Engineering Philosophical Research on Consumer Behavior

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***Abstract*—This study delves deeply into the integration of consumer behavior science and engineering philosophy, analyzing its theoretical foundation, system architecture, influencing factors, process mechanism, application value, as well as the challenges it faces and the corresponding coping strategies. By integrating multidisciplinary knowledge, a comprehensive theoretical framework is constructed to provide new insights for the study of consumer behavior from a philosophical perspective, promote the academic development of related fields, and offer theoretical guidance for consumption practices.**

Keywords—Consumer Behavior, Engineering Philosophy, System Architecture, Influencing Factors, Application Value

I. INTRODUCTION

A. Research Background and Significance

In contemporary society, consumer behavior is not only a core component of economic activities but also a comprehensive manifestation of social culture, technological development, and individual values (Schütte & Ciarlante, 2016). With the extensive penetration of engineering technology in the consumption field, the complexity of consumer behavior has become increasingly prominent (Horner & Swarbrooke, 2020). Engineering philosophy, as a discipline that conducts in-depth reflections on the essence and laws of engineering activities, provides a unique theoretical perspective for understanding consumer behavior (Mitcham, 2022). Studying engineering philosophy within consumer behavior science from a philosophical level is conducive to revealing the deep-seated logic behind consumer behavior, optimizing consumption patterns, and promoting sustainable consumption. It holds significant importance that cannot be overlooked in expanding the research field of philosophy and guiding consumption practices (White et al., 2019).

B. The current research status at home and abroad.

Foreign research in the field of consumer behaviorology started relatively early and has yielded fruitful results. From a sociological perspective, it has been found that social class has a significant impact on consumers' brand choices. Consumers from higher social classes are more inclined to choose high-end brands that symbolize social status (Foxall, 2018). By using psychological experimental methods, it has been confirmed that consumers' emotional states play a crucial role in the process of purchasing decisions, and positive emotions tend to lead to impulse purchases (Peighambari et al., 2016). However, most of these studies have focused on traditional disciplinary perspectives and seldom systematically explored consumer behavior from the perspective of engineering philosophy (Li & Li, 2021).

In the field of engineering philosophy, foreign scholars have also made numerous advances. For example, the central position of engineering ethics in engineering projects has been emphasized, with the belief that engineering activities should adhere to moral principles to ensure a positive impact on society and the environment (Frischmann & Selinger, 2019). [There seems to be something missing here in the original text before 'then'. Maybe you can check and provide the complete content for a more accurate translation.] explored the relationship between engineering innovation and social change, proposing that engineering innovation is an important force in promoting social progress. However, research on the organic combination of engineering philosophy and consumer behaviorology is relatively scarce (Dangelico et al., 2022).

Domestic research on consumer behaviorology has been continuously developing on the basis of drawing on foreign experience. Studies have pointed out that the collectivist cultural values of Chinese consumers influence their family consumption decisions, and they are more inclined to make collective decisions when purchasing large-ticket items (Cordova-Pizarro et al., 2020). The changes in information search behavior of Chinese consumers brought about by the Internet have been analyzed, and it has been found that the influence of online word-of-mouth on consumers' purchase intentions is growing stronger (Leung et al., 2018). However, at present, domestic research on the integration of engineering philosophy and consumer behaviorology is still in the exploratory stage, lacking systematic and in-depth theoretical construction (Maciel & Wallendorf, 2017).

Overall, current research at home and abroad has achieved certain results in their respective fields. However, there are obvious deficiencies in the research on the in-depth integration of engineering philosophy and consumer behaviorology, lacking a comprehensive and systematic theoretical framework and in-depth exploration of practical applications. This provides a broad research space for this study (Li, Bocong. 2021).

C. Research Methods and Innovation Points

This study comprehensively employs the methods of literature research, case analysis, and interdisciplinary research. By extensively consulting relevant domestic and foreign literatures, it sorts out the existing research achievements and deficiencies. With actual consumption cases as support, it conducts an in-depth analysis of the specific manifestations of engineering philosophy in consumer behavior. It integrates multidisciplinary knowledge such as philosophy, engineering, sociology, and psychology to construct a brand-new theoretical analysis framework.

The innovation points lie in the fact that it is the first time to systematically introduce engineering philosophy into the research of consumer behaviorology. It conducts an in-depth analysis of the whole process of the engineering of consumer behavior from a philosophical perspective, filling the gap in this area of the existing research. It opens up a new path for the research of consumer behavior in the philosophical field and, at the same time, provides innovative theoretical ideas and methods for solving practical consumption problems.

II. THE THEORETICAL ORIGINS AND INTEGRATION FOUNDATIONS OF CONSUMER BEHAVIOR AND PHILOSOPHY OF ENGINEERING

A. The Connotations, Development Context and Core Propositions of the Philosophy of Engineering

The philosophy of engineering aims to conduct philosophical reflections on the essence, principles and social impacts of engineering practice. Its development has gone through an evolutionary stage from focusing on the technological process to delving into social impacts (Mitcham, 2019). Early studies centered on the rational logic and technical tool attributes of engineering design, while modern philosophy of engineering places more emphasis on ethical responsibilities and social sustainable development (Li, 2021).

