sustainability

MDPI

Article

Utilizing a Hybrid Approach to Identify the Importance of Factors That Influence Consumer Decision-Making Behavior in Purchasing Sustainable Products

Chun-Wei Chen

Department of Mechanical Engineering, National Chin-Yi University of Technology, Taichung 411030, Taiwan; chenschool@yahoo.com.tw; Tel.: +886-4-23924505 (ext. 7175)

Abstract: Consumer decision-making behaviors play a pivotal role in the realm of purchasing sustainable products. It is crucial for businesses to understand the key factors that influence consumers' choices in this context, especially if they aim to align with eco-friendly trends. Conventional methods are inadequate for accurately and successfully identifying the importance of factors that influence consumers' decision-making behaviors in purchasing sustainable products and stem from a lack of holistic consideration. Conventional methods, like AHP, surveys, questionnaires, interviews, and focus groups, often do not fully consider the many aspects of consumer behavior related to sustainability. To address this gap, our study aims to (1) employ a hybrid approach, integrating conventional methods with cutting-edge machine-learning technology for predicting consumer's decision-making behaviors in purchasing sustainable products; (2) demonstrate the practical application of this hybrid approach through the example of green furniture; and (3) provide a practical guide for identifying the importance of factors influencing consumers' decision-making behaviors in purchasing sustainable products. This study will map out implications for the future of consumer decision-making behaviors in purchasing sustainable products. The hybrid approach to studying consumer decision making in sustainable product purchases, combining quantitative and AI methods. This methodology provides a comprehensive analysis of factors influencing environmentally friendly choices, fostering awareness and informed decision making. Businesses can use these insights to tailor strategies, enhance offerings, and meet the rising demand for sustainable products, contributing to environmentally responsible consumer behaviors and promoting economies of scale for sustainable products and innovation. This holistic understanding is crucial for creating a sustainable and socially responsible marketplace.

Keywords: decision-making behaviors; purchasing; sustainable products; AHP; DNNs; optimization algorithm

check for updates

Citation: Chen, C.-W. Utilizing a Hybrid Approach to Identify the Importance of Factors That Influence Consumer Decision-Making Behavior in Purchasing Sustainable Products. *Sustainability* **2024**, *16*, 4432. https://doi.org/10.3390/su16114432

Academic Editor: Riccardo Testa

Received: 29 March 2024
Revised: 18 May 2024
Accepted: 19 May 2024
Published: 23 May 2024

Copyright: © 2024 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

1.1. The Significance of Identifying the Importance of Factors Influencing Consumers' Decision-Making Behaviors in Purchasing Sustainable Products

Consumer decision-making behaviors play a pivotal role in the realm of purchasing sustainable products [1]. For example, statistics from reputable sources, such as the United Nations or environmental organizations, can highlight the increasing adoption of sustainable practices among consumers [2]. In the food industry, there has been a notable surge in the demand for organic products, with sales of organic food and beverages in the United States alone reaching USD 56.4 billion in 2020, according to the Organic Trade Association [3]. Furthermore, consumers are showing a preference for companies with transparent and environmentally friendly practices [4]. A Nielsen survey found that 73% of consumers globally are willing to pay more for sustainable products. This trend underscores the importance for businesses to align with sustainable practices to meet consumer expectations [5]. These statistics reveal trends like the rising sales of eco-friendly products, the growing

number of companies implementing sustainability initiatives, and the increasing awareness of environmental issues among the general population. Overall, while the trend toward sustainable consumption presents opportunities for businesses, it also requires them to adapt and innovate to meet the evolving demands of eco-conscious consumers.

Understanding how consumers navigate choices in this context is crucial for businesses aiming to align with eco-friendly trends [6]. Sustainable products, characterized by their reduced environmental impact and ethical sourcing, have gained traction in recent years [7]. The decision-making process involves a complex interplay of factors, such as environmental awareness, personal values, product information, and perceived benefits [8]. Consumers who prefer sustainable products make informed choices by considering the ecological impact of their options compared to conventional ones, demonstrating their dedication to sustainability [9]. Consequently, businesses need to grasp these intricate behaviors to tailor marketing strategies and product offerings that resonate with consumers seeking eco-conscious solutions [10]. This exploration into consumer decision making sheds light on the evolving landscape of sustainable consumption, guiding businesses toward more environmentally responsible practices [11].

Identifying the importance of factors influencing consumers' decision-making behaviors in purchasing sustainable products is crucial for several reasons [12]. First, understanding these key factors allows businesses to tailor their marketing strategies to align with consumers' values and preferences, increasing the likelihood of successful product adoption [13]. Second, as sustainability becomes an increasingly important factor in purchasing decisions, businesses need to anticipate and respond to shifts in consumer behavior to stay competitive in the market [14]. Additionally, identifying the importance of factors influencing decision-making behaviors enables companies to develop and promote sustainable products that not only meet consumer demands but also contribute positively to environmental and social concerns [15]. This foresight aids in resource allocation and investment planning, ensuring that businesses are well-positioned to meet the growing demand for sustainable products [16]. In essence, the ability to identify the importance of factors influencing consumers' decision-making behaviors in purchasing sustainable products is integral to fostering long-term business success, fostering positive societal impact, and addressing environmental challenges.

