

Impacts of Residents' Characteristics on Travel Attitude toward Weather Information: an Analytical and Empirical Study

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ABSTRACT: To explore the relationship between individual characteristics and residents' travel attitude toward weather information, the hypothesis of dependence of travel attitude on individual characteristics was formally tested. Stated adaptation surveys were conducted to collect residents' attitudes toward weather information. Then Statistical analysis of Pearson chi-square independence tests were employed on the basis of empirical data collected in Nanjing, China. Results from both the descriptive analysis and the statistical test confirmed that the individual characteristics mattered and that the likelihood of residents changing their travel behaviors in response to weather information they acquired was highly dependent on some of individual characteristics.

KEYWORD: Weather information; Travel attitude; Individual characteristics; Stated adaptation surveys

1 INTRODUCTION

Nowadays, Meteorological information services are sent to travellers through cellphone, radio, television and so on. Residents can easily obtain weather forecast information, which can be used to avoid the risks from adverse weather on travelling. According a travel behavior survey in Nanjing, 55.7% of respondents acquire weather information frequently and 21% occasionally inquire weather information.

Even travelers get the appropriate weather information, the difference of attitude toward weather information and the way they deal with information make it variation on travel decision making. As (Kilpelainen and Summala 2007) suggested, the on-road driving behavior is predominantly affected by the prevailing observable conditions, rather than traffic weather forecasts.

What do determine residents' travel attitudes toward weather information? Existing Literatures related this aspect is still Sparse. (Line, Chatterjee et al. 2010) found that the participants' travel behaviour intentions are dominated by a desire to drive and that their values relating to identity, self-image, and social recognition. As well, their affective attitudes towards transport modes were key influences on this. (He, Ma et al. 2009) found Individual socio-economic characteristics (e.g., age, gender, income, education, children, and vehicle) had a considerable influence on learning ability.

In light of the prior results, there is a need to deepen the study on the impact of individual's

characteristics on travel attitude. The main purpose of the present study is to investigate the relationship between travel attitudes toward weather information and individual socio-economic characteristics. The hypothesis that individual characteristics determine the likelihood of change travel behavior was tested via statistical analysis on the empirical data from a stated adaptation study in Nanjing, China.

Before addressing the impacts of individual's characteristics, a short description of the field work of stated adaptation survey is presented in the paper. The following discusses how the impacts of individual characteristics on travel attitudes can be explored, which is followed by illustrating the statistical results. The last part summarizes the most important conclusions and identifies directions for future research.

2 DATA AND METHODS

2.1 A stated adaptation survey

In transport research, stated adaptation experiments (D'ARCIER et al. 1998), in which respondents are asked to indicate how they would change their behavior considering experimentally varied attribute profiles, typically representing scenarios. And it can be used to solve travel attitude problem which is a medium to long term perspective.

Therefore a stated adaptation experiment about residents' travel attitude toward weather information was carried out in Nanjing, in which questionnaire

was split into two parts, corresponding to the two types of variables considered in the analysis. In the first part, respondents are asked to state their 12 personal and family characteristics which may relate to travel behavior such as residents' demographic variables, transit accessibility and car ownership. The second part is mainly about residents' travel attitudes toward weather information. Respondents were asked 9 questions to indicate the likelihood based on residents' experience and perception, which were expressed by never, rarely, maybe, mostly and certainly. As an illustration of the questionnaire style, Figure 1 shows questions on residents' travel attitudes.

The questionnaire was distributed in 4 businesses or service centers (e.g. Library, city center, book store and business center) located in urban areas of Nanjing. The data were collected between December of 2012 and February of 2013, during which adverse conditions were expected.

Please mark the answer that corresponds mostly to your situation. Only one answer is possible for each weather condition					
	never (<15% of the cases)	rarely (15%-40% of the cases)	maybe (40%-60% of the cases)	mostly (60%-85% of the cases)	certainly (>85% of the cases)
Do you change departure time for work/school according to weather information before leaving?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Do you change departure time for shopping/leisure/entertainment according to weather information before leaving?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Do you change destination for shopping/leisure/entertainment according to weather information before leaving?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Do you make mode choice according to weather information before leaving home?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Do you change trip mode according to weather information on your way?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Do you think your experience is more reliable than weather forecast information?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Do you expect more precise weather information?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Do you inquire weather information before travelling?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
if so, when?	<input type="checkbox"/> never	<input type="checkbox"/> one day before	<input type="checkbox"/> one hour before	<input type="checkbox"/> 0.5 hour before	<input type="checkbox"/> 5 minutes before
				<input type="checkbox"/> departure time	

Figure 1. Questions on residents' travel attitudes.

Altogether 408 residents filled out the questionnaire. 31 cases were rejected due to a clearly insufficient or meaningless filling of the questionnaire.