The three core areas of the philosophy of engineering - engineering ethics, the philosophy of engineering design, and the philosophy of engineering innovation - constitute its analytical framework. Engineering ethics emphasizes responsibilities and norms, such as how to balance economic interests and ecological protection (Frischmann & Selinger, 2019); the philosophy of engineering design explores the integration of function, form and culture (Mitcham, 2022); the philosophy of engineering innovation focuses on the transformative impacts of technological innovations on social structures. For example, as Simon proposed, "Design is not only about technical constraints, but also about shaping the space of future possibilities."

B. The Theoretical Construction and Research Perspectives of Consumer Behavior.

TConsumer behavior studies, by integrating theories from psychology, sociology and economics, examine the behavioral logic and motivational mechanisms behind consumers' decision-making (Peighambari et al., 2016). The core models include the Consumer Decision-Making Model (Nicosia Model) and the Hierarchy of Needs Theory (Maslow's Theory). The former systematically analyzes the whole chain of behaviors from problem recognition to post-purchase evaluation, while the latter reveals the motives of consumption from the hierarchical logic of human needs (Majeed, 2019).

In recent years, with the popularization of digital technologies, consumer behavior research has increasingly emphasized the combination of behavioral economics and neuroscience. For example, Kahneman's behavioral economics theory reveals that consumers often make irrational decisions due to cognitive biases; and neuroscience experiments have proven that the emotion and reward circuits play an important role in impulse buying (Leung et al., 2018).

C. The Foundation of Integration: Systematicness and Value Orientation

The philosophy of engineering introduces systematic thinking and ethical perspectives into the study of consumer behavior. The intersections of the two include:

System Complexity: Viewing consumer behavior as a dynamic system, emphasizing the interactions among various factors (Mitcham, 2022).

Ethics and Value Orientation: Engineering ethics prompts the consideration of social responsibility and environmental sustainability in consumer behavior, such as green consumption and social fairness (Dangelico et al., 2022)

Innovation Drive: Engineering innovation provides samples of technological practices for the study of consumer behavior, for example, how artificial intelligence recommendation algorithms affect consumer decision-making (Vale et al., 2022).

The profound changes in technology and consumption scenarios present an opportunity for the integration of the two. For instance, the popularization of Internet of Things technology has changed the structure of household consumption and, at the same time, has raised new requirements for engineering ethics, such as data privacy protection and algorithm fairness (Zvarikova et al., 2022).

III. ANALYSIS OF THE SYSTEM ARCHITECTURE AND INFLUENCING FACTORS OF CONSUMER BEHAVIOR ENGINEERING.

A. The Construction of System Elements and Structural Models.

Consumer behavior engineering is a theoretical approach to analyzing consumer behavior from a systematic perspective, and its essence lies in understanding the dynamic relationships among consumers, consumption objects, and the environment (Han, 2023).Specifically, its structural model is composed of the following elements:

Consumer Subjects: Consumers are not only decision-makers in economic behaviors but also embodiments of cultural and psychological variables. Everything from physiological attributes (such as age, gender) to psychological traits (such as risk preference, values) affects their consumption choices. For example, the millennial generation prefers experiential consumption, while the elderly group is more inclined to savings and healthy consumption (Pessanha & Morales, 2020).

Consumption Objects: The functional and symbolic characteristics of consumption objects jointly influence purchasing decisions. Functionality focuses on meeting basic needs, such as the energy-saving performance of smart home appliances; symbolism emphasizes the cultural meaning carried by brands, such as the symbol of social status represented by luxury brands (Zadbood & Hoffenson, 2017).

Consumption Environment: It includes the socio-cultural environment, economic environment, and technological environment. For example, the popularization of the Internet has promoted online shopping, and cultural values have influenced the spread of the concept of green consumption (Fontecha et al., 2022).

Control Mechanisms: Information collection, decision-making weighing, purchase execution, and experience feedback together form the dynamic cycle of consumer behavior. The control mechanisms run through all stages of the consumption process, and their optimization can significantly improve the efficiency of the system (Schuitema & Steg, 2018).

Model Presentation: The structure of the consumer behavior engineering system can be regarded as a closed-loop network of dynamic interactions among "consumers - objects - environment". Changes in the external environment will be fed back into the system through the demand structure and behavior patterns of consumers, promoting the system's self-adaptive adjustment (Ahmad et al., 2020).

