# Influence of Planned Behavior on Residents' Low-Carbon Travel Intention in Chengdu City, China

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## Abstract

The objectives of this research are to investigate the influence factors of the correlation between planned behavior and residents' low-carbon travel intention in Chengdu city, China. The research was designed as quantitative research. Based on the previous mature scales, this paper designs the questionnaire of low-carbon travel intention. Questionnaires were distributed to urban residents of Chengdu. After the reliability and validity test, a formal questionnaire was formed and 440 questionnaires were collected. Software SPSS 26.0 was used for reliability analysis. CFA analysis was used to analyze the data. SEM is used to verify the correlation and influence path among low-carbon travel attitude, low-carbon travel subjective norms, low-carbon travel perceived behavior control and low-carbon travel intention. The results show that attitude, subjective norms and perceived behavior control have a direct influence on low-carbon travel intention. Attitude plays a mediating variable between subjective norms and intention, which plays a mediating variable between perceived behavior control and intention too, the hypothesis 1-5 were verified which proposed in this paper, according to the research conclusion, this paper puts forward the countermeasures and suggestions to promote the implementation of low-carbon travel of urban residents.

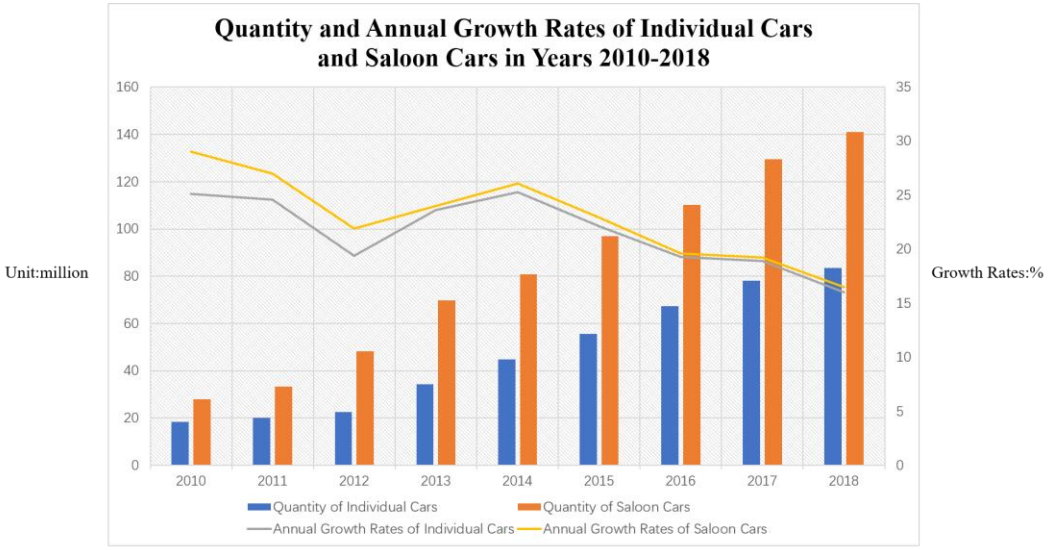
**Keywords:** Subjective norm; perceived behavioral control; low-carbon travel intention; attitude; planned behavior; TPB

## Introduction

Carbon emissions are increasing globally. According to the data of the National Bureau of statistics ,traffic travel is the main factor which leading to the increase of carbon emissions in China.

With the sustained and rapid development of China's economy and society, since 2000, the number of private cars in China has increased rapidly. According to the data of the National Bureau of statistics, by the end of 2018, the number of civil cars in China had reached 260 million, an increase of 11.8% over the end of the last year(2017), including 186.95 million private cars, increase by 12.9%.

The number of cars in 66 cities in China exceeds one million, and more than 2 million in 30 cities, including more than 3 million in 11 cities, including Beijing, Chengdu, Chongqing, Suzhou, Shanghai, Zhengzhou, Shenzhen, Xi'an, Wuhan, Dongguan and Tianjin. What is more noteworthy is that fundamental changes have taken place in the traffic travel structure of Chinese residents, and the proportion of private cars in residents' travel mode has been the first choice for a long time. Taking Chengdu city as an example, from 1986 to 2019, the proportion of private cars in residents' travel mode increased dramatically, and the number of cars ranked second in the country, reaching 5.195 million(Figure 1).




