

A Review of Research on Low-Carbon Customization

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Abstract. In recent years, environmental protection has become the consensus of people all over the world, and the implementation of low-carbon economic model is the inevitable choice of global economic development. Consumption is an important link in economic development. How to enhance residents' willingness to low-carbon consumption has become a hot topic, and low-carbon customization has been gradually derived. Different from traditional low-carbon consumption, low-carbon customization is a complex consumption pattern. Therefore, it is necessary to review the existing research results and grasp its research status. In this paper, the existing research literature on low-carbon consumption and low-carbon customization is systematically reviewed. First of all, the concept and connotation of low-carbon consumption are improved, and various influencing factors (including demographic factors, psychological factors and external factors) of low-carbon consumption are summarized. Then the concept of low-carbon customization is further clarified, and the important influence of the choice architecture in the customization process is emphasized. Finally, this paper analyses the limitations of the current research and proposes the possibility of future research, hoping to contribute to the existing research on low-carbon consumption.

1 Introduction

Since the 1980s, developed countries have continuously carried out research on the relationship between residents' consumption patterns and environmental resources. It is found that consumer s' behaviors directly cause most of the environmental pollution problems, and even affect 45% to 55% of the total energy consumption [1]. In this context, green consumption, sustainable consumption, low-carbon consumption and other new consumption patterns emerged at the historic moment, and were rapidly recognized and promoted in the whole world. Carbon emission is an important indicator to measure the degree of environmental pollution. In recent years, global warming, extreme weather, sea level rise and other environmental problems caused by excessive CO₂ emission have aroused human thinking. Reducing carbon emission is a key concern of the world today, and low-carbon consumption has attracted wide attention.

However, even though the world is carrying out the publicity and promotion of low-carbon behavior, low-carbon consumption is still difficult to transform from "slogan" to "action". There is still a significant difference between the public's positive attitude towards low-carbon consumption and the actual purchase behavior [2]. One of the important reasons is that the traditional popular and general low-carbon products are increasingly unable to satisfy the demand of contemporary consumers. Therefore, with the booming development of emerging technologies such as the Internet, Artificial Intelligence, Big Data and 5G, digitally-intelligent transformation provides important support for enterprises to realize business upgrading. As a result, a new consumption patterns,

personalized customization, has emerged, providing consumers with richer shopping choices and meeting their consumption needs at different levels [3]. More and more low-carbon product manufacturers are trying to introduce low-carbon customization to reduce the negative impact of green premium, information overload and other factors on residents' low-carbon consumption willingness, and to meet consumers' demand for personalized at the same time.

It is worth noting that low-carbon customization is not a simple combination of low-carbon consumption and personalized customization. The conclusions of existing low-carbon consumption research should not be directly applied to the research on low-carbon customization. At present, there are few researches on the new consumption mode, so targeted studies should be carried out to explore the differences between low-carbon customization mode and traditional low-carbon consumption. This model provides personalized green options for low-carbon consumption and encourages consumers to translate environmental protection concepts into practical actions. It will help reduce carbon emissions at the consumer side, thus promoting the transformation and upgrading of social consumption.

2 Research on low-carbon consumption

2.1 Connotation of low-carbon consumption

Under the low-carbon economic development model, countries should pursue a virtuous cycle of low energy consumption and low emissions. As an important part of social production, consumption must adapt to this mode,

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and the government and enterprises need to actively guide the public to reduce carbon emissions from the consumption side, thus the concept of low-carbon consumption has emerged. At present, the specific definition of low-carbon consumption is still unclear in the academic circle, but the research results on ecological consumption, sustainable consumption, green consumption, circular consumption and other aspects are very rich. Therefore, this study will appropriately expand the scope of the literature by retrieving green consumption studies involving carbon emission elements together.