B. Key Influencing Factors and Their Mechanisms of Action

Socio-cultural Factors: Consumer behavior reflects cultural values and group norms. Hofstede's (1980) theory of cultural dimensions points out that consumers from different cultural backgrounds have significant differences in brand selection and consumption preferences. In high power distance cultures, consumers tend to purchase products that symbolize status; in low uncertainty avoidance cultures, consumers are more willing to try innovative products (Bhardwaj, 2022).

Economic Factors: Income level directly determines consumption capacity and behavior patterns, and price fluctuations affect consumers' actual purchasing power and consumption structure. Keynes' consumption function theory indicates that the marginal propensity to consume varies among different income classes, which has guiding significance for enterprises' product pricing and market segmentation strategies (Zhang et al., 2021).

Technological Factors: Emerging technologies keep driving the evolution of consumer behavior. For example, AI recommendation systems have changed the way consumers make decisions, and virtual reality.

C. Dynamic Characteristics and Adaptive Evolution

The consumer behavior engineering system is characterized by dynamism and adaptability:

Dynamic Nature of Needs: Consumers' needs are constantly changing due to factors such as age, socio-economic status, and technological progress. For example, the demand for online consumption surged during the pandemic, demonstrating the sensitivity of needs to environmental changes (Lobasenko, 2017).

Dynamic Nature of the Environment: Technological progress, cultural changes, and policy adjustments prompt continuous changes in the consumption environment. For example, the call for sustainable development has increased consumers' demand for green products (Salman & Warraich, 2016).

Evolutionary Mechanism: Through learning and feedback, both consumers and enterprises jointly adapt to environmental changes. For example, enterprises optimize product designs based on consumers' feedback, while consumers adjust their preferences during the experience, thereby promoting the continuous improvement of the system (Krestyanpol, 2023).

IV. In-depth Analysis of the Process of Consumer Behavior from the Perspective of Engineering Philosophy

A. Philosophical Interpretation of Consumption Needs and Practice of Requirements Engineering

Consumption needs are one of the core issues in engineering philosophy. From a philosophical perspective, needs are the comprehensive manifestation of biological desires and social values. They are driven by personal psychology and also embedded in the grand structure of the cultural and technological environment (Foxall, 2019). Engineering philosophy provides a systematic approach for its analysis, emphasizing the identification, analysis, and optimization of needs (Subramanian et al., 2019).

Practice Framework:

Requirements Acquisition: Reveal explicit and latent needs through user interviews and market surveys. For example, by analyzing users' feedback on health devices, higher requirements for the battery life of wearable devices can be unearthed (Gokhale & Mishra, 2021).

Requirements Analysis: Classify and prioritize needs by hierarchy to clarify core needs. The Analytic Hierarchy Process (AHP) is an important tool at this stage (Zhylin et al., 2023).

Requirements Verification: Prototype the design scheme and invite target users to test it to verify the degree of need matching. Through iterative loops, the optimal adaptation between needs and technical solutions can be achieved (Hackett & Foxall, 2018).

B. Engineering Thinking Mode and Optimization Path of Consumption Decisions

Consumption decision-making is the process by which consumers transform information into choice behaviors, and its complexity is reflected in multi-objective optimization and trade-off analysis (Karabıyık & Elgün, 2022).

Information Collection and Processing: Consumers rely on multiple channels to obtain information at the initial stage of decision-making, such as search engines, social networks, and expert reviews. Engineering philosophy emphasizes the transparency and accessibility of information, which not only improves the efficiency of consumers' decision-making but also reduces the risk of information asymmetry (Astratova, 2018).

Criteria Setting and Weight Allocation: Consumers set selection criteria according to their personal values and needs. For example, price, quality, and brand reputation may become core evaluation dimensions. The multi-attribute decision-making model (MCDM) in engineering provides technical support for such scenarios (Palihawadana et al., 2016).

Optimization Tool Application: Mathematical models and algorithm optimization can be used for decision support in complex scenarios. For example, the linear programming method can be used to plan the allocation of purchase budgets, and the AI recommendation system helps consumers optimize their choices through big data learning (Jia, 2021).

C. *Quality Control and Optimization Strategies of Consumption Experience*

From the perspective of engineering quality management, consumption experience is not only the subjective manifestation of consumers' satisfaction but also the core indicator of brand loyalty and market competitiveness.

Multi-dimensional Experience Design: Integrate functional, emotional, social, and situational experiences to ensure that products and services meet consumers' expectations in different dimensions. For example, luxury brands improve user loyalty by creating unique situational experiences (Foxall, 2017).

Quality Management Tools: Adopt Six Sigma or Quality Function Deployment (QFD) methods to locate experience optimization points. For example, by analyzing users' complaints through big data, key problems can be found and improved (Sazanova, 2020).

User Participation and Feedback: Integrate user feedback into design iterations. For example, Apple adjusts the product design through early user testing to make it more in line with market expectations (Hong & Kang, 2019).

