AN EMPIRICAL STUDY ON HOW CLIMATE AND ENVIRONMENTAL ISSUES AWARENESS AFFECTS LOW CARBON USE BEHAVIOUR

Abstract: Using survey, we discuss how climate and environmental issues awareness affects residents’ low carbon use behaviour. The results are following. Firstly, climate and environmental issues awareness positively affects residents’ low carbon use. Secondly, perceived effectiveness has mediate effect on the relationship between climate and environmental issues awareness and low carbon use behaviour partly. Thirdly, perceived value has negative moderate effect on the relationship between climate and environmental issues awareness and low carbon use conduct. The results of this study show that when residents feel higher perceived value about their low carbon consumption, they will engage in low carbon use even with lower climate and environmental issues awareness. It tells us that we should treat the residents differently with classification when advocate low carbon use. Specifically, there are some product and service in which consumers can gain high perceived value if the residents frugally use them with high efficiency. And we need to make effort to the following things: we improve the perceived value with hard working, and on the other hand, we make enough effort to enable the residents to deeply experience the perceived value via multiple means.

Keywords: low carbon consumption, perceived effectiveness, perceived value, carbon reduction, sustainability

Introduction

The high amount of carbon dioxide has raised an urgent problem [1]. Most of exist related researches investigate how can decrease urban energy use and carbon dioxide emissions from industrial production or technology research and development. At the same time, businesses face moral responsibilities to reduce carbon dioxide emissions, interest in business responses to climate change has a significant growth [2], scholars have also focused on consumer energy-saving action [3], but the researches in this field about residents’ living consumption are not so rich. Actually, carbon dioxide emissions from residents’ living should not be underestimated. With the acceleration of industrialization and urbanization in China, the households’ consumption level and quality of life are continuously growing, and the over-consumption is placing unprecedented demands on
natural resources [4]. As a result, carbon dioxide emissions produced by residents’ consumption have huge incremental potential, which is particularly serious in mega-cities with dense population. Against this background, many organizations use proactive actions to plan carbon management. However, it is more meaningful to consider carbon emission reduction from an individual perspective. Low carbon consumption is important component of low carbon development [5-7]. Low carbon development is dependent upon the residents’ adoption and implement of low carbon consumption. In order to have a sustainable development, the low carbon economy need to be boosted [4]. Therefore, it is significant that we make great efforts to uncover the veil about the complex factors influencing low carbon consumption and the mechanism.

The residents’ low carbon consumption refers to the consumption that the residents decrease energy use and carbon dioxide emissions in the daily consumption, including buying behaviour, using behaviour and discarding behaviour [8-10]. There are numerous related researches elaborate the influencing mechanisms about low carbon consumption conduct, low carbon product’s consumption or low carbon buying [11, 12]. However, the researches aimed at low carbon use are rare. Low carbon using, which happens in the late phases after buying of low carbon consumption, is referred to a kind of rational consumption act in that the residents limitedly use energy, choose green transportation and reuse daily consumer goods for reducing carbon dioxide emissions in daily life. Taking it as an example, consumers are saving water, electricity and gas. Consumers choose public transportation, riding or walking when traveling. They reuse goods to avoid disposable goods, and so on [13, 14]. It is shown that household energy use and transportation, including private transportation and public transportation, take 77% of carbon dioxide emissions direct from households [15-17]. Making great efforts to initiate low carbon use become an important way to reducing carbon dioxide emissions from residents’ consumption [18, 19].

This paper investigates the mechanism about how climate and environmental issues awareness, perceived effectiveness and perceived value have influence on low carbon use residents living in Beijing. We try to give some theoretical advice for guiding urban residents’ low carbon consumption.

Theory and hypotheses

Climate and environmental issues awareness and low carbon use behaviour

With the progress of science and technology, the ability of human beings to transform nature is constantly improving. At the same time, human activities exert more and more pressure on the environment [20]. Fortunately, people have begun to pay attention to and try to improve the situation [21]. Climate and environmental issues awareness refers to residents’ subjective judgments towards global climate change, which is awareness or understanding towards carbon dioxide pollution because of individual’s consumption. Hines et al. classified environmental awareness into three types, including natural environmental knowledge, climate and environmental issues awareness and environmental action knowledge [8]. In this paper, we stress the concept climate and environmental issues awareness and discuss it.