In a broad sense, low-carbon consumption is subordinate to green consumption and sustainable consumption. After the industrial revolution, the environmental problems of high pollution and high energy consumption have attracted people's attention, and the concept of environmental protection has gradually evolved from the field of production to the field of consumption. In 1987, John and Julia systematically reviewed the previous research results and defined the concept of green consumption for the first time, which was simply summarized as the consumption of products that are pollution-free, resource-free and harmless to human safety and national development. In existing researches, sustainable consumption, green consumption and low-carbon consumption are often studied as the same concept. However, low-carbon consumption has a prominent and unique focus, which lays more emphasis on greenhouse gas emission reduction in the process of consumption and is a more specific way to realize green consumption. Therefore, it is necessary to distinguish them. For example, the study by Ali et al. (2022) proposed that social media can increase teenagers' green consumption behavior and effectively reduce carbon emissions. The concept of green consumption in this study focuses on the carbon emissions of commodities, which is actually the concept of low-carbon consumption [4].

In a narrow sense, low-carbon consumption refers to the consumption behaviors of residents that are conducive to reducing carbon emissions, including the choice of purchasing energy-saving products or facilities, the application of green energy, energy saving in daily life and other consumption behaviors that are conducive to reducing carbon emissions [5]. In terms of connotation, low-carbon consumption belongs to an environmentally friendly lifestyle and consumption mode. Its key word is to reduce carbon emissions, while other environmental keywords (such as protecting biodiversity, paying attention to the impact of products on health, etc.) are not its main concerns.

2.2 Factors Affecting low-carbon consumption

In existing studies, the influencing factors of low-carbon consumption are mainly divided into demographic factors, psychological factors and external factors.

In terms of demographic factors, it is one of the important factors affecting consumer behavior, research through analyzing the characteristic of the consumer population differences to explain why some consumers have a strong preference for low-carbon consumption. For

example, Geng et al. (2022) found that consumers' willingness to pay for low-carbon leafy green vegetables showed significant group differences in income, gender, age and education [6]; Stern et al. (2000) pointed out that compared with men, women would seriously consider the impact of their own behaviors on the environment and others, have a stronger ecological awareness, and are more inclined to low-carbon consumption that represents social responsibility [7]. In addition, groups with higher income, higher education level and higher social status are more likely to participate in low-carbon consumption [8]. Although demographic factors are easy to measure and can reflect consumers' environmental attitudes to a certain extent, their impact on low-carbon product purchase behavior is very limited, and the factors that really affect consumers' green consumption are often more direct variables.

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In terms of psychological factors, TPB explains the decision-making process of human behavior from the perspective of information processing. Based on the TPB, Gunarathne et al. (2020) and Pristl et al. (2021) proved that factors such as attitude, subjective norm and perceived behavioral control have a significant impact on residents' behaviors of low-carbon consumption [9]. Mostafa (2006) used multilevel regression analysis to confirm the factors affecting people's low-carbon consumption behavior, including environmental knowledge, environmental concern, altruism and convenience. Verplanken and Holland (2002) confirmed that activating values related to environmental protection will increase consumers' attention to the corresponding information, leading them to purchase environmentally friendly products [10].

In terms of external factors, the factors affecting consumer behavior mainly involve the government, enterprises and other departments. Wei et al. (2020) proved that rational information policies issued by the government can promote the improvement of residents' carbon capacity, while egoistic information policies can promote the improvement of residents' willingness to low-carbon consumption [11]. The production of low-carbon products or low-carbon production environment can effectively enhance the competitiveness of enterprises and effectively drive the low-carbon consumption behavior of consumers [12]. Other departments include environmental NGOs and the mass media, whose publicity and education can effectively increase citizens' awareness of green knowledge and environmental protection [4].

2.3 Research methods and theories

The methods used by scholars to study low-carbon consumption fall into two main categories. One is questionnaire survey, which measures low-carbon consumption intention or low-carbon consumption behavior. The other is the experimental research method,

mainly through the experimental design to directly study the individual low-carbon consumption behavior.

