

# Study on the Influential Factors of Consumers' Purchase of Carbon Labelled Products

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## Abstract:

*With the rapid development of social economy, various environmental problems have become increasingly prominent. In particular, the global climate change has aroused widespread concern all over the world. In order to guide consumers to select lower carbon products, the carbon label system has been established gradually. However, only when carbon label products are purchased can consumers contribute to the low-carbon economy. Therefore, the research aim of this paper is to explore the factors that affect consumers' willingness to buy carbon label products, and to provide valuable market research reports and practical suggestions for the establishment of carbon label system in China in the future. Firstly, through descriptive analysis, the respondents' low-carbon awareness, carbon label cognition, low-carbon consumption view, carbon label reliability Purchase intention and low-carbon consumption perceived effectiveness were investigated; then, factor analysis is carried out on the items, and four common factors are put forward, which are included as independent variables in the multivariate linear regression model. Results show that benefit awareness and cognitive reliability have a significant impact on purchase intention, and the impact is positive.*

**Keywords:** carbon labeling, willingness to pay, low carbon, purchase

## 1 INTRODUCTION

Climate change as well as resource and environmental problems are increasingly serious and threaten the survival and development of mankind [1]. In order to effectively reduce greenhouse gas emissions and cope with the problem of climate change, many countries have designed and practiced relevant systems, and carbon labeling is one of them [2]. Carbon label quantifies the greenhouse gases emissions generated in the product life cycle and presents it on the product label, so that consumers can intuitively understand the carbon information of the product and can also serve as the basis for consumers to consume products or services [3-5]. With regard to the carbon label system, Britain is the first country to establish the carbon label system, and formulated the relevant standard PAS2050 [6]. Subsequently, the United States, Canada, France, Japan, South Korea and other countries began to introduce

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relevant policies. The International Organization for Standardization has also issued ISO 14067 [7], which provides a standard for accounting the carbon footprint of products or services [8].

Carbon label products are ultimately to be purchased by consumers, so consumers' willingness to purchase directly determines the implementation effect after the establishment of carbon label system [9-10]. Therefore, there are many researches on the factors that influence consumers' purchase intention. For example, Maniatis et al concluded that consumers' desire to buy green products increases with the increase of their understanding of green knowledge[11]; Li et al found that residents' attitude towards green consumption is related to values and positively correlated with collectivist values[12]; Emberger-Klein & Menrad found that the existence of carbon label will lead consumers to pay more attention to carbon label products, and then affect their purchase decisions[13]; Gadema & Oglethorpe found that the convenience of obtaining carbon label information and the size of carbon footprint significantly affected consumers' decision[14]; Vanclay et al summarized that consumers will be more inclined to buy green products when they receive reasonable green guidance[15]; Boardman studied the influence of the complexity of carbon label on consumers[16]. Previous studies mainly investigated the factors affecting consumers' purchasing decisions, and the influence of carbon label related factors on consumers. However, there are few studies on the factors affecting consumers' purchase of low-carbon products in countries without carbon labeling system, such as China.

As the largest developing country in the world, in the context of the globalization, China's economic development needs to be in line with the development of the world economy. Accelerating the improvement of China's carbon label system and promoting carbon labeling products will not only promote the concept of low-carbon and environmental protection to consumers, but also standardize the low-carbon transformation of various industries in China. In order to gain a firm foothold in international trade, it is necessary to accelerate the establishment of carbon label system in order to gain competitive advantages, avoid the possible formation of "green barriers"[2], and achieve sustainable development of trade. Therefore, the research object of this paper is to explore the factors that affect consumers' willingness to buy carbon label products, and to provide valuable market research reports and practical suggestions for the establishment of carbon label system in China in the future. The structure of this article is as follows. After the introduction of this part, section 2 describes the questionnaire design and questionnaire collection process, section 3 presents the results of descriptive analysis and regression analysis, section 4 summarizes the conclusions.

## **2 RESEARCH METHODS**

### ***2.1 Questionnaire design***

The questionnaire is divided into three major sections: statistics of personal characteristics, understanding of low-carbon concept and knowledge related to carbon labels, and low-carbon consumption habits, with a total of 27 questions. Details of the questionnaire are shown in the Appendix. Part 1 is the survey of demographic variables, including the gender, age, education, position, monthly income and residence of the respondents.