*Data source: China Statistical Yearbook,2010-2018.*

**Figure 1** Quantity and Annual Growth Rates of Individual Cars and Saloon Cars in Years 2010–2018

**Source** China Statistical Yearbook, 2010–2018

Carbon emission can be reduced by guiding residents to travel with low-carbon. Advocating low-carbon transportation for urban residents is one of the important ways to solve the above-

mentioned problems. What's more, it is the inevitable requirement to realize the low-carbon and healthy development of the whole society.

The influence of planned behavior on residents' low-carbon travel intention, advocating low-carbon travel has become a common consensus of society. An accurate analysis of the law of residents' daily low-carbon travel intention is the prerequisite for scientific formulation of urban transport policy and planning of transport facilities. However, the research on low-carbon travel intention mainly focused on travel cost, travel time and individual characteristics in the past, and the impact of planning behavior on low-carbon travel behavior intention is seldom considered.

Therefore, based on these research gaps, the purpose of this research is to study the influence of planning behavior on Residents' low-carbon travel intention, to improve and supplement the research and analysis method of low carbon travel intention, and to provide suggestions for the formulation of urban transport policy.

Residents choose low-carbon travel will reduce carbon emissions and air pollution of city. In order to carry out scientific traffic planning and management, it is necessary to understand and analyze residents' low-carbon travel intention, to make an in-depth study on the internal causes of low-carbon travel intention, and to improve low-carbon travel intention of residents.

The travel behavior model combined with external objective indicators has good effect in the analysis of conventional travel mode, such as cost, time and individual economic and social attributes, but it cannot fully adapt to the study of low-carbon travel intention. It is a new idea to study residents' low-carbon travel behavior intention from the perspective of psychological factors. Based on these research gaps, this study uses the theory of planned behavior (TPB) to organize the psychological influencing factors, to study the influence of planned behavior on residents' low-carbon travel intention and the relationship between these factors.

The author analyzes the information from books, texts, and academic journal articles and discovered the relationship between low-carbon travel intention and planned behavior. This researcher develops the conceptual framework based on The Theory of Planned Behavior (Ajzen,1991).

Synthesizing the above researches, Figure 2 shows the logical relationships among independent variables, mediating variable, and dependent variable. In literature review section, it will be discussed and analyzed specifically.