1.2. Limitations and Deficiencies in Current Research Methods

Five cognitive aspects, namely awareness, knowledge, perceived value, personal values, and emotional connection, contribute to successfully influencing consumers' decision-making behaviors when purchasing sustainable products [17]. Understanding the factors of these cognitive aspects is crucial for businesses aiming to align their products with the preferences and values of environmentally conscious consumers [1]. These factors encompass various aspects, such as product transparency, brand reputation, pricing strategies, accessibility, consumer education, and the influence of social networks [18]. By comprehensively analyzing and incorporating these factors into predictive models, businesses can enhance their ability to anticipate and cater to consumers' sustainable purchasing behaviors' comprehensiveness.

To identify the factors that influence consumer decision-making behavior, several methods can be employed. One approach is through surveys and questionnaires, where consumers are asked to rank or rate various factors based on their influence on their purchasing decisions. This method allows for the collection of quantitative data that can be analyzed to determine the relative importance of each factor [19]. Another method is through interviews and focus groups, where consumers are asked open-ended questions about the factors that influence their decision-making process. This approach provides qualitative insights into the reasons behind consumer choices and can help identify new factors that may not have been considered previously [20]. Additionally, observational research can be conducted to observe consumer behavior in real-world settings. By observing how consumers interact with products and make purchasing decisions, researchers

can gain valuable insights into the factors that are most influential in driving consumer behavior [21]. Finally, data-analysis techniques, such as regression analysis and factor analysis, can be used to identify the underlying factors that drive consumer decision-making behavior [18]. These statistical methods can help identify patterns and relationships in the data that may not be immediately apparent. The current methods' inadequacy in accurately and successfully predicting consumers' decision-making behaviors when purchasing sustainable products results from the lack of a holistic consideration of the importance of factors influencing such behaviors [22]. Some methods, like regression analysis, factor analysis, AHP, surveys, questionnaires, interviews, and focus groups, often overlook the multifaceted nature of consumer behavior in the sustainability context [23]. Factors, such as the dynamic nature of consumer preferences, evolving market trends, and the impact of external influencers, are often neglected [24]. As a result, these conventional methods fall short of providing a comprehensive understanding of the intricate interplay of variables that shape consumers' choices in the sustainable product landscape.

One approach to potentially improve the identification of factors influencing consumer choice of sustainable products is to explore a collaborative method that combines conventional analysis techniques with optimization algorithms. By leveraging the strengths of both approaches, businesses can achieve a more nuanced understanding of consumer behavior in the context of sustainability. Some methods, like regression analysis, factor analysis, AHP, surveys, questionnaires, interviews, and focus groups, provide a solid foundation by capturing historical trends and market dynamics, while optimization algorithms excel in processing vast amounts of data, identifying the importance of factors influencing consumers' decision-making behaviors in purchasing sustainable products, and adapting to evolving consumer preferences. The integration of these methodologies empowers businesses to navigate the complexities of the sustainable product market and make informed decisions that resonate with environmentally conscious consumers.

This study distinguishes itself from the existing literature by offering a comprehensive approach to understanding and predicting consumers' decision-making behaviors when purchasing sustainable products. While previous studies have identified cognitive aspects, such as awareness, knowledge, perceived value, personal values, and emotional connection as key influencers, they often fall short of providing a holistic view. Conventional methods tend to overlook the multifaceted nature of consumer behavior in sustainability contexts, neglecting factors like dynamic consumer preferences, evolving market trends, and external influencers. To address these gaps, this study advocates for a synergistic approach that combines conventional methods, like focus groups and AHP, with optimization-algorithm technology. This integration allows for a more nuanced understanding of consumer behavior regarding sustainability, enhancing businesses' ability to anticipate and cater to consumers' sustainable purchasing behaviors effectively. Conventional methods lay the groundwork by capturing historical trends and market dynamics, while optimization algorithms excel in processing vast amounts of data and identifying the importance of factors influencing consumers' decision-making behaviors. By bridging these methodologies, this study contributes to filling the gap in current knowledge by providing businesses with a more comprehensive understanding of the intricate interplay of variables that shape consumers' choices in the sustainable product landscape. This approach empowers businesses to make informed decisions that align with the preferences and values of environmentally conscious consumers, ultimately enhancing their ability to succeed in the sustainable product market.