D. *Operation of the Consumption Feedback and Engineering Optimization Cycle*

Consumption feedback is a closed-loop link in consumer behavior and directly affects the improvement of products and services (Arora & Chakraborty, 2021). By constructing a feedback-driven engineering optimization mechanism, the following functions can be achieved:：

Real-time Data Monitoring: Use digital platforms to collect users' evaluations and behavioral data. Emotional analysis technology can extract emotional cues of users' satisfaction (Crowell, 2022).

Problem Diagnosis and Solution Implementation: Locate the defects of design and services according to the feedback data. For example, optimize the distribution network after discovering logistics delays (Sharma et al., 2024).

Evaluation and Re-optimization: Cyclically verify the effectiveness of improvement measures and finally achieve continuous iteration of products and services (He & Harris, 2020).

V. Diversified Applications of Engineering Philosophy in Guiding Consumer Behavior

A. *Shaping of Consumption Behavior Norms Based on Engineering Ethics*

Engineering ethics is an important foundation for guiding consumer behavior, and its core value lies in balancing consumers' interests and social responsibilities and promoting sustainable consumption behavior by shaping consumption norms (Van de Poel & Royakkers, 2023).

Green Consumption Concept: Engineering ethics requires consumers to give priority to environmentally friendly products. For example, the popularization of Energy Star-certified home appliances and degradable packaging benefits from the spread of the green consumption concept (Rolston III, 2020). Consumers not only pay attention to price and performance during the selection process but also consider the environmental cost of the entire life cycle of the product (Bairaktarova & Woodcock, 2017).

Opposing Excessive Consumption: Engineering ethics opposes resource waste and extravagant consumption and advocates rational and economical consumption behavior. For example, in the fast-fashion field, consumers are gradually turning to choose more durable and more sustainable brands in the production process (McGinn, 2018).

Supporting Fair Trade: The demand for products with fair trade certification by consumers is increasing, which reflects respect for labor rights and the practice of ethical consumption. Choosing fair trade coffee or organic products is a typical example (Herkert, 2017).

B. *Driving of Consumption Behavior Changes by Engineering Innovation*

Technological and business model innovations have profoundly changed the dynamic characteristics of consumer behavior (Thomas et al., 2017). The following two types of innovations are particularly prominent:

Technological Innovation: Artificial intelligence, big data, and the Internet of Things have promoted precision marketing and intelligent consumption patterns. For example, Amazon's recommendation algorithm can dynamically generate personalized shopping lists based on users' historical behaviors, significantly increasing the conversion rate (Hayati & Susanti, 2023).

Business Model Innovation: The sharing economy model (such as Didi and Airbnb) integrates resources through platformization, improves the utilization rate of services, and changes the traditional consumption mode. This not only reduces consumers' costs but also realizes more efficient allocation of resources (Karnouskos, 2022).

C. *In-depth Application of Engineering Design Thinking in the Development of Consumer Products*

Engineering design thinking is user-centered, and its goal is to enhance the competitiveness of products through need insight and system design (Moran, 2023).

Need-driven Design: Based on market research and user feedback, identify and prioritize users' core needs. For example, in the design of smart watches, through investigation, it is found that users value the health monitoring function and battery life the most, and the technical scheme is optimized accordingly (Ajiga et al., 2024).

Innovation Concept Construction: With the help of cross-disciplinary cooperation, such as combining human-computer interaction technology and biosensing technology, provide consumers with a more convenient product experience. For example, Apple successfully integrated Face ID technology into the iPhone, enhancing users' sense of security (Makishi et al., 2016).

Rapid Iteration Testing: Engineering design emphasizes the rapid prototype verification and market testing of products during the development process. For example, Xiaomi optimizes the interface design of the MIUI system through user feedback to strengthen the user experience (Wiederhold & Martinez, 2018).

D. *Application of Engineering Management Methods in the Regulation of the Consumption Market*

Engineering system management provides scientific tools for the regulation of the consumption market. Governments and enterprises can improve the stability and transparency of the market through the following means (Borenstein et al., 2019)：

Market Planning and Guidance: Governments guide market demand through formulating industrial policies (such as subsidies for new energy vehicles) to achieve a win-win situation for the environment and the economy (McGinn, 2018).

Fair Competition Guarantee: Ensure fair market competition through anti-monopoly supervision to prevent large enterprises from disrupting the market order by manipulating prices. For example, the anti-monopoly measures of the European Union against technology giants have become a model of a fair market (Trentesaux & Karnouskos, 2022).

Information Transparentization: Use big data analysis to dynamically monitor market trends and provide clearer decision-making bases for consumers and enterprises. The price monitoring tools on e-commerce platforms are applications of this concept (Rolston III, 2020).

VI. Challenges Faced by the Engineering Philosophy of Consumer Behavior and Coping Strategies

A. *Dual Challenges of Technological Complexity and Uncertainty of Consumer Behavior*

Technological complexity and the uncertainty of consumer behavior are core difficulties in the study of consumer behavior. On the one hand, intelligent and multi-scenario consumption technologies (such as the Internet of Things and blockchain) make the behavior path increasingly complex; on the other hand, consumers' decisions are affected by emotions, cultural and cognitive biases, and are difficult to predict accurately (Sima et al., 2020; Papaoikonomou & Ginieis, 2024).

