 Information levels	0.33
F2 Position	A4 Positioning	0.48
	A5 Map navigation	0.52
F3 Search	A6 Accommodation search	0.35
	A7 Traffic ticket search	0.34
	A8 Attraction search	0.31
F4 Price	A9 Accommodation price	0.32
	A10 Air ticket price	0.34
	A11 Scenic ticket price	0.34
F5 Booking	A12 Accommodation booking	0.34
	A13 Traffic ticket booking	0.33
	A14 Scenic ticket booking	0.33
F6 After-sale service	A17 Order tracking	0.24
	A18 Order modification and cancellation	0.27
	A19 Customer service attitudes	0.23
	A20 Customer service efficiency	0.26
F7 Others	A15 Customized service	0.30
	A21 Background behaviors	0.33
	A22 Application update	0.37
F8 Trust	A16 Payment options	0.10
	A23 Fulfillment	0.17
	A24 Refunds	0.17
	A25 Compensations	0.16
	A26 Payment security	0.21
	A27 Information security	0.19
F9 Technique	A28 Resource occupancy	0.26
	A29 Application stability	0.40
	A30 Application fluency	0.34

5 Conclusion

Based on confirmatory factor analysis, the quantitative measurement system is a good reflection of user opinions because its data resources were totally user evaluations and the confirmatory factor analysis had good goodness of fit. The divergences between the results of grounded theory and confirmatory factor analysis mainly lied in how users treated and classified customized service, payment options, background behaviors and application update. To further recognize the affiliations and relationships between these indexes, additional data on user attitudes needs to be collected, and qualitative researches are also necessary.

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