The research on influencing factors of low-carbon consumption is mainly based on several classical behavioral theories and models. The most commonly used model is the Theory of Planned Behavior (TPB), which is based on the Theory of Reasoned Action (TRA). It is proposed based on Perceived Behavioral Control (PBC) (Ajzen, 1991). According to this theory, behavior is mainly influenced by willingness. Willingness is influenced by attitude, subjective norm and perceived behavior control, emphasizing the degree of difficulty consumers perceive individual actions. The model

framework of planned behavior theory is shown in Fig.1.

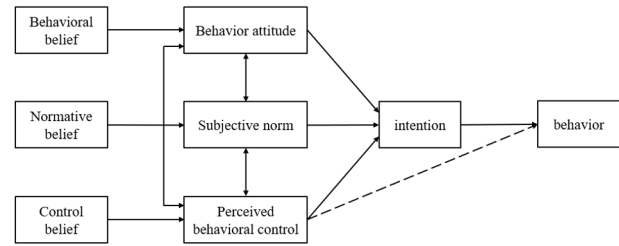


Fig. 1. the theory of planned behavior.

Common theoretical models of low-carbon consumption research and other recent findings are shown in Table 1.

Table 1. Common theoretical models of low-carbon consumption research and other recent findings.

Author	Object	Theory	Conclusion
Zhong and Chen (2019) [13]	Low-carbon rice	Game theory	The enhancement of consumers' environmental belief can increase consumers' willingness to pay a green premium.
Luo <i>et al.</i> (2020) [14]	Recycled products; Phosphate-free laundry	S-O-R model	Green advertising on social media is suspected to negatively influence green purchase intention through the intermediary of perceived information utility.
Halder <i>et al.</i> (2020) [15]	Low-carbon products	Green consumption values	1) Collectivism has a significant positive impact on green consumption values. 2) Long-term planning has a significant positive impact on green consumption values, while traditional values have a negative impact.
Valor and Martínez (2021) [16]	Sustainable products	Personality analytical constructs	1) The development of sustainable personal projects is related to the adoption of sustainable consumption. 2) Personal projects mediate between self-transcendence values and sustainable consumption.
Yan <i>et al.</i> (2021) [17]	Green battery; Hand wash; Backpack	Agentic-Communal model	1) Low power increases consumers' preference for green products. 2) The influence of power on green consumption is more significant in the group with high green consumption value;
Khan <i>et al.</i> (2021) [18]	Hospitality and tourism industry	Signaling theory	1) Green supply chain management and strategic green marketing orientation have positive and significant effects on green consumption intention. 2) Environmental concerns play a partial mediating role in the relationship between strategic green marketing orientation, green supply chain management and green consumption behavior.
Xie <i>et al.</i> (2022) [19]	Green products	Theory of planned behavior	Environmental cognition and regional economic development level positively affect green consumption attitudes, subjective norms and perceived behavior control.
Li <i>et al.</i> (2023) [20]	Energy efficient household appliances	Social cognitive theory	1) The target framework of climate change information affects household low-carbon behavior. 2) Environmental self-efficacy plays a mediating role between framing effect and household low-carbon behavior. 3) Residents' global-local identity moderates the impact of frame information on household low-carbon behavior.
Wei <i>et al.</i> (2023) [21]	Low-carbon behavior	Rational choice theory	1) Low-carbon consumption behavior is determined by purchasing behavior, daily use behavior, garbage disposal behavior and public participation behavior. 2) Information incentive and social influence are two important predictors of low carbon consumption behavior

3 Research on low-carbon customization

3.1 Connotation of low-carbon customization

Personalized customization refers to products or service projects developed by enterprises according to customers' unique needs, which makes customers' preferences highly

match product design. The mass customization model derived from it is widely used in today's society and has become the main object of scholars' research. In recent years, with the development of e-commerce technology, online personalized product customization enables consumers to do personalized customization more quickly and freely, and has become a new choice for consumers to shop online. Customization is one of the main drivers of the "new economy" because it effectively solves the

problem that consumer needs change faster than organizational innovation. Franke and Piller (2004) showed that users' willingness to pay for customized products may be much higher than standardized products in certain situations [22].