Part 2 is a survey of consumers' low-carbon concept and their awareness of carbon labels, which contains 10 questions. Among them, questions 1-6 assess the

understanding of consumers' low-carbon concept, and questions 7-10 reflect the understanding of consumers' cognition and acceptance attitude towards carbon labels. Through the investigation of part 2, we hope to see the real and concrete influence of consumers' carbon label cognition on their consumption behavior. Likert scale was used for all the questions of part 2, and the scale was divided into 1-5 points, including "very inconsistent", "comparatively inconsistent", "fair", "comparatively consistent" and "very consistent".

Part 3 is a survey of consumers' low-carbon consumption behavior, which is used to measure their perception and purchase intention of carbon-labeled products, including 12 questions. The 5-point Likert scale is still used in this part of scale, but there are also some questions with separate measurement options. Question 1-2 is to measure consumers' low-carbon purchase behavior for ordinary products, so as to understand consumers' low-carbon consumption behavior without carbon label. Question 3-9 measure consumers' acceptance and purchase intention of carbon label products. Question 10 is to reflect the influence of low-carbon behavior of product manufacturing companies on consumers' consumption choices, and questions 11-12 can measure consumers' ideas and attitudes towards low-carbon consumption behavior.

## **2.2 Collection of questionnaires**

Questionnaire collection methods are divided into two types: collecting data in large shopping malls and collecting data in online community. A total of 227 questionnaires were collected, and the number of valid questionnaires was 227 after screening.

There are some differences in the characteristics of the interviewees. For example, most of the interviewees are under 26 years old, and students account for a large proportion, accounting for 67.84%. The main reason is that when collecting the questionnaire, people who are willing to participate in the questionnaire survey are young students, and the participants in the online community are also college students who are conducting research. The unbalanced proportion of the population may lead to unnecessary deviation of the experimental results. Therefore, 227 questionnaires are screened twice to obtain sample data with coordinated proportion for statistical analysis. In China, the proportion of students who are educated in schools is about 20.07% of the total population. Therefore, in the final samples, the number of students is 20.07% of the total samples, so as to obtain the total samples that conforms to the large environmental proportion and minimize the influence of similar groups on the survey results. Among the 227 collected questionnaires, 73 were non-student questionnaires, and the total number of final samples was 100 after calculation. In order to ensure randomness, Excel random number generator was used for sampling, and each students interviewee is assigned a random number, from which 27 samples are taken to participate in the final data analysis.

SPSS 20.0 software was used to test the reliability and validity of the questionnaire. In reliability analysis, Cronbach's coefficient is used to test whether the design of the questionnaire is reliable and whether there is a better correlation between the questions of the questionnaire. The Cronbach's coefficient of the present study is 0.939, higher than 0.9, showing that the reliability quality of research data is very high. Validity analysis is used to test whether the topic of questionnaire is consistent with the research purpose, and the structural validity of the scale is mainly tested by exploratory factor analysis (John & Brendan, 2012)[17]. The prerequisite for factor analysis is to satisfy the Kaiser-Meyer-Olkin (KMO) test and Bartlett's sphericity test. The KMO value of the present study is 0.874, greater than 0.6, which means that the

data are valid. The significance level of Bartlett's sphericity test is 0, which indicates that the items in the questionnaire are suitable for factor analysis.

### 3 RESULTS AND DISCUSSIONS

#### 3.1 Descriptive statistical analysis

Table 1 is the demographic characteristic of this survey sample. Generally speaking, there is no phenomenon that the proportion of the same kind of people is too high, but in the sample, the proportion of women is more than that of men. The possible reason is that the data collection place is a large shopping mall, and the shopping mall is a place where there are more women than men, so most of the collected questionnaires come from female respondents.

**Table 1: Distribution of the sample characteristics**

Demographic variables	Classified items	Frequency	Percentage	Demographic variables	Classified items	Frequency	Percentage
Gender	Male	25	25%	Occupation	Students	27	27%
	Female	75	75%		Doctors, educators and researchers	27	27%
Age	Under 18 years old	11	11%	Social public official	7	7%	
	19-25 years old	37	37%	Businessmen and employees	29	29%	
	26-35 years old	9	9%	Farming	8	8%	
	36-50 years old	40	40%	Unemployed	1	1%	
	Over 50 years old	3	3%	retirement	1	1%	
Residence	City	57	57%	Monthly income (RMB)	≤1500	27	27%
	Township	22	22%		1500-3000	22	22%
	Countryside	21	21%		3000-4500	18	18%
			4500-6000		11	11%	
				≥6000	22	22%	