1.3. Purpose

The primary objective of this research is to employ a hybrid approach, integrating conventional methods, like focus groups and AHP, with optimization-algorithm technology. The hybrid approach proposed in this study involves several steps. Initially, the conventional AHP method is employed to identify key factors. Subsequently, the results of this identification are utilized as input information for DNNs to develop a decision-making

model for consumers to switch to sustainable products. The intention is that this information serves as a solid foundation for the DNNs to effectively identify and establish a rapid and accurate discrimination mode. Ultimately, the hybrid approach will prove to be crucial for achieving discrimination results that are superior to those obtained by solely employing the AHP method or the DNN method individually.

1.4. Contribution

This research presents a significant contribution to the field of consumer-behavior factors analysis by proposing and validating a hybrid approach that seamlessly integrates conventional methods with optimization-algorithm technology. The primary focus is on identifying the importance of factors influencing consumers' decision-making behaviors in purchasing sustainable products. Conventionally, researchers have relied upon conventional analytical tools, such as regression analysis, factor analysis, and AHP, to understand and predict consumer behaviors. However, with the ever-evolving landscape of technological advancements, incorporating artificial intelligence technology into the analysis process has become imperative for achieving more accurate and precise predictions. Our research addresses this gap by introducing a hybrid model that synergistically combines the strengths of conventional methods with optimization-algorithms technology.

The hybrid approach combines the technologies of AHP and DNNs. It exhibits characteristics such as robustness and optimization capabilities. By employing this integrated methodology, our research demonstrates a substantial improvement in the identifying capabilities of the importance of factors influencing consumers' decision-making behaviors in purchasing sustainable products. The results reveal that the hybrid model not only enhances the accuracy of predicting consumer preferences but also provides valuable insights into the intricate decision-making processes associated with sustainable product choices. This research contributes to the advancement of consumer-behavior analysis methodologies, offering a more comprehensive and nuanced understanding of the factors influencing purchasing decisions in the realm of sustainable products.

In conclusion, our research underscores the importance of adopting a hybrid approach, marrying conventional methods with optimization-algorithms technology. This synthesis of methodologies significantly enhances the precision and effectiveness of identifying the importance of factors influencing consumers' decision-making behaviors in purchasing sustainable products, contributing to the ongoing discourse on consumer-behavior analysis and aiding businesses in tailoring their strategies to meet evolving consumer preferences.

2. Technical Background Review

2.1. AHP

AHP is a decision-making methodology developed by mathematician and operations researcher Thomas L. Saaty in the 1970s. AHP is a structured technique that allows individuals or groups to make complex decisions by breaking them down into a hierarchical structure of criteria and alternatives [25]. It aims to assist individuals or groups in making complex decisions by breaking them down into smaller, more manageable components and evaluating them systematically [26]. This process facilitates a systematic approach to decision-making by providing a framework for organizing and analyzing various factors that influence a decision.

The principles of AHP revolve around hierarchical structuring, pairwise comparisons, and mathematical calculations [27]. First, the decision problem is decomposed into a hierarchical structure comprising criteria, sub-criteria, and alternatives. Then, pairwise comparisons are conducted to assess the relative importance of criteria and alternatives. Participants assign numerical values, typically on a scale from one to nine, based on their judgment of how one element compares to another in terms of importance. These comparisons are then synthesized using mathematical algorithms to derive priority weights for each element in the hierarchy. Finally, consistency checks are performed to ensure the reliability of the judgments provided [28]. Operating the AHP involves a series of steps. Ini-

tially, the decision-maker establishes a hierarchy of criteria and sub-criteria that are relevant to the decision at hand. They then compare these elements pairwise, assigning numerical values to express their relative importance. Subsequently, mathematical computations are applied to derive a set of weights that quantify the significance of each criterion and alternative. Finally, a consistency check is performed to ensure the reliability of the decision model [29]. AHP provides a comprehensive and logical method for decision makers to navigate complex choices and arrive at well-informed decisions [30].

The advantages of AHP include its systematic approach to decision making, its ability to accommodate subjective judgments through pairwise comparisons, its flexibility in handling complex decision structures, and its provision of clear, quantifiable results that aid in informed decision making. One key function is its ability to handle both qualitative and quantitative data, accommodating subjective judgments alongside objective measurements [27]. AHP also facilitates the consideration of multiple criteria, allowing decision-makers to account for diverse factors in their evaluations [31]. Additionally, the process promotes transparency and clarity in decision-making, making it easier to communicate and understand the reasoning behind a particular choice [32].

AHP finds applications across various fields, such as business, engineering, healthcare, and environmental management. Its versatility lies in its ability to handle both qualitative and quantitative data, making it suitable for complex decision scenarios where multiple criteria need to be considered [33]. AHP has been utilized in project selection, resource allocation, supplier selection, product design, and strategic planning, among others [34]. The flexibility and adaptability of AHP make it a valuable tool in various fields, from business and engineering to environmental planning.