With the further innovation of customization in business model, enterprises gradually integrate the concepts of sustainability and environmental protection into the customization model, forming new customization systems such as sustainable mass customization. This makes the traditional low-carbon consumption model more based on customer demand. It also integrates low-carbon technology and green environmental protection into the traditional customization mode, forming a new consumption mode of low-carbon customization. Low-carbon customization has further upgraded consumption patterns in the new era. For example, the Explorer series products of tomtoc, a Chinese luggage brand, support personalized customization of multiple parts and introduce recycled materials into the customization of materials (see Fig.2). Meituan, Ele. me and other food delivery brands can select "no cutlery" or "degradable cutlery" options in the cutlery properties when ordering delivery packages.

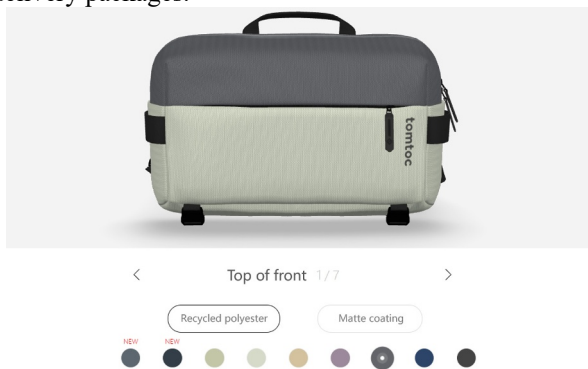


Fig. 2. low carbon customization of bags.

3.2 Effect of choice architecture in low-carbon customization

In addition to the influence of individual factors, consumers' decision in low-carbon customization is also influenced by government incentive measures, merchants' marketing methods and other factors. Therefore, researchers are increasingly focusing on the design of intervention measures for consumers. Among the various customization options, the choice architecture effect of product customization interface is one of the important contents. The choice architecture effect refers to changing consumer decisions by changing the way choices are presented to consumers, but not the category or price of goods. It was initially applied to the offline retail industry [23]. In recent years, with the popularity of online shopping, the role of choice architecture in online customization has gradually attracted the attention of scholars.

The choice architecture of the online customization interface involves the information presentation way of the product. It guides consumers' customization choices by influencing their psychological expectations. At present, scholars have used choice architecture effect to find ways to improve consumers' low-carbon customization

intention.

Panzone et al. (2021) adjusted the presentation of information and tried to classify products into low-carbon, medium carbon and high carbon categories [23]. This reduced search costs for consumers and effectively increased the carbon footprint of consumers' shopping carts in the experiment. Theotokis and Manganari (2015), by changing the default presentation of low-carbon options, verified that the default opt-out option would increase consumers' guilt, thus driving them to choose sustainable products [24].

4 Conclusions

This study mainly summarizes the research status of low-carbon customization, and expounds the background, connotation and influencing factors of low-carbon consumption, the connotation of low-carbon customization, and the important influence of the choice architecture. This study draws the following conclusions, hoping to be helpful for future research.

First of all, low-carbon consumption is the new consumption pattern. It has a different definition, rather than green consumption, it is more concerned with the reduction of carbon emissions in environmental protection. It is mainly influenced by demographic factors, psychological and external factors. Secondly, low-carbon customization mainly satisfies complex consumer needs by introducing personalized elements into low-carbon consumption. At the same time, the choice architecture is an important factor influencing customized consumption, which can effectively influence consumers' willingness to low-carbon customization.

There are still many shortcomings in the existing research. On the one hand, the research of low-carbon customization model is still in its infancy, and its definition is still very vague. More targeted research should be carried out on this new consumption model. On the other hand, science and technology have given birth to many new consumption patterns, and how to use new ways such as choice architecture to achieve low-carbon economic development needs to be further discussed.

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