The questionnaire measures the public's awareness of low carbon through questions 7.1-7.6. The total average value of the six questions is 3.68, which is a moderate score, indicating that the public does not have a strong awareness of low-carbon environmental protection. This result shows that it is necessary to strengthen publicity in raising public awareness of low-carbon so as to have a stable ideological foundation when developing the carbon labeling system in the future. The public's awareness of carbon labels is measured by questions 7.7-7.10. The total average of the four questions is 3.74, indicating that the public has a better degree of awareness and acceptance of carbon labels. However, specifically, 58% of the public convey that they know or eager to know the definition of carbon label. Combined with the phenomenon that respondents often ask about the definition of carbon label in the process of questionnaire collection, it is not difficult to draw a conclusion that the number of people who are eager to understand carbon label is much higher than the number of people who already know its definition. At the same time, 63% of the respondents indicated that they had not been exposed to carbon label, which is consistent with the current situation that carbon labeling system have not been established in China. Therefore, before promoting carbon label system in China, it is necessary to strengthen publicity and popularize relevant knowledge so that the public can understanding the significance of carbon label.

**Table 2: Statistical analysis of low carbon consciousness and recognition degree of carbon label**

Variables	Total mean	Question number	Mean	Standard error
Low carbon consciousness	3.680	7.1	3.780	0.894
		7.2	3.520	1.059
		7.3	3.940	0.983
		7.4	3.530	0.979
		7.5	3.420	0.997
Cognition degree of carbon label	3.740	7.6	3.900	0.870
		7.7	3.626	0.954
		7.8	4.040	0.828
		7.9	4.100	0.847
		7.10	3.220	1.115

Table 3 shows the results of research on public low-carbon consumption ideas and behaviors. The total average of consumers' low-carbon consumption awareness is 3.46, which needs further strengthening. The total average of the items on the degree of consumer trust in carbon label is 3.488, which indicates that consumers are still friendly about carbon label and have a trusting attitude towards carbon label certification agencies without a deep and comprehensive understanding of carbon label.

**Table 3: Statistical analysis of low-carbon consumption thoughts and behaviors**

Variables	Total mean	Question number	Mean	Standard error
low-carbon consumption view	3.460	8.1	3.350	0.903
		8.2	3.570	0.977
carbon label reliability	3.488	8.3	3.180	0.947
		8.4	3.380	0.885
		8.5	3.470	0.881
		8.6	3.500	0.948
		8.7	3.910	0.842
Purchase intention	3.450	8.8	3.450	0.869

Table 4 shows that more than half of the people are willing to pay the premium of carbon label products within 10% of the original price of the products, which means that after the establishment of carbon label system in China, it is best to control the premium within 10% of the product price in order to win the favor of consumers and make the carbon label products have high sales volume. Table 5 indicates that only 3% of consumers explicitly claim that they are not inclined to buy products from companies with strong low-carbon concept. It can be seen that if an enterprise follows low-carbon operation concept, it will be easier to attract public consumption. Therefore, enterprises should keep a positive response attitude to the development of carbon labeling system and the production of carbon labeling products, so as to obtain long-term development. As for the perceived effectiveness of low-carbon consumption, 83% of respondents believe that their low-carbon behavior can affect their family, friends and colleagues, and 96% of respondents believe that their low-carbon behavior can contribute to the protection of environment. This data shows that the low-carbon perception efficiency of the public is relatively high, but there is no strong performance in low-carbon behavior. The reasons may be that the policy is not strict, the social environment has not formed a low-carbon trend, and the crisis awareness of environmental pollution is not strong enough.

**Table 4: Premium payment statistics (Assume that the unit price of a product is 5 yuan)**

Premium (yuan)	≤0.25	0.25-0.5	0.5-1	1-1.5	1.5-2	≥2
Frequency	20	33	18	16	8	5
Percentage	20%	33%	18%	16%	8%	5%

**Table 5: Statistical analysis of low carbon perception effectiveness**

Variables	Total mean	Question number	Mean	Standard error
Low-carbon concept of enterprises	3.770	10.1	3.770	0.802
Perceived effectiveness of low-carbon consumption	3.775	10.2	3.610	0.898
		10.3	3.940	0.802

### 3.2 Regression analysis

Linear regression analysis is a method to explore the influence relation, and its essence is to study the influence relation of X (independent variable) to Y (dependent variable). The general expression of multiple linear regression equation is

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_n X_n \quad (1)$$

wherein  $\beta_1, \beta_2 \dots \beta_n$  are partial regression coefficients, which are used to represent the average change to Y caused by each corresponding independent variable when it changes by one unit while the other variables remain fixed.