Now, considering the application of AHP in identifying the importance of factors influencing consumer decision-making behavior toward purchasing sustainable products, its adoption would have significantly strengthened the decision-making process. By structuring the decision problem hierarchically, AHP would have allowed researchers to systematically break down the complex factors influencing consumer behavior into more manageable components. These could include environmental concerns, product attributes, pricing, brand reputation, and social influences. Through pairwise comparisons, researchers could have quantitatively assessed the relative importance of these factors from the perspective of consumers. This structured approach would have provided a clearer understanding of which factors have greater sway in influencing purchasing decisions for sustainable products. Moreover, AHP's ability to handle both qualitative and quantitative data would have facilitated the integration of diverse sources of information, such as consumer surveys, market-research data, and expert opinions. By synthesizing these inputs into a coherent framework, AHP would have enabled researchers to derive priority weights for each factor, thereby identifying the key determinants of consumer decision-making behavior in the context of sustainable product purchases. Overall, the application of AHP in this scenario would have enhanced the rigor and objectivity of the analysis, providing decision makers with valuable insights to formulate effective strategies for promoting sustainable consumption behaviors.

2.2. DNNs

Deep neural networks (DNNs) are a subset of artificial neural networks (ANNs) that are designed to model complex patterns in data by composing multiple layers of interconnected nodes, or neurons [35]. These networks employ sophisticated algorithms to learn representations of data with multiple levels of abstraction, enabling them to automatically extract relevant features and make accurate predictions [36]. DNNs find applications across various fields, including image and speech recognition, natural language processing, medical diagnosis, and financial forecasting. In consumer-behavior analysis, DNNs are extensively utilized for market segmentation, personalized recommendations, sentiment analysis, and predictive modeling [37]. DNNs have the following advantages, including 1. feature learning, DNNs excel at learning hierarchical representations of data, enabling

them to capture intricate patterns and relationships; 2. scalability, they can handle large volumes of data efficiently, making them suitable for big data applications; 3. adaptability, DNNs can adapt to different types of data and tasks, offering flexibility in diverse applications; and 4. performance, with appropriate training and tuning, DNNs often outperform conventional machine-learning algorithms in terms of accuracy and generalization [38].

DNNs consist of multiple layers, including input, hidden, and output layers. Each layer comprises interconnected nodes, and information flows through the network via weighted connections. During training, DNNs adjust these weights through a process called backpropagation, minimizing prediction errors and improving performance [39]. Operating a DNN involves a systematic approach to training and inference. The training process involves presenting the network with labeled data, allowing it to adjust its internal parameters through a process known as backpropagation. This iterative learning process refines the network's ability to make accurate predictions. Once trained, the DNN can be deployed for making predictions on new, unseen data, providing valuable insights and automating complex tasks [39]. The architecture and parameters of a DNN, such as the number of layers and nodes, are crucial considerations in optimizing its performance [40].

Consumer-behavior analysis involves understanding patterns, preferences, and decision-making processes among consumers [41]. DNNs are relevant in this context due to their ability to 1. model complex patterns, DNNs can identify intricate patterns in consumer data, such as purchase history, browsing behavior, and social media interactions; 2. personalize, by analyzing vast amounts of data, DNNs enable personalized recommendations and marketing strategies tailored to individual consumer preferences; and 3. conduct predictive analytics, DNNs can forecast future trends, anticipate consumer needs and optimize business decisions based on predictive insights derived from historical data [42]. DNNs are employed in predicting consumer preferences and decision-making behaviors by 1. feature extraction, by extracting relevant features from diverse data sources, such as demographic information, purchase history, and online activities; 2. pattern recognition, by identifying subtle patterns and correlations in consumer-behavior data, including product preferences, brand loyalty, and purchase intent; 3. segmentation, by grouping consumers into distinct segments based on common characteristics or behaviors, enabling targeted marketing campaigns and product recommendations; and 4. behavioral forecasting, by anticipating future trends and consumer behaviors, facilitating proactive decision-making and strategic planning for businesses [43]. For instance, in e-commerce platforms, DNNs analyze past purchases, browsing history, and demographic information to predict which products a consumer is likely to purchase next. By leveraging these predictions, businesses can personalize product recommendations, offer targeted promotions, and enhance the overall shopping experience, thereby increasing customer satisfaction and loyalty [44]. In summary, deep neural networks (DNNs) offer a powerful framework for analyzing consumer behavior, leveraging their capabilities in feature learning, scalability, and predictive modeling to uncover insights and drive strategic decision making in various industries.