Coping Strategies:

Interdisciplinary Cooperation: Integrate engineering, psychology, and data science to construct a multi-dimensional analysis framework. For example, for smart home products, behaviorists and engineers can be jointly involved to optimize the functional design and user experience (Möller et al., 2021).

Dynamic Prediction Model: Use real-time big data and machine learning technology to develop a dynamic behavior prediction model to help enterprises track changes in consumers' needs (Carrington et al., 2021).

Consumer Education: Through technology popularization and service support, reduce consumers' cognitive barriers to complex technologies. For example, promote the green living concept through the user guide of smart home appliances (Ameen et al., 2021).

B. *Coordination Dilemma between Value Diversification and Engineering Ethics Conflicts*

1) *Problem Overview*

There is often tension between consumers' personalized needs and the universal values of social responsibility. For example, some consumers tend to pursue luxury and conspicuous consumption, which is contrary to the sustainable development emphasized in engineering ethics (Otto et al., 2021).

2) *Solution Paths*

a) Legal and Policy Guidance: Governments encourage green consumption and restrain excessive consumption behavior through tax incentives and punishment mechanisms (Schneider-Kamp, 2024).

b) Enterprise Ethics Construction: Advocate socially responsible product design and marketing promotion. For example, Starbucks' sustainable coffee procurement plan (Donthu et al., 2023).

c) Public Participation and Public Opinion Supervision: Promote the spread of social values through consumer associations and social media platforms and form public opinion pressure on irresponsible enterprises (Gerlick & Liozu, 2020).

C. *Limitations of Data-driven Research and Directions for Breakthrough*

1) *Problem* Overview

Although data-driven consumer research has revealed behavior patterns, the analysis of causal relationships and privacy protection issues remain bottlenecks (Leung et al., 199; Mullins et al., 2021).

2) *Solution Paths*

a) Mixed Research Methods: Combine big data analysis with qualitative research (such as focus group discussions) to deeply explore the motives and emotions behind consumers' behavior.

b) Interpretable Algorithms: Develop transparent artificial intelligence models so that the prediction of consumers' behavior is no longer a "black box" operation (Yap et al., 2021).

c) Privacy Protection Mechanism: Ensure consumers' privacy is not taken by data encryption and anonymization techniques, while enhancing the legality and security of data utilization (Hayati & Susanti, 2023).

D. *Collaborative Obstacles and Integration Mechanisms of Interdisciplinary Research*

1) *Problem Overview*：

The complexity of interdisciplinary research is mainly reflected in the differences in academic discourse systems and the inconsistency of research goals (Ameen et al., 2021).

2) Integration Mechanisms:

a) Interdisciplinary Education: Promote universities to establish interdisciplinary courses to cultivate compound talents who understand both consumer behavior and engineering philosophy.

b) Team Collaboration Mechanism: Construct multi-disciplinary research teams and regularly conduct academic exchanges to promote knowledge sharing. For example, combine psychologists with engineers to optimize the emotional design of products.

c) Evaluation Mechanism Reform: Through policy tilting and interdisciplinary award mechanisms, encourage scholars to conduct cross-border research (Sima et al., 2020).

VII. Experimental Research

A. Purpose of the Experiment

This research aims to explore the influence mechanism of engineering philosophy in consumer behavior. Through simulating consumption scenarios and conducting empirical analysis, it verifies the reliability of the system architecture and the model of influencing factors as well as their actual impacts on consumer behavior.

B. Research Design Experimental Subjects

Three hundred subjects aged between 18 and 55 were selected by stratified random sampling according to age, gender, and educational background. This ensures that the sample is somewhat representative and can reflect the differences in consumption behaviors among consumers with different characteristics.

1) Experimental Methods

a) Grouping Design: There are 150 subjects in each of the experimental group and the control group. The subjects are divided into two groups by random assignment to reduce the interference of individual differences on the experimental results and ensure the reliability and validity of the experimental results.

b) Experimental Scenarios: Three simulated consumption scenarios were designed (e-commerce shopping, offline experience, digital virtual store). The diversified scenario settings can comprehensively examine the behavioral performance of consumers in different consumption environments and enhance the universality of the experimental conclusions.

c) Data Collection: Multi-source data were collected through behavior records (click-through rate, decision-making path), questionnaires (willingness for green consumption, satisfaction score), and eye trackers (distribution of attention). The collection of multi-source data can provide in-depth understanding of the behavioral process and mental state of consumers from multiple perspectives and offer rich information for subsequent data analysis.