Before analyzing, the variables of bike and e-bike ownership were merged as non-auto. While the ones of walking distance from home to the nearest bus stop and the one to metro station were dealt with transit accessibility. And therefore 10 individual characteristics variables and 9 travel attitudes were combined to estimate. Table 1 shows the variables and indications in analysis.

Table 1 variables and indications

Variables	Indications
Gender	Binary variable(Female:0;Male:1)
Age, Education, Private monthly income, Occupation	Ordinal variables (1, 2, 3, 4...)
Family annual income, Distance to bus/metro station	Ordinal variables (1, 2, 3, 4...)
School children, Bike and E-bike ownership, Car ownership	Numerical variables (0, 1, 2...)
Travel Attitudes toward weather information	Ordinal variables (1, 2, 3, 4...)

2.2 Statistical methods

It's important to test if the survey sample can represent Nanjing population. As mentioned above, simple random sampling (SRS) method was employed in this stated adaptation survey and the respondent rate was more than 2/3 by face to face interview. The samples' representativeness were examined by matching the distributions of the survey sample to the distributions of the population (From statistic yearbook: Nanjing 2010). Age, gender and private monthly were the basis for this matching process. Chi-square and P-value showed there was no significant variation between observed data and official statistic data on a significant level of 95% and the variation on weighted private income was 9.2%. Thus, the survey sample has a good representativeness.

Recalls testing the hypothesis that the individual's characteristics determine his/her travel attitude toward weather information, independence tests were performed by The Pearson statistic as:

$$Q_p = \sum_{i=1}^k \sum_{j=1}^l \frac{(n_{ij} - \mu_{ij})^2}{\mu_{ij}} \quad (1)$$

Where n_{ij} and μ_{ij} are respectively the observed and the expected frequency for table cell (i,j).

A criticism of the Pearson statistic is that it does not give a meaningful description of the degree of dependence (or strength of association). Cramer's contingency coefficient (Cramer V, R_v) and Pearson's coefficient of mean square contingency (R_p) are methods for interpreting the strength of association as:

$$R_v = \sqrt{\frac{Q_p}{N(\min(R, C) - 1)}} \quad R_p = \sqrt{\frac{Q_p}{N + Q_p}} \quad (2)$$

Where, N is the total sample size and R, C are the row and column numbers. The degrees of freedom are calculated by (R-1) (C-1). Basically, Cramer V and Pearson's coefficient of mean square contingency scales the chi-square statistic to a value between 0 (no association) and 1 (maximum association).

3 DESCRIPTIVE ANALYSIS OF THE IMPACT ON TRAVEL ATTITUDE

Descriptive analyses clearly indicate that individual characteristics really can influence the travel attitudes toward weather information and the relationships between individual characteristics and travel attitude vary.

The result shows education background has a great impact on commuting departure time and home basic model choice. And young people (age of 18-45) and those employees and civil servants tend to keep their commuting trip habits but to change departure time and destination for non-commuting trip. Those who have good income don't like to change their departure time for all trips. This is because they are more likely to own private car and have a stronger risk resistance capacity.

It seems that school child character has little influence on trip attitude. Those who own private car and have a high family income, less likely to change commuting departure time. For mode choice attitude, they hold the opposite opinion, and car owners don't like to make home basic and return mode choice while those have a high family income share a more probability to make mode choice. That's because not all high income family own a private car in Nanjing (only 37.9% in 2012).

When walking distance from home to bus stop/metro station is longer, people tend to make more change in departure time and destination for non-commuting trip, and share a less probability in mode choice. On the opposite, those who own a bike or e-bike are more likely to change non-commuting departure time and less likely to change commuting departure time. That is because they are concerned with more punctuality in commuting trip and more safety and comfort in non-commuting trip.

4 STATISTICAL ANALYSIS OF THE IMPACT ON TRAVEL ATTITUDE

In this part, Pearson chi-square independence tests were employed on different levels (aggregate and disaggregate) to test the hypotheses mentioned formally. Before analysis, each of the individual characteristics is combined into two or three categories, to avoid cells of expected frequency less than 5 in the two-way contingency table.

4.1 Dependence test on aggregate level

In order to gain an integral understand whether individual characteristics have a significant impact on travel attitude. Individual characteristics and travel attitudes were respectively integrated into 5 and 1 categories by factor analysis.

It can be concluded from Table 2 that all travel attitude changes highly depend on the 5 individual characteristics with a p-value smaller than .001, except family economics with a p-value smaller than .01. From the Pearson's coefficient, it can be concluded that personal economics and transit accessibility have the greatest influence on the all travel attitude toward weather information.