In the realm of identifying the importance of factors influencing consumers' decision-making behaviors in purchasing sustainable products, DNNs offer a valuable tool for businesses and researchers alike. The complexity of consumer behavior and the multitude of factors influencing purchasing decisions make conventional analytical methods challenging. DNNs, with their capacity to handle intricate behaviors and large datasets, can analyze diverse variables, such as consumer preferences, social trends, and environmental concerns. By leveraging these capabilities, businesses can gain deeper insights into consumer choices and tailor their strategies to align with evolving preferences for sustainable products, contributing to a more informed and targeted approach in the market. DNNs excel at capturing non-linear effects in predictor factors that influence consumer decision-making behavior when purchasing sustainable products, thanks to their inherent architecture and training processes. Unlike conventional linear models, which assume a linear relationship between predictor variables and outcomes, DNNs consist of multiple layers of interconnected nodes capable of capturing complex, non-linear relationships. DNNs operate on an abductive

logic, engaging in an iterative process between emerging patterns and associations in the data to provide a rational theoretical explanation for these patterns [45]. In other words, DNNs do not actively verify theories but seek the most likely explanation at each step. This study leverages the characteristic that "DNNs can learn and adjust their internal representation to better reflect latent patterns in the data" through forward and backward propagation, enabling effective prediction of price, product features, brand, and other factors, and modeling the complex and often non-linear interactions between reputation and sustainability considerations. This ability to capture non-linear effects is crucial for understanding and predicting consumer behavior, especially in the context of sustainable products, where decision-making processes are influenced by a myriad of factors that may not follow simple linear relationships.

2.3. The Technical Differences between the Hybrid Approach and Conventional Analysis Techniques

To understand the technical differences and why the hybrid approach may have better predictive power for identifying the importance of factors influencing consumer decision-making behaviors in purchasing sustainable products, we break down the components.

1. The conventional methods (regression analysis and factor analysis) are:
    - Regression Analysis: This statistical method examines the relationship between a dependent variable and one or more independent variables. It assumes a linear relationship between the variables and aims to model the relationship to make predictions [46]. However, it may not capture complex, nonlinear behaviors in the data;
    - Factor Analysis: This technique identifies underlying factors that influence observed variables [47]. It is used to reduce the dimensionality of the data and uncover latent structures [48]. However, it assumes linearity and may struggle with capturing intricate relationships between variables.
2. The hybrid approaches (AHP and DNNs methods) are:
    - AHP: AHP is a structured decision-making method that decomposes complex problems into a hierarchy of criteria and alternatives, assigning weights to different elements based on pairwise comparisons. It provides a systematic way to handle multiple criteria in decision-making processes;
    - DNNs: DNNs are a class of machine-learning algorithms that excel at capturing intricate behaviors and relationships within data, even in a nonlinear fashion. They consist of multiple layers of interconnected nodes, allowing them to learn complex representations from the input data.
3. The advantages of the hybrid approach are:
    - Robustness of AHP: AHP brings robustness to the hybrid approach by providing a structured way to handle criteria and alternatives, which is essential in decision-making scenarios;
    - Power of Machine-Learning Algorithms (DNN): DNN methods excel at capturing complex, nonlinear behaviors in the data that conventional methods may overlook. They can identify intricate relationships between variables, leading to more accurate predictions;
    - Complementary Strengths: The hybrid approach combines the strengths of both conventional and machine-learning techniques. AHP provides a solid foundation for decision making, while DNN methods enhance the model's ability to capture nuanced behaviors in consumer decision making;
    - Improved Predictive Power: The hybrid approach leverages the complementary strengths of AHP and DNNs, addressing the limitations of each. AHP provides structure and robustness, while DNNs enhance the model's capacity to handle complex, nonlinear relationships. This combination is likely to result in a more powerful and accurate predictive model for understanding and forecasting consumer decision-making behaviors in purchasing sustainable products.

In summary, the hybrid approach combines the structured decision making of conventional methods like AHP with the advanced behavior-recognition capabilities of optimization algorithms like DNNs. This integration allows for a more comprehensive analysis of consumer behavior, leading to improved predictive power compared to relying solely on conventional methods like regression analysis and factor analysis.

3. A Framework of Hybrid Approach

The framework (Figure 1) of the hybrid approach comprises four distinct stages. 1. The preparing materials stage is where, in this preliminary stage, the focus is on assembling and organizing the necessary materials essential for the research process. This involves the collection of sustainable products that contribute to a comprehensive understanding of consumer behavior in the context of purchasing sustainable products. 2. The exploring the factors that consumers will consider when purchasing such products stage is the second stage and involves a comprehensive exploration of the factors influencing consumer decision making when it comes to the purchase of sustainable products. This includes an in-depth analysis of socio-economic factors, environmental concerns, brand perception, and other variables that play a role in shaping consumer choices. At this stage, the Impactor Factors Card is the tool mainly used for exploring the factors that consumers will consider when purchasing sustainable products. At this stage, the hybrid approach will initially obtain the factors that will influence consumers to purchase sustainable products. 3. The using AHP to analyze consumer decision-making behaviors in the purchasing of sustainable products stage is where the analytic AHP is employed to systematically analyze and quantify the identified factors produced in the phase of exploring the factors that consumers will consider when purchasing. AHP provides a structured methodology for evaluating and prioritizing these factors, enabling a deeper understanding of their relative importance in the consumer decision-making process. At this stage, the hybrid approach will capture the significant factors that will influence consumers to purchase sustainable products. 4. Using DNNs to identify the importance of factors influencing consumers' decision-making behaviors in purchasing sustainable products stage is the final stage and integrates advanced technology, specifically DNNs, to identifying the importance of factors influencing consumers' decision-making behaviors. DNNs, known for their ability to recognize intricate behaviors in extensive datasets, are employed to develop predictive models that forecast and anticipate identifying the importance of factors influencing consumer behavior in the context of purchasing sustainable products. This hybrid approach, by combining preparatory groundwork, factor exploration, analytical prioritization using AHP, and predictive modeling with DNNs, aims to offer a comprehensive understanding of identifying the importance of factors influencing consumers' decision-making behaviors. At this stage, the hybrid approach will capture the importance of the significant factors that influence consumers to purchase sustainable products.