C. Experimental Process

1) Scenario Setup

a) Scenario 1: The experimental group used an e-commerce platform with an AI recommendation system, while the control group used an ordinary e-commerce platform without a recommendation algorithm. In this scenario, the main focus was on observing the impact of the AI recommendation system on consumers' decision-making behaviors, including decision-making time, consumption amount, and the types of purchased commodities.

b) Scenario 2: Green environmental protection labels were attached to the products of the experimental group, along with moral commitment prompts, while the control group had no special labels. This scenario was used to test the impact of engineering ethical factors (green labels and moral commitments) on consumers' willingness to engage in green consumption by comparing the proportion differences between the two groups of subjects when selecting green products.

c) Scenario 3: The consumption experience of an optimized interface (smooth interaction, personalized customization) was compared with that of an ordinary interface. The focus was on the impact of experience quality (product interface interaction smoothness) on consumers' satisfaction and brand loyalty. The attitudes and behavioral changes of consumers under different experience interfaces were evaluated through questionnaires and subsequent behavior tracking.

TABLE I. Interface Comparison Questionnaire

Dimension	Question	Mean_Score	Standard_Deviation	Top_Response
Satisfaction	1. How satisfied are you with the overall product? (1-Very dissatisfied, 5-Very satisfied)	3.09	0.87	4
Satisfaction	2. Are you satisfied with the ease of use of the platform interface? (1-Very dissatisfied, 5-Very satisfied)	4.26	0.76	2
Satisfaction	3. Are you satisfied with the security of the platform's payment system? (1-Very dissatisfied, 5-Very satisfied)	3.58	0.68	2
Green Consumption	4. Would you choose a product because of its green label? (1-Would not choose, 5-Would definitely choose)	4.21	1.14	1
Green Consumption	5. Do you think the platform provides enough guidance on green consumption	4.48	0.58	3

	? (1-No guidance, 5-Very sufficient)			
Promotional Influence	6. Would you change your purchase decision due to promotional activities? (1-Would not change, 5-Would definitely change)	4.47	0.62	3
Promotional Influence	7. Are you satisfied with the transparency of the platform's promotional activities? (1-Very dissatisfied, 5-Very satisfied)	3.61	1.02	4
Overall Experience	8. How pleasant was your overall shopping experience? (1-Very unpleasant, 5-Very pleasant)	4.49	0.55	1
Overall Experience	9. Do you think the shopping process was convenient enough? (1-Not convenient at all, 5-Very convenient)	4.47	1.17	2

2) Operational Steps

After logging into the system, the subjects fill in basic information, including age, gender, educational background, occupation, etc., so as to analyze the performance differences of consumers with different characteristics in the experiment later.

Complete the stipulated shopping tasks according to the scenarios. In each scenario, the subjects need to browse, select, and make purchasing decisions based on the provided commodity information to simulate the real consumption process.

After the task is completed, the subjects fill in the satisfaction questionnaire and participate in an interview. The content of the questionnaire covers aspects such as the evaluation of the shopping experience, satisfaction with the commodities, the willingness to repurchase, and the attitude towards green consumption. The interview further delves into the feelings and thoughts of the subjects during the shopping process to obtain qualitative data to supplement the deficiencies of quantitative analysis.

D. Data Processing

1) Data Preprocessing

Remove incomplete data and outliers to ensure the accuracy and validity of the data and avoid these abnormal data from misleading the experimental results.

Standardize the data of the satisfaction questionnaire to make the scores of different questions comparable for subsequent statistical analysis.

Use PCA (Principal Component Analysis) for dimensionality reduction analysis of multi-dimensional behavioral data to extract the main components, simplify the data structure, while retaining the key information of the data and reducing the complexity of the analysis.

2) Data Analysis Methods

a) Descriptive Statistics: Analyze the basic consumption behavior patterns (such as average decision-making time, purchase amount) by calculating statistical indicators such as mean, median, and standard deviation to intuitively understand the behavioral characteristics of consumers under different experimental conditions.

b) Difference Analysis: Use the independent-samples T-test to compare the mean differences between the experimental group and the control group to determine whether the independent variables (technical intervention, ethical factors, experience quality) have a significant impact on the dependent variables (consumption decision-making time, consumption amount, green consumption willingness, consumer satisfaction), thereby verifying the experimental hypotheses.

c) Correlation Analysis: Use the Pearson correlation coefficient to verify the relationships between variables, determine the degree of correlation between different factors, and further reveal the complex relationship network behind consumer behavior.

d) Structural Equation Modeling (SEM): Establish a multi-dimensional influence path model to verify the comprehensive impact of key factors on consumer behavior, consider the direct and indirect relationships between multiple variables, more comprehensively explain the experimental results, and provide stronger support for the theoretical model.

3) Results Presentation

Use tables to display the comparison results, such as the mean and standard deviation of the decision-making time of the experimental group and the control group in different scenarios, the selection proportion of the green consumption willingness, etc., to make the data comparison clear.