Some researches and reports address those carbon emissions by human consumption have remarkable role on global climate change. Nordfjærn and Rundmo classified that in order to facilitate pro-environmental transport mode use, it is important to promote
intentions to use public transport [22]. This opinion influences people’s view about environmental problem. But residents have different levels on climate and environmental issues awareness because of the differences of their capability, situation or education background. We argue that the residents can have stronger environmental crisis awareness and they can much easier feel the close relationship between their low carbon use behaviour and environment. Those people may hold more fierce intention of low carbon use.

There are many factors can contribute to individual’s pro-environmental behaviours, ethical and life values are included [23]. It is verified by researchers that climate and environmental issues awareness is a significant factor influencing residents’ pre-environmental behaviour. General environmental knowledge can still significantly predict recycling practice after taking controlling variables in consideration, including attitude, subjective norm and so on. Bamberg finds that climate and environmental issues awareness is momentous factor influencing pre-environmental behaviour by using meta-analysis [24]. Hence, we put up our hypothesis as follow:

H1: Climate and environmental issues awareness has positive effect on residents’ low carbon use behaviour.

Perceived effectiveness and its mediate effect

Perceived effectiveness is defined that the residents hold the belief, which their low carbon use can have positive effect on global climate change in this paper. Individuals often have confidence that their actions result in particular outcomes [25]. Hanss advise that perceived effectiveness is similar to self-efficacy about environmental conservation, and it means that people have the confidence in their ability to make the environment better [26]. Lee uses perceived effectiveness replaced self-efficacy to express the perception about to what extant individual can solve environmental problem through their own effort [27]. We suggest that the person who holds higher level environmental awareness has higher level perception on climate and environmental issues awareness because they are more sentimental than the general. These people bear more moral responsibility consciousness when they face the climate change. So they can just undertake low carbon use, of course. According to self-efficacy theory by Bandura [28] , the main source for self-efficacy is the emotional response when they engage in an act. Therefore, we present that climate and environmental issues awareness can improve the residents’ perceived effectiveness positively. Thompson raises that the person’s knowledge and experience have significant effect on perceived effectiveness [29]. So we suggest that:

H2: Climate and environmental issues awareness has positive effect on perceived effectiveness.

The positive relationship between perceived effectiveness and pro-environmental behaviour has been testified in prior researches. Ellen et al. demonstrate that perceived customer effectiveness is distinct from environmental concern and contributes uniquely to the prediction of pro-ecological behaviour [30]. Roberts advises that perceived consumer effectiveness can easier affect pro-environmental behaviour than other antecedents, such as altruism or environmental concern [31]. Straughan and Roberts suggest that perceived consumer effectiveness is the most important factor using to predicting consumers’ pro-ecological behaviour [32]. As consumers believe their efforts have an impact on solving the environmental issues, so Kabaday et al. suggested high perceived consumer effectiveness is crucial to consumers with positive attitudes for pro-environmental consumption [33]. Therefore, we advance that the positive environmental attitude is shaped
when the persons feel they can decrease carbon dioxide emissions and improve environmental problem, and this attitude may lead to individuals’ low carbon use. Conversely, the negative environmental attitude comes out and the persons may not undertake low carbon use action when they don’t believe to have ability to influence the environmental problem. So we raise the following hypothesis:

H3: Perceived effectiveness has positive effect on residents’ low carbon use behaviour.

The researchers find that climate and environmental issues awareness does not always influence people’s doing towards the environment directly, but there may be some mediate effects. Typically, Hungerford and Volk put forward the knowledge-attitude-belief-practice (KABP) model [34]. This theory suggests that individuals’ knowledge related to environment is not enough to affect and change action, but it needs to form correct attitude and belief via deliberate thought and judgment and then influence behaviour. The theory is used to demonstrate and interrupt individuals’ health management in health education at feast and then it is widely applied and developed in other fields, taking consumer behaviour for example. In this paper, we adopt KABP to explain the mediation of perceived effectiveness between climate and environmental issues awareness and low carbon use.