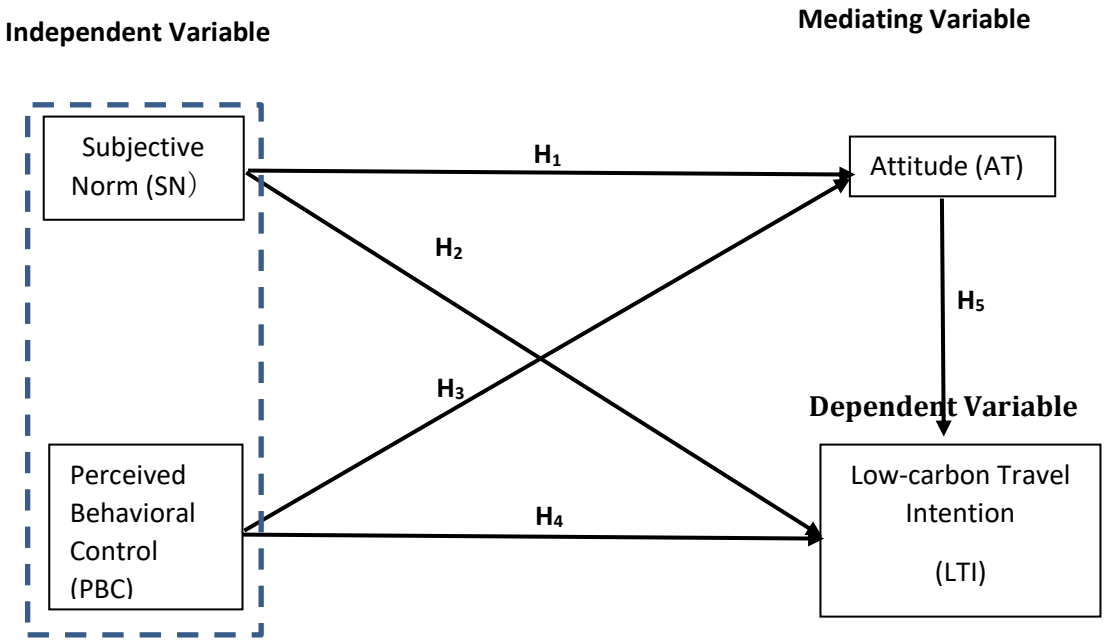



**Figure 2** Research Conceptual Framework

**Source** Authors developed from Ajzen (1991) & Zhang et al. (2020)

Based on the theoretical discussion, the following hypothesis is put forward in this paper.

H1: Residents' subjective norm positively influence residents' attitude.

H2: Residents' subjective norm positively influence residents' low-carbon travel intention.

H3: Residents' perceived behavioral control influence residents' attitude.

H4: Residents' perceived behavioral control influence low-carbon travel intention.

H5: Residents' attitude influence low-carbon travel intention.

## Literature Review

As a kind of low-carbon consumption behavior, the concept of low-carbon travel does not have a unified definition. Different studies have different definitions based on different research positions. Most of the time, it is similar to the concepts of green travel, low-carbon transportation and green transportation. However, it generally refers to the active selection of vehicles with low carbon dioxide emissions during the travel process. Low carbon travel usually does not refer to a specific travel tool, but more often refers to a low-carbon travel and low-carbon life. In a broad sense, low-carbon travel includes both daily transportation and non-daily transportation (such as tourism), while in a narrow sense, low-carbon travel mainly refers to daily transportation. Daily transportation refers to the process

of commuting from home to work In order to facilitate the study, in this study, low-carbon travel refers to the narrow sense of low-carbon travel.

In 1991, Ajzen put forward the theory of planned behavior (Ajzen, 1991) by introducing the variable of perceived behavioral control (PBC) on the basis of rational behavioral rationality. Among them, attitude refers to the individual's evaluation of the positive or negative degree of a certain behavior, which is the core concept in the theory of planned behavior. It is also a relatively small concept under debate. Subjective norm refers to the pressure that individuals feel from reference in decision-making, which is composed of normative belief and compliance motivation. Behavioral intention refers to the individual's willingness to perform a specific behavior.

PBC refers to the factors perceived by individuals that can promote or hinder the occurrence of behavior, which not only affects behavior intention, but also directly affects actual behavior to a certain extent. Attitudes, subjective norms and PBC can be completely separated conceptually, but sometimes they may have a common belief basis, so they are independent of each other and related to each other. Individuals have a large number of beliefs about behavior, but only a small number of behavioral beliefs can be acquired in a specific time and environment. These acquired beliefs are also known as salience beliefs, which are the cognitive and emotional basis of attitudes, subjective norms and PBC.

Generally speaking, the more positive an individual's attitude towards a particular behavior is, the more positive the subjective norm is, and the stronger the PBC is, the stronger the individual's behavioral intention is. When predicting the behavior that is not completely controlled by will, the effect of PBC is more significant. However, when the beliefs about the behavior evaluation of the behavior attitude subjective North options of reference other intention behavior is closer to the strongest degree, or the control problem is not considered by the individual, the prediction effect of planned behavior theory is similar to that of rational behavior theory. In addition, individual and socio-cultural factors indirectly affect behavior attitude, subjective norms and PBC through influencing behavior beliefs, and ultimately affect behavior intention and behavior.

## Research Methodology

Although there are countless existing researches on low-carbon travel intention form perspectives of psychology, sociology and social psychology, the understanding of the relationship between planned behavior and low-carbon travel intention. In order to achieve the research objectives, this study was designed to explain how the planned behavior influence low-carbon travel intention of

residents with the model developed based on the theory of planned behavior. A questionnaire was designed to collect data for empirical study using quantitative research method.