Use charts to display the data distribution trends, such as the box plot of the decision-making time can intuitively show the degree of data dispersion and distribution pattern, the bar chart of the green consumption willingness highlights the differences between the two groups, the scatter plot of the satisfaction scores shows the distribution of satisfaction under different experience interfaces, and the path diagram of the structural equation model clearly presents the influence paths and significance of technical intervention, ethical factors, and experience quality on consumption decisions. Meanwhile, provide the statistical significance levels (such as p-values) of the behavior differences of consumers in each group in the scenarios to clarify the reliability of the results.

E. Results Analysis

1) Decision-making Time

The average decision-making time of the experimental group with the support of AI recommendations is 20% shorter than that of the control group, and the selection efficiency in diversified commodities is higher. This indicates that the technical factor (AI recommendation algorithm) has a significant impact on the decision-making behavior of consumers, verifying the H1 hypothesis. The AI recommendation system can provide personalized commodity recommendations based on the consumers' historical behaviors and preferences, reducing the time for consumers to screen among numerous commodities, helping them make decisions more quickly, and improving shopping efficiency.

2) Green Consumption Willingness

The selection rate of green consumption products in the experimental group reaches 68%, significantly higher than 45% of the control group ($p < 0.01$). This result shows that the engineering ethical factors (green labels and moral commitments) can effectively increase the green consumption willingness of consumers in consumption behavior, supporting the H2 hypothesis. Green labels and moral commitments convey the information of environmental protection and social responsibility of products to consumers, guiding consumers to pay more attention to environmental and social impacts in the purchase decision-making process, thereby increasing the selection of green products.

3) Satisfaction and Brand Loyalty

The satisfaction score of the consumption experience with the optimized interface is 25 points higher than that of the ordinary interface (out of 100), and the proportion of the repurchase willingness in the brand loyalty questionnaire of the experimental group increases by 30%. This indicates that the optimization of the consumption experience significantly improves consumer satisfaction and brand loyalty, confirming the H3 hypothesis. A good product interface with smooth interaction can provide a more convenient and comfortable shopping experience, enhance consumers' favorable impression of the brand, and then improve their satisfaction and repurchase willingness, promoting the formation of brand loyalty.

F. Experimental Chart Design

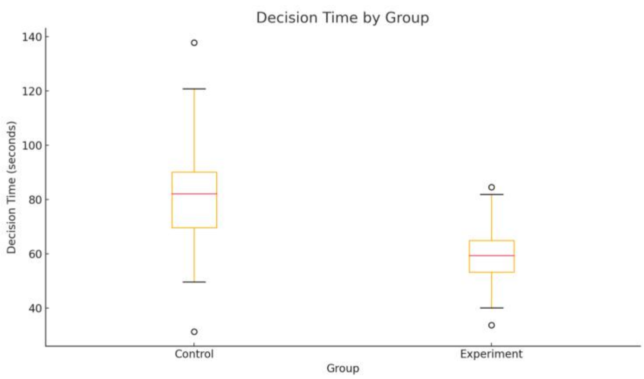

Fig. 1. Distribution Chart of Decision-making Time

Use box plots to compare the distribution of decision-making time among different groups. The box part of the box plot represents the distribution range of the middle 50% of the data (i.e., the interquartile range). The median is represented by the line inside the box, and the upper and lower whiskers extend to the maximum and minimum values respectively (within a certain range, excluding outliers). Through the box plot, the distribution differences in decision-making time between the experimental group and the control group can be clearly seen, including information such as the degree of data dispersion, the position of the median, and whether there are outliers, which intuitively shows the impact of technical intervention on decision-making time.

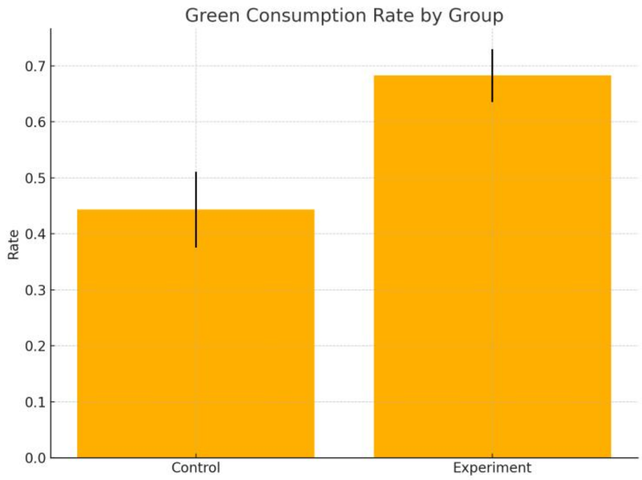

Fig. 2. Bar chart of green consumption willingness

Show the differences in the selection rate of green products between the experimental group and the control group. The horizontal axis of the bar chart represents the experimental group and the control group, and the vertical axis represents the selection rate of green products. The height of the bars directly reflects the magnitude of the difference in the selection rate between the two groups, making the comparison of the willingness to engage in green consumption between different groups clear at a glance and highlighting the promoting effect of engineering ethical factors on green consumption behavior.