According to the KABP theory, knowledge (cognition and learning) is the foundation of behaviour, belief (attitude and belief) is the stimulus of action and the act is the goal and consequence. Individuals’ cognition is the necessary prerequisite of behaviour. However, it is not the sufficient condition. In another words, cognition can be the driving force to change conduct only if it transforms into positive attitude or belief. As far as residents’ low carbon use is concerned, climate and environmental issues awareness is individual’s cognition and understanding towards the current climate and environmental issues. Climate and environmental issues awareness may result in residents’ low carbon use. The conformed belief will transform person’s crisis awareness into continuous motivation of specific practice. In this paper, perceived effectiveness means the belief that consumers work for improving environmental issues actively. The motivation of cognition transforming into doing may enhance when individuals feel their action have more influence on improving climate and environmental issues. For this reason, we suggest:

H4: Perceived effectiveness has mediate effect on the relationship between climate and environmental issues awareness and residents’ low carbon use behaviour.

**Perceived value and its moderate effect**

The relationship between perceived value and consumer behaviour is increasingly discussed in the recent years. Perceived value is always used to express customers’ subjective feelings towards specific product or service. We use this concept to express consumers’ subjective feelings towards their action, especially their low carbon use. According to the definition of perceived value raised by Zeithaml [35], we define that low carbon use perceived value is the overall evaluation about their experienced value when they undertake specific activity of low carbon use, including emotional value (the emotional utility value when undertaking low carbon use behaviour), utilitarian value (the improvement of life when undertaking low carbon use), and economic value (the economic utility value when undertaking low carbon use behaviour). In a specific consumption environment, consumers will weigh different value dimensions [36]. The interaction between the environment and individual’s values varies as the situation varies [37]. The psychological factors of individual’s morality are the focus of attention when explaining residents’ low carbon consumption. Obviously, perceived value, one of the non-
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Ethical factors, did not gain equal attention. At the same time, there are a few researches taking both ethical and non-ethical factors into consideration. Schwarfz suggests that non-ethical cost could distort ethical factors’ influence on behaviour, taking personal norms for example [38]. Some research suggest that material rewards indeed have short-time influence on resource conservation and the reduction of carbon dioxide emissions, but the corresponding action would disappear once the return is cancelled. Perceived value is person’s evaluation of value towards some action in this paper, and it is a non-ethical factor. Residents prefer to believe that it is the value to make them undertake pro-ecological behaviour but not their ethical judgment if they perceive their doing as having more value.

In our paper, we think the residents are not sensitive to personal interest when they get less perceived value. So it depends on their ethical judgment if they adopt low carbon use or not. But, when they get more perceived value, residents may pay more attention to non-ethical factors. Further, climate and environmental issues awareness the ethical factor have less effect on individuals’ low carbon use. Therefore, we suppose as the following:

H5: Perceived value has negative moderate effect on the relationship between climate and environmental issues awareness and residents’ low carbon use. In another words, climate and environmental issues awareness’s effect on residents’ low carbon use behaviour is weaker when the residents gain more perceived value.

The research model is as follow as Figure 1.

![Research model](image)

**Method**

**Sampling and data collection**

We choose the urban residents of Beijing as the object of this investigation. The reasons why we chose the urban residents of Beijing are as the following: Firstly, Beijing is a typical mega-city with large population and high population density. Our survey would advocate low carbon consumption when we carry on the investigation, because we need demonstrate the content of the questionnaire to the object. It may make bigger contribution to decreasing energy consumption and protecting the environment if most of the urban residents of Beijing can engage in low carbon consumption. Secondly, the structure of the urban residents in Beijing is with diversity, which means the structure of
consumers is not unitary. Beijing is the capital of China and a lot of people live there because of study, employment or family from all over the country. Thirdly, Beijing’s residents bear the harm of haze pollution and unusual hot weather in the recent years and they are more sensitive to climate and environmental issues. The questionnaires were sent out at public places, such as squares, parks, shopping malls, communities and so on. In order to make sure the quality of the data collection, we use the face-to-face questionnaire survey. And we design appropriate ratio of the samples with diversified levels. 1000 questionnaires were sent out and we received the 1000 questionnaires with 783 effective questionnaires in the end, for a 78.3% response rate. Table 1 shows the samples’ demographic characteristics.