## Population and Sample

This research took Chengdu as a case to study the influence of planned behavior on residents' low-carbon travel intention. The reason why we chose Chengdu city was because the number of individual cars ranks second in China. What's more, Chengdu city has good foundation on low-carbon travel, public transport is developing rapidly in Chengdu. Population of this study consisted people who are urban residents of Chengdu. According to the latest report of Chengdu Statistical Yearbook (2018), the population size was around 6 million. Researchers pointed out sample size will influence the analysis result when SEM is applied. Structural equation modeling (SEM) is an increasingly popular choice for quantitative statistical analyses, as it allows researchers to model complex relationships while taking into account measurement error of latent variables. The stability of covariance structure matrix, generated by samples less than 100, will be reduced, thus the reliability of analysis result will be reduced. Different researcher hold different ideas about the minimum sample size for SEM. Bommsma mentioned for SEM research bigger sample size is better and he suggests sample size should not less than 100 and more than 200(Boomsma, 2013). Anderson and Gerbing (1988) suggests more than 150. For instance, some statistics scholars have recommended using the ratio of observations to estimated parameters (N:q) as a guide. Specifically, Kline (2015) recommended that the N:q ratio should be 20 to 1, or 20 observations (participants) for each estimated parameter in the model. Others have suggested that the N:q ratio can be as low as 10 to 1 (Schreiber et al., 2006) or 5 to 1 (Bentler & Chou, 1987). On the basis of suggestions from SEM experts, best sample size for this study with 4 constructs including 22 observing variables should be over 440.

## Research Findings and Discussions

Descriptive statistics is generally used to calculate the percentage of respondents choosing the questions in the questionnaire. The distribution of the options in each question can be obtained, and the relevant information such as frequency statistics can be obtained. A total of 440 questionnaires were distributed at three areas in Chengdu city and finally 408 questionnaires were usable for this research.

Reliability analysis is to ensure the validity of model fitting evaluation and hypothesis testing. In order to ensure the reliability and stability of the questionnaire, it is necessary to analyze the reliability of the questionnaire. In this paper, Cronbach's alpha reliability coefficient is used to measure the

reliability of the questionnaire. The greater the alpha coefficient, the higher the reliability of the questionnaire, that is, the higher the reliability and stability of the questionnaire. The questionnaire with a coefficient greater than 0.7 is a questionnaire with excellent reliability. When the $\alpha$ coefficient is greater than 0.8 or even greater than 0.9, the questionnaire can be considered as having excellent reliability. In this study, 0.7 was used as the acceptable range. considered as having excellent reliability. In this study, 0.7 was used as the acceptable range.

Table 1 Reliability Analysis

| Scale | Cronbach's Alpha | Number of items |
|---|---|---|
| AT | 0.923 | 6 |
| SN | 0.907 | 7 |
| PBC | 0.895 | 6 |
| LTI | 0.856 | 3 |

It can be seen from table 1 that the reliability coefficient of each scale is greater than 0.8, indicating that all the scales have good reliability. On the whole, the questionnaire scale has good reliability.

Confirmatory factor analysis is to test whether the subordination relationship between items and dimensions in the questionnaire is correct. The main purpose of confirmatory factor analysis is to verify the fitness of the actual measurement data with the theoretical framework.

Table 2 Fitting Indexes of Confirmatory Factor Analysis

| | X2 | df | X2/df | SRMR | GFI | AGFI | NFI | IFI | TLI | CFI | RMSEA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Standard value | | | 1–3 | < 0.05 | > 0.9 | > 0.9 | > 0.9 | > 0.9 | > 0.9 | > 0.9 | < 0.08 |
| Test value | 275.613 | 203 | 1.358 | 0.033 | 0.943 | 0.929 | 0.952 | 0.987 | 0.985 | 0.987 | 0.030 |

From the above table of confirmatory factor analysis fitting indicators, it can be seen that the fitting degree of X2 / df = 1.358 is between 1 and 3, GFI = 0.943 > 0.9, IFI = 0.987 > 0.9, TLI = 0.985 > 0.9, CFI = 0.987 > 0.9, RMSEA = 0.030 < 0.08, SRMR = 0.033 < 0.05, all of which reach the ideal value. Therefore, it can be considered that this model has good matching degree.