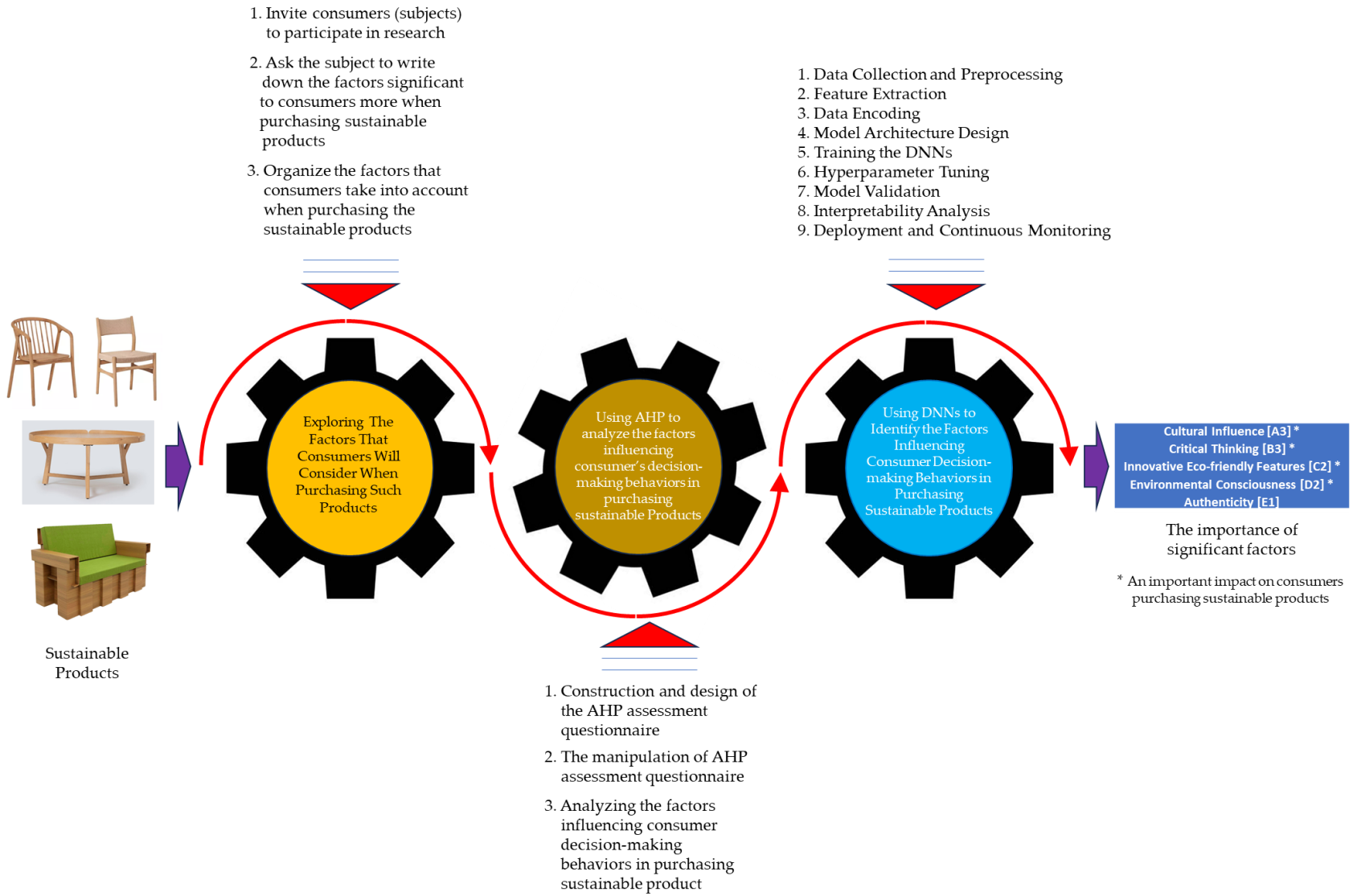


Figure 1. The framework of hybrid approach.