The dependent variable of this study is consumers' willingness to buy carbon label products, which is measured by question 8.8. In order to research the factors that influence consumers' purchase of carbon label products, this paper first conducts exploratory factor analysis on 20 items, then incorporates the extracted common factors into regression model, and conducts linear regression analysis on the influencing factors of dependent variables.

**Table 6: Component matrix of factor analysis on the 20 question items**

Question number	Component			
	Low carbon consciousness	Low carbon execution	Cognitive reliability	Benefit consciousness
7.1	0.820			
7.2	0.488			
7.3	0.509			
7.8	0.681			
8.2	0.425			
7.4		0.700		
7.5		0.543		
7.6		0.660		
7.7		0.500		
7.10			0.739	
8.1			0.804	
8.3			0.807	
8.4			0.809	
8.5			0.779	
8.6			0.422	
7.9				0.464
8.7				0.511
10.1				0.724
10.2				0.767
10.3				0.833

The factor analysis results of 20 items shows that a total of 4 factors are extracted from the factor analysis, the characteristic root values are all bigger than 1, and the cumulative variance interpretation rate after rotation is 69.311%. The common factors

are defined as public awareness of low carbon (Question 7.1-7.3, 7.8 and 8.2), low carbon executive ability (question 7.4-7.7), cognitive trust of carbon labels (question 7.10, 8.1 and 8.3-8.6), and consumer benefit awareness (question 7.9, 8.7 and 10.1-10.3). Then, establishes the linear regression model, and four variables generated from the four principal component respectively, and inputs it into linear regression model as independent variable X area, while the consumer purchase intention of carbon labels products selected as dependent variable Y. According to the results of linear regression analysis, the influence relationship between the independent variables and dependent variable is observed (results are shown in Table 6).

**Table 7: Multivariate linear regression analysis on consumers' willingness to buy carbon label products**

	Non-standardized coefficient		Standard coefficient $\beta$	t	Sig.	Collinearity statistics	
	B	Standard error				Tolerance	VIF
Constant	0.018	0.401		0.044	0.965		
Low carbon consciousness	-0.08	0.153	-0.067	-0.524	0.601	0.348	2.877
Low carbon execution	0.146	0.133	0.124	1.102	0.273	0.443	2.26
Cognitive reliability	0.360	0.114	0.329	3.165	0.002	0.519	1.927
Benefit consciousness	0.520	0.142	0.404	3.658	0	0.461	2.167

The adjusted  $R^2$  value is 0.449, indicating that the explanatory degree of independent variables reaches 44.9% and is greater than 30%, and it is considered that the explanatory degree of independent variables selected by the model is higher; In addition, the D-W value is 2.061, near the number 2, which indicates that there is no autocorrelation in the model and there is no correlation between the sample data. VIF values in table 7 are all less than 5, which means that there is no collinearity problem. In addition, the P value of benefit awareness and cognitive reliability in Table 7 is less than 0.05, which indicates that these two variables have a significant impact on consumers' purchase intention of carbon label products. Their regression coefficients are 0.404 and 0.329, respectively, which are all greater than 0. Therefore, this significant impact is positive, that is, when consumers' awareness of benefits in low carbon and environmental protection is stronger, and consumers' awareness and trust in carbon label is improved, their willingness to purchase carbon label products will be stronger. As for demographic variables, we did not include them in the regression model, because the research on demographic variables to consumers' willingness to buy low-carbon products is quite mature at present [18]. Such as, Shuai et al found that the higher the education level and monthly income, the stronger consumers' willingness to pay for low-carbon products, while other conditions remain fixed [19]; Peschel et al discovered that consumers' knowledge level has a positive impact on environmental protection behavior[20].

#### 4 CONCLUSIONS

The analysis results show that the low carbon consciousness of consumers is general and needs to be further improved, At the same time, the low carbon behavior performance is not good and does not match the low carbon thought; Most consumers do not clearly understand the meaning and significance of carbon label, but most people have a trust attitude towards carbon label certification authorities or agencies, and

have a high willingness to buy it; The low-carbon image of a enterprise can improve the favorable impression of consumers and promote consumers to buy the products manufactured by them; Benefit awareness and cognitive reliability have a significant impact on purchase intention, and the impact is positive. Therefore, in order to improve consumers' purchase intention of carbon label products, the publicity of low-carbon environmental protection concept should be strengthened and the participation of enterprises should be encouraged. The gradual integration of carbon label products into public life is not only conducive to the long-term development of enterprises but also contributes to environmental protection. For this study, there are some limitations such as unbalanced demographic characteristics of interviewees and insufficient samples, which cause errors in some data analysis and fail to reflect the real social situation appropriately.

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