Table 3 Structural Equation Model Path Analysis Parameters Table

| | | | Unstandardized estimate | Standard error S.E | C. R. (t value) | P | Standardized beta coefficient | R side |
|---|---|---|---|---|---|---|---|---|
| AT | <--- | PBC | 0.432 | 0.050 | 8.728 | *** | 0.432 | 0.438 |
| AT | <--- | SN | 0.360 | 0.045 | 7.994 | *** | 0.394 | |
| LTI | <--- | PBC | 0.177 | 0.060 | 2.937 | 0.003 | 0.175 | 0.337 |
| LTI | <--- | SN | 0.204 | 0.054 | 3.787 | *** | 0.221 | |
| LTI | <--- | AT | 0.323 | 0.069 | 4.665 | *** | 0.320 | |

***p-value< .001

It can be seen from the table above: PBC has a significant positive impact on AT ($\beta$ = 0.432, P < 0.05); SN has a significant positive impact on AT ($\beta$ = 0.394, P < 0.05); the total explanation R of the model to the feasibility is 0.438, indicating that the interpretation variation is strong. It can be seen from the table above: PBC has a significant positive impact on LTI ($\beta$ = 0.175, P < 0.05); SN has a significant positive impact on LTI ($\beta$ = 0.221, P < 0.05); AT has a significant positive impact on LTI ($\beta$ = 0.320, P < 0.05); the total explanation R of the model for profitability is 0.337, indicating strong explanatory variation. In conclusion, AT has significant positive effects on PBC and SN, and PBC, AT and SN have significant positive effects on LTI, so the hypothesis is acceptable.

Table 4 Test of Mediating Effect of AT on LTI on PBC

| Route | Effect | SE | p | Bias Corrected | |
|---|---|---|---|---|---|
| | | | | LLCI | ULCI |
| Total effect | 0.314 | 0.053 | 0.000 | 0.206 | 0.420 |
| Direct effect | 0.175 | 0.058 | 0.002 | 0.062 | 0.290 |
| Indirect effect | 0.138 | 0.029 | 0.000 | 0.086 | 0.200 |

From the bootstrap mediation effect test in the table above, it can be seen that the indirect effect of PBC on LTI is 0.138, and the confidence interval of Bias-Corrected method is [0.086, 0.200] at 95% confidence level, excluding 0, indicating that the indirect effect is significant; the direct effect is 0.175, and the confidence interval of Bias-Corrected method under 95% confidence level is [0.062, 0.290], excluding 0, indicating that it is direct In other words, AT plays a mediating role in PBC to LTI. The hypothesis is acceptable.

Table 5 Test on Mediating Effect of AT on LTI Caused by SN

| Route | Effect | SE | p | Bias Corrected | |
|---|---|---|---|---|---|
| | | | | LLCI | ULCI |
| Total effect | 0.347 | 0.049 | 0.000 | 0.246 | 0.440 |
| Direct effect | 0.221 | 0.057 | 0.000 | 0.108 | 0.332 |
| Indirect effect | 0.126 | 0.029 | 0.000 | 0.077 | 0.191 |

From the bootstrap mediation effect test in the table above, it can be seen that the indirect effect of SN on LTI is 0.126, and the confidence interval of Bias-Corrected method is [0.077, 0.191] at 95% confidence level, excluding 0, indicating that the indirect effect is significant; the direct effect is 0.221, and the confidence interval of Bias-Corrected method under 95% confidence level is [0.108, 0.332], excluding 0, indicating direct In other words, AT plays a mediating role between SN and LTI. The hypothesis is acceptable.

## Conclusion and Recommendations

Urban residents' low-carbon travel intention is affected by low-carbon travel attitude, low-carbon travel subjective norms and low-carbon travel perceived behavior control. Among them, low-carbon travel attitude has a direct positive effect on low-carbon travel intention, and the path coefficient is 0.32. The low-carbon travel subjective norm and low-carbon travel perceived behavior control have a direct positive effect on low-carbon travel intention, with path coefficients of 0.221 and 0.175, respectively. Obviously, the influence of low-carbon travel attitude on low-carbon travel intention is higher than that of low-carbon travel subjective norm and low-carbon behavior control, but the influence of low-carbon travel subjective norm on low-carbon travel intention is higher than that of low-carbon travel perceived behavior control. Travel attitude has the greatest impact on travel intention, which confirms the research results of most scholars (Ajzen, 1975). Due to the general recognition of low-carbon travel, most residents think that low-carbon travel is worth promoting, which can reduce pollution and alleviate traffic congestion

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