Table 2 Dependence test for aggregated characteristics on aggregated attitudes

characters	χ^2	df	p-value	cramer's v	p	signif.
personal basics	250.3	180	0.0004	0.0955	0.188	***
personal economics	475.7	360	0.0000	0.0760	0.210	***
family economics	345.0	270	0.0014	0.0748	0.180	**
transit availability	373.3	225	0.0000	0.1043	0.227	***
non-motor ownership	228.2	135	0.0000	0.1053	0.180	***

***p-value<0.001,**0.001<p-value<0.01,*0.01<p-value<0.05, NS=not significant p-value>0.05

Table 3 shows the independence test of the "all travel attitude" on each individual characteristic. The results also confirm the preliminary conclusions. The extent to which people adapt their travel behaviour according weather information is dependent on the 10 individual characteristics in different degree (all p-values smaller than .01 except one smaller than .05). Education and age have the biggest influence on residents' travel attitudes with the Pearson coefficient more than 0.21, While the occupation impacts the travel attitude on a smallest degree (p-value of 0.0115, Cramer's coefficient of 0.1341 and degrees of freedom of 90) yet still significant.

Table 3 Dependence test for disaggregated characteristic on aggregated attitude

characters	Df	p-value	Cramer's v	P coefficient	Signif.
gender	45	0.0000	0.1643	0.162	***
education	90	0.0000	0.1518	0.210	***
age	90	0.0000	0.1611	0.222	***
occupation	90	0.0115	0.1341	0.186	*
private income	90	0.0015	0.1403	0.195	**
school child	45	0.0000	0.1709	0.168	***
car ownership	45	0.0067	0.1448	0.143	**
family income	90	0.0015	0.1404	0.195	**
transit	90	0.0000	0.1177	0.164	***
nonauto	45	0.0008	0.1087	0.108	***

***p-value<0.001,**0.001<p-value<0.01,*0.01<p-value<0.05, NS=not significant p-value>0.05

4.2 Dependence test on disaggregate level

To further investigate the dependence of travel attitudes on individual characteristics, a more-detailed analysis was performed: for all 9 travel attitudes and 10 individual characteristics. Various conclusions could be drawn from this disaggregate analysis. The Pearson's coefficients show almost the same conclusions as Cramer's Vs.

As showed in table 4. Gender has the greatest influence on commuting trip departure time changes (p-values all smaller than 0.001), while transit accessibility and education share the least influence. On the other hand, age and transit accessibility produce the greatest influence on the attitude of non-commuting trip departure time changes. Schoolchild, transit accessibility and non-auto ownership hold the greatest influence on the attitude of non-commuting trip destination change. It can be seen that schoolchild affects non-commuting trip attitudes greatly. However, education shares the greatest influence on the attitude of mode change before leaving home. While transit accessibility affects the attitude of mode change on the way home most.

That's because residents can easily change their trip mode when they travel by transit.

In line with the preliminary descriptive results, education, occupation and family income have a closet relationship to residents' belief of experience more reliable. For the frequency of inquiring weather information before travel, education, schoolchild, family income and transit accessibility make the largest influence. While car ownership, transit accessibility, family income and age hold p-values less than .001.

In brief, Gender, education, age, car ownership, transit accessibility and non-auto ownership really have significant influence on residents' attitudes of whether make some changes to resist inclement weather conditions.

Table 4 significances of Dependence test on disaggregate level

	gender	edu	age	occu	pincom	child	cars	fincom	transit	nonauto
T	***	NS	*	NS	*	NS	*	NS	NS	*
S	*	NS	***	NS	NS	NS	NS	NS	**	*
D	*	NS	NS	NS	NS	**	*	NS	**	**
M	NS	***	NS	*	NS	NS	NS	NS	NS	NS
O	NS	*	*	NS	NS	NS	NS	NS	**	NS
B	**	***	**	***	**	**	NS	***	*	NS
E	NS	NS	NS	NS	**	***	NS	NS	*	NS
F	NS	***	NS	*	*	***	NS	**	**	*
W	NS	NS	**	NS	NS	NS	**	**	***	NS

***p-value<0.001,**0.001<p-value<0.01,*0.01<p-value<0.05, NS=not significant p-value>0.05

*T: work/study departure time change; S:shopping/leisure departure time change; D:shopping/leisure destination change; M:mode change before leaving home; O:mode change on way back; B:Belief of experience more reliable; E:Expectation of more precise weather info.; F:Frequency of inquiring whether info.; W:when to inquire weather information

5 CONCLUSIONS

In this study, the hypothesis of dependence of travel attitude toward weather information on individual characteristics was formally tested. Results from both the descriptive analysis and the Pearson chi-square independence tests confirmed that the individual characteristics matters and that the likelihood of residents changing their travel behaviors in response to weather information they acquired, is highly dependent on some individual characteristics.

The clear dependence of individual characteristics on travel attitudes provides a deeper understanding of how individual characteristics affect their attitudes. The findings in this paper are consonant with international literature and provide a solid basis for further analysis of weather-related travel behaviour, such as residents' home based departure time choice for different trip purposes and their trip model choice from home and on the way. Studying and modelling the residents' travel behaviour by adding travel attitude toward weather information is a key challenge for further research.

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