| Items                     | Levels                        | Rate [%] |
|---------------------------|-------------------------------|----------|
| Sex                       | Male                          | 50.2     |
|                           | Female                        | 49.8     |
| Age                       | Under 20 years old            | 8.6      |
|                           | 21-30 years old               | 48.4     |
|                           | 31-40 years old               | 28.7     |
|                           | 41-50 years old               | 7.4      |
|                           | 51-60 years old               | 3.4      |
|                           | Over 60 years old             | 3.4      |
| Education                 | Junior school or under        | 3.8      |
|                           | High school                   | 10.2     |
|                           | Associate degree or Bachelor degree | 65.0 |
|                           | Graduate or over              | 20.9     |
| Income                    | Under 265 €                   | 24.0     |
|                           | 266-530 €                     | 20.2     |
|                           | 531-790 €                     | 19.9     |
|                           | 791-1,055 €                   | 21.8     |
|                           | 1,056-1,320 €                 | 7.3      |
|                           | Over 1,321 €                  | 6.8      |
| Number of family members  | 1 person                      | 29.4     |
|                           | 2 persons                     | 13.7     |
|                           | 3 persons                     | 39.6     |
|                           | 4 persons and over             | 17.4     |

"1 yuan = 0.13 € (01.03.2020)

**Measures**

There are four variables in our research which are necessary to be measured, including climate and environmental issues awareness, perceived effectiveness, perceived value and residents’ low carbon use behaviour. Our questionnaires use a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Scale items used to measure residents’ low carbon use behaviour in this study, including 5 items [39], are mainly derived from Kaiser et al. According to the condition of China, we design a special item “I prefer to choose public transportation/riding/walking in a short trip”. We adopt 3 items mainly from Garling to measure climate and environmental issues awareness [40], and we do some modification. For example, we replace “the shortage of resource and the environmental pollution threaten human beings’
survival and health” with “global climate change threatens human beings’ living environment”. We design 4 scale items to measure perceived effectiveness. “I think that my low carbon use behaviour can make role on improving climate change” is one of the 4 items. And 6 scale items were used to measure perceived value. We separately design 2 items aimed at the three dimensions, including emotional value, utilitarian value and economic value. We did reliability test over the four main concepts. The values of Cronbach’s are separately 0.887, 0.846, 0.681 and 0.738 of climate and environmental issues awareness, perceived effectiveness, perceived value and low carbon use behaviour. The coefficient of internal consistency of them is nearly 0.7, and it means that the scale used in our study has good reliability.

Control variables and common methodology bias

We adopt several demographic variables as control variable, including sex, age, education and income. As for common methodology bias, we took a pre-test in designing the scale and modified the fuzziness of language. And then, we use EFA to test the 18 items. The results show that the first factor explains only 31.79 % variance. Hence, the common methodology bias can be ignored in our study.

Results

Descriptive statistics

The Table 2 shows the results of descriptive statistics. The mean value of residents’ low carbon use behaviour is 4.31, and the standard deviation is 0.59. Low carbon use is positively related to climate and environmental issues awareness, perceived effectiveness and perceived value, and the coefficients of correlation are separately 0.391 (p < 0.01), 0.536 (p < 0.01) and 0.408 (p < 0.01). Residents’ low carbon use is negatively related to their education and the coefficient of correlation is –0.151 (p < 0.01).