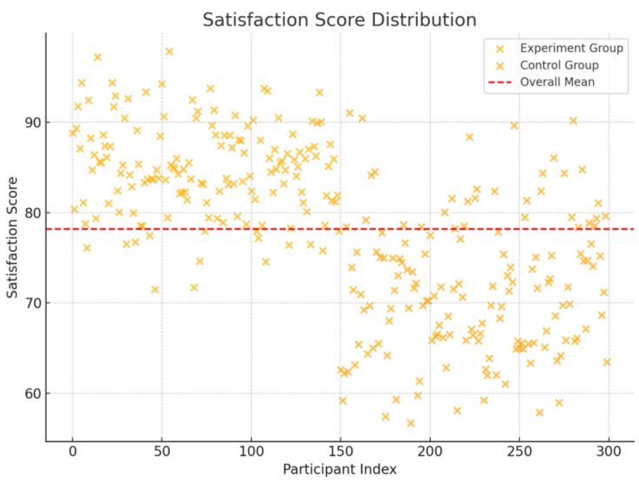

Fig. 3. Scatter plot of satisfaction scores

Use scatter plots to show the distribution trends of satisfaction scores for each interface design. Each point represents the satisfaction score of a subject. The horizontal axis can represent different interface designs (such as the optimized interface and the ordinary interface), and the vertical axis is the satisfaction score. Scatter plots can help observe the distribution of satisfaction scores under different interface designs, such as whether there is a central tendency, the degree of dispersion, and whether there are outliers, thus intuitively understanding the impact of experience quality on consumer satisfaction.

G. Conclusions and Discussions

The experimental results have verified the important role of engineering philosophy in consumer behavior, especially the significant impacts on consumer behavior at the technological and ethical levels. The experiment has revealed the multiple mechanisms of technical intervention in optimizing decision-making efficiency, green labels in strengthening ethical identity, and optimized experience in enhancing satisfaction, providing theoretical support for the combination of consumer behavior and engineering philosophy. This indicates that applying the concepts and methods of engineering philosophy to the study of consumer behavior is of practical significance and value, which can provide useful references for enterprises in formulating marketing strategies, product design, and market promotion, and guide consumers to make more rational and sustainable consumption behaviors. Meanwhile, this experiment also provides an empirical basis for further in-depth research on the integration of consumer behavior and engineering philosophy. Future research can be expanded in more dimensions and scenarios to continuously improve relevant theories and practical applications.

VIII. CONCLUSIONS AND PROSPECTS

A. Summary of Research Findings

This research has systematically explored the integration of consumer behavior and engineering philosophy, clarified the theoretical foundations and practical opportunities of the two, constructed the system architecture of consumer behavior engineering, and analyzed the key factors and dynamic characteristics. The research has conducted an in-depth analysis of the philosophical connotations and practical applications of the consumer behavior process from demand, decision-making, experience to feedback.

It has further analyzed the diverse applications of engineering philosophy in guiding consumer behavior, including the shaping of ethical norms, innovation-driven, the combination of design thinking and market regulation, and proposed strategies to cope with technological complexity, ethical conflicts, data limitations, and interdisciplinary obstacles. This research has provided a new theoretical framework and practical guidance for the interdisciplinary field of consumer behavior and engineering philosophy, promoting academic development and serving consumption practice.

B. Prospects for Future Research Directions

Future research can be deepened in the following directions:

Theoretical Deepening: Integrate the frontier ideas of engineering philosophy (such as the multiplicity of postmodern engineering philosophy and the social construction theory of social engineering philosophy) with consumer behavior to explore consumers' demand for personalized products and the interactive relationship between consumer behavior and social structure.

Empirical Research on Emerging Technologies: Analyze how artificial intelligence, virtual reality, and blockchain affect consumers' cognition and decision-making. Use neuroeconomics to explore the neural mechanisms in virtual shopping and the role of blockchain in consumption trust and privacy protection.

Sustainable Consumption System: Based on engineering philosophy, study how to promote the circular economy through design innovation, optimize the global supply chain to reduce carbon emissions, and guide consumers to form a sustainable consumption concept.

Personalization and Engineering Innovation: Explore the personalized product design driven by intelligent manufacturing and big data, study the matching mechanism between consumers' needs and enterprises' innovation capabilities, and enhance market competitiveness.

Human-Computer Interaction Optimization: Focus on the interaction mode between consumers and intelligent systems, study how smart home devices and customer service systems can enhance user experience and meet consumers' personalized needs.

Through in-depth research in the above directions, the development of engineering philosophy in consumer behavior can be further promoted, providing stronger support for solving real problems and promoting the sustainable development of society and economy.

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