| Variables | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|-----------|---|---|---|---|---|---|---|---|
| 1. SEX    | 1 |   |   |   |   |   |   |   |
| 2. AGE    | 0.048 | 1 |   |   |   |   |   |   |
| 3. EDUCATION | 0.067 | -0.204 | 1 |   |   |   |   |   |
| 4. INCOME | 0.126 | 0.186 | 0.195 | 1 |   |   |   |   |
| 5. CEIW   | -0.033 | 0.056 | -0.029 | -0.017 | 1 |   |   |   |
| 6. PE     | 0.038 | 0.198 | -0.060 | 0.054 | 0.378 | 1 |   |   |
| 7. PV     | -0.062 | 0.156 | -0.183 | -0.086 | 0.318 | 0.330 | 1 |   |
| 8. LCUB   | 0.059 | 0.241 | -0.151 | 0.037 | 0.391 | 0.536 | 0.408 | 1 |
| M         | 0.50 | 2.59 | 3.03 | 2.89 | 4.33 | 4.17 | 3.83 | 4.31 |
| SD        | 0.50 | 1.09 | 0.68 | 1.51 | 0.67 | 0.62 | 0.60 | 0.59 |

*Significant at p < 0.05; **Significant at p < 0.01; ***Significant at p < 0.001; CEIW means climate and environmental issues awareness, PE means perceived effectiveness, PV means perceived value and LCUB means low carbon use behaviour

Hypothesis testing

This study analyses the data using hierarchical regression. Firstly, we run Model 1, in which residents’ perceived effectiveness is dependent variable and independent variables
are the four control variables, including sex, age, education and income. Secondly, Model 2 is manipulated, in which dependent variable is also perceived effectiveness and independent variables are climate and environmental issues awareness and the four control variables. From the comparison of the results (see Table 3), the explanatory power of the dependent variable significantly raises when the model takes climate and environmental issues awareness in consideration on the base of the four control variables. The results show that climate and environmental issues awareness can contribute the percent of 13.6 for the variance variation of perceived effectiveness ($\Delta R^2 = 0.136, p < 0.001$). It is shown that climate and environmental issues awareness has positive effect on perceived effectiveness ($\beta = 0.344, p < 0.001$).

| Variables         | Perceived effectiveness | Model 1 | Model 2 |
|-------------------|-------------------------|---------|---------|
| Control variable  |                         |         |         |
| SEX               | 0.035                   | 0.050   |         |
| AGE               | 0.106***                | 0.094***|         |
| EDUCATION         | -0.025                  | -0.021  |         |
| INCOME            | 0.009                   | 0.012   |         |
| Main-effect variable |                    |         |         |
| CEIW              | 0.344***                |         |         |
| $R^2$             | 0.041                   | 0.177   |         |
| $\Delta R^2$      | 0.041                   | 0.136   |         |
| $\Delta F$        | 8.256***                | 128.478 |         |

All of the regression coefficients are non-standardized; $R^2$ is not adjusted; *Significant at $p < 0.05$; **Significant at $p < 0.01$; ***Significant at $p < 0.001$; All of them are based on two-tailed tests.

And then, we take residents’ low carbon use as dependent variable and climate and environmental issues awareness together with the four control variables as independent variables to run regression analysis. As the Table 4 shows, the regression coefficient of climate and environmental issues awareness towards low carbon use is 0.338 ($p < 0.001$), and it is significant in Model 4. Further, we run the regression analysis, in which the dependent variable is low carbon use action and the independent variables are the main-effect variable climate and environmental issues awareness and the mediating variable perceived effectiveness together with the control variables. After putting the mediating variable perceived effectiveness into the model, the explanatory power of the dependent variable significantly raises (up to 14.4 %), the regression coefficient of perceived effectiveness is 0.401 ($p < 0.001$) and the regression coefficient of climate and environmental issues awareness significantly declines, down to 0.200 ($p < 0.001$). It means that perceived effectiveness has partly mediating effect on the relationship between climate and environmental issues awareness and residents’ low carbon use conduct. Hence, H1, H2, H3 and H4 are supported.

We run regression analysis using Model 6, in which the moderating variable perceived value is put in on the base of Model 4. The explanatory power of the dependent variable significantly raises 7 % ($\Delta R^2 = 0.070, p < 0.001$). The interaction is added into Model 6 and the Model 7 is shaped. As a result, the explanatory power of the dependent variable significantly raises 1.4% ($\Delta R^2 = 0.014, p < 0.001$). So the interaction of climate and environmental issues awareness and perceived value really has negative moderating effect.
on residents’ low carbon use ($\beta = -0.056, p < 0.001$). H5 is supported. We make a picture to clearly show the interaction’s influence on residents’ low carbon use. We can know the interaction’s influence on residents’ low carbon use practice at high perceived value and low perceived value.

Discussion and conclusion

Residents’ low carbon use is important part of low carbon consumption, and it is increasingly critical to the pattern of developing sustainable low-carbon consumption. Compared to low carbon buying and low carbon disposal, low carbon use is more important in low carbon consumption. In other words, there is amazing potential and value to run low carbon living pattern in using product or service. This study investigates residents’ low carbon use conduct from the perspective of climate and environmental issues awareness. Obviously, human beings have to rationally rethink the developing path and mode as enjoying the benefit of economic development and technologic advances, when the both bring about climate change and environment deterioration.

Firstly, the people increasingly have experienced a fair bit about the crisis of climate and environment because of the horrible pollution haze which happen frequently in many areas, such as Beijing, Tianjin, and so on. This kind of crisis awareness drives residents to undertake low carbon consumption consciously. This study collects the data towards the urban residents of Beijing via survey and analyses the data using regression. The results show that people’s climate and environmental issues awareness indeed affects their low carbon use positively. Therefore, governments, institutional organizations and the business related to low carbon is necessary to improve the urban residents’ climate and environmental issues awareness by advertising or other communication means in order to make them get a sense of urgency about environmental crisis, and then behave under low
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carbon mode to result in the decrease of life energy consumption and pollutant discharging. In real life, the government has adopted relevant policies, such as, Chinese government has issued numerous policies to guide urban residents’ low-carbon travel [41].

Secondly, the findings of this study are showing that residents’ perceived effectiveness partly affects the relationship between climate and environmental issues awareness and low carbon use act. It is necessary to try the best to increase consumers’ belief that their low carbon consumption can dramatically help relieve climate and environmental issues, leading to make residents to undertake low carbon use because of their climate and environmental issues awareness. So that we need to guide the urban residents engaging in low carbon economics and low carbon life and let them realize that their participation is really important and necessary to the shaping of low carbon economics and low carbon life.

Thirdly, it is interesting that we conclude residents’ perceived value towards their low carbon consumption practice has negative moderating effect on the relationship between climate and environmental issues awareness and low carbon use. The residents more likely engage in low carbon use with higher climate and environmental issues awareness, when they feel lower perceived value about their low carbon consumption. On the contrary, when residents’ feel higher perceived value about their low carbon consumption behaviour, they will engage in low carbon use even with lower climate and environmental issues awareness. It tells us that we should treat the residents differently with classification when advocate low carbon use action. Specifically, there are some product and service in which consumers can gain high perceived value if the residents use them with low carbon use conduct. And we need to make effort to the following things: we improve the perceived value with hard working, and on the other hand, we make enough effort to enable the residents to deeply experience the perceived value via multiple means. Otherwise, as for the product and service with low perceived value when consumers use them, we can increase their crisis awareness to induce them engaging in low carbon use in the progress of the consumption.

Limitations and future research

The findings of this paper further provide an encouraging start in understanding low carbon use [42]. However, there still are some limitations that may be addressed in subsequent studies and the findings of our study should be interpreted with caution. This study only investigates the mechanism of residents’ low carbon use from the one perspective climate and environmental issues awareness, and we just think about the factors of consumers’ individual level. Hence, maybe we need a more comprehensive and systematic framework to interpret the mechanism. In the future, we can try to construct a systematic model together with other levels’ factors to demonstrate the research. And then, our survey just chooses Beijing to carry out, so we suggest that it is necessary to collect the data from several cities’ residents in future research. In addition, we strongly recommend testing the hypotheses with several countries in order to reveal the influence of other related factors, such as cultural value, level of development and so on.

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