4. Methods and Results

4.1. Preparing Materials

The initial phase in the hybrid-approach framework involves the preparation of materials. Several materials, such as sustainable products, need to be sourced and prepared. In our study, the definitions of a sustainable product are as follows. Sustainable products are goods or services created with minimal impact on the environment and society. They are designed to meet current needs without harming the ability of future generations to meet their own needs. These products have eco-friendly credentials, aiming for ecological integrity, social responsibility, and economic viability throughout their design, production, and distribution processes. In this study, we focus on green furniture (shown in Figure 2), which exemplifies sustainable products with their eco-friendly credentials, to investigate consumer decision-making behaviors.



Figure 2. The photos of green furniture (sustainable products).

4.2. Exploring the Factors That Consumers Will Consider When Purchasing Such Products

The second phase in the hybrid-approach framework involves exploring the factors that consumers take into account when purchasing sustainable products. The following are the steps for the method.

Assess the environmental impact. Consumers evaluate how a product affects the environment. They look for eco-friendly materials, energy-efficient production methods, and reduced carbon footprints. When assessing the environmental impact of a product, they are examining how the product interacts with the natural world throughout its lifecycle. This evaluation involves looking at various aspects.

- Eco-friendly materials: Consumers seek products made from materials that are sustainable and have minimal negative impact on the environment. This can include using renewable resources, recycled materials, or materials that are easily biodegradable;
- Energy-efficient production methods: Consumers consider how the product is manufactured. They prefer products that are made using energy-efficient processes, such as those powered by renewable energy sources like solar or wind power. Energy-efficient production methods help reduce the overall environmental footprint of the product;
- Reduced carbon footprint: Consumers also look for products that have a low carbon footprint. This means that the product is produced and transported in ways that minimize greenhouse-gas emissions. Factors such as sourcing materials locally, optimizing transportation routes, and using energy-efficient logistics contribute to reducing the carbon footprint of a product.

Consider ethical and social factors. Consumers also think about how products are made. They consider fair labor practices, humane treatment of workers, and adherence to human rights standards. When consumers consider ethical and social factors related to product manufacturing, they focus on how the production process impacts the people involved in making the product. This evaluation involves several key aspects.

- Fair labor practices: Consumers prioritize products that are produced under fair labor conditions. This means workers are paid fair wages, have safe working conditions, and are not subjected to exploitative practices like forced labor or child labor;

- Humane treatment of workers: Consumers look for products that ensure humane treatment of workers throughout the supply chain. This includes considerations such as reasonable working hours, respect for workers' rights, and policies against discrimination and harassment;
- Adherence to human rights standards: Consumers seek products from companies that uphold human rights standards. This involves respecting basic human rights, such as the right to freedom, dignity, and equality for all individuals involved in the production process.

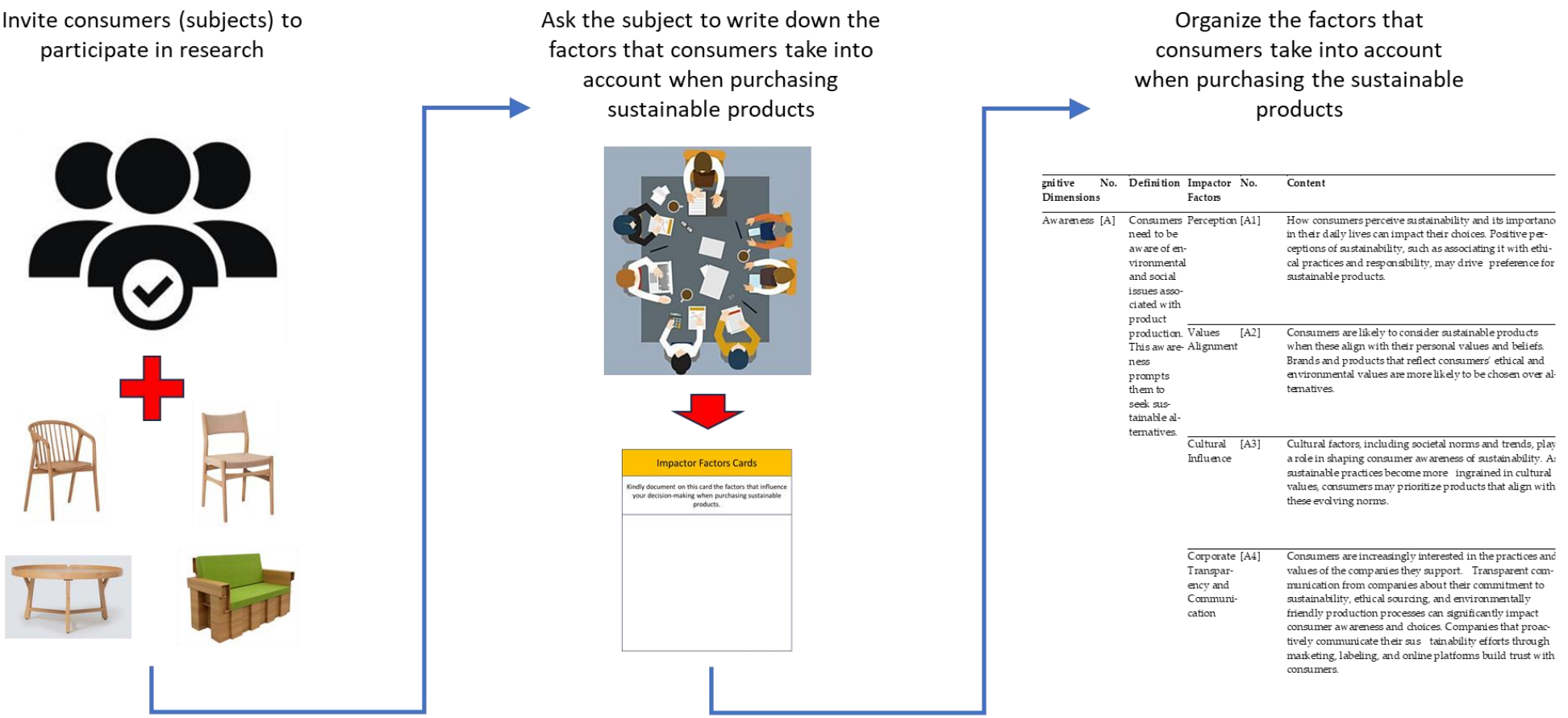
Evaluate durability and recyclability. Additionally, consumers look at how long a product will last and if it can be recycled. They consider if the product supports a circular economy. During this phase, we will engage invited subjects (consumers) in the study to explore the factors influencing their decision to purchase sustainable products. In this step, consumers examine two important aspects of a product:

- Durability: Consumers assess how long a product is likely to last. They prefer products that are durable and can withstand regular use over an extended period without needing frequent replacement. Durable products contribute to sustainability by reducing waste and the need for frequent consumption;
- Recyclability: Consumers consider whether a product can be easily recycled at the end of its lifecycle. They look for products made from materials that are recyclable or have a minimal impact on the environment when disposed of properly. Recyclable products support the principles of a circular economy, where materials are reused and repurposed rather than discarded.

Figure 3 shows the work of exploring the factors that consumers will consider when purchasing such products:

1. Invite consumers (subjects) to participate in research.

In the initial phase of this study, the researchers undertook a comprehensive approach to invite a diverse group of participants. The first step involved identifying potential subjects through various channels, such as social media, community organizations, and academic institutions. Once potential participants were identified, invitations were extended to them, providing detailed information about the study's objectives and the significance of exploring factors influencing sustainable product purchases. Clear instructions were given on how to express interest in participation, ensuring a transparent and voluntary recruitment process. This meticulous approach aimed to create several samples, fostering a thorough exploration of the diverse perspectives on sustainable product decision making. Table 1 displays the identity and background details of the subjects who have been invited to take part in the research. A total of six consumers have been invited to participate. The age range of these individuals spans from 35 to 55 years. All of them possess experience in the procurement of green furniture. Based on the information provided in Table 1, we can highlight the positive aspects related to career positions, human capital, and gender. 1. For career position, the table showcases a diverse range of career positions among the individuals who have purchased green furniture, including mechanical engineer, product designer, housewife, bank clerk, product manager, and store salesperson. This diversity in career positions indicates a broad spectrum of professional backgrounds and expertise among the individuals involved in purchasing eco-friendly furniture. 2. For human capital, the individuals at the table represent a valuable pool of human capital, with varied skills and experiences. For example, the mechanical engineer, product designer, and product manager bring technical expertise and design knowledge to their purchasing decisions, while the housewife, bank clerk, and store salesperson contribute unique perspectives and insights based on their respective roles and experiences. This diverse human capital enriches the discussion and decision-making processes related to green furniture purchases.



gnitive Dimensions	No.	Definition	Impactor Factors	No.	Content
Awareness	[A]	Consumers need to be aware of environmental and social issues associated with product production. This awareness prompts them to seek sustainable alternatives.	Perception	[A1]	How consumers perceive sustainability and its importanc in their daily lives can impact their choices. Positive perceptions of sustainability, such as associating it with ethical practices and responsibility, may drive preference for sustainable products.
			Values Alignment	[A2]	Consumers are likely to consider sustainable products when these align with their personal values and beliefs. Brands and products that reflect consumers' ethical and environmental values are more likely to be chosen over alternatives.
			Cultural Influence	[A3]	Cultural factors, including societal norms and trends, play a role in shaping consumer awareness of sustainability. A sustainable practices become more ingrained in cultural values, consumers may prioritize products that align with these evolving norms.
			Corporate Transparency and Communication	[A4]	Consumers are increasingly interested in the practices and values of the companies they support. Transparent communication from companies about their commitment to sustainability, ethical sourcing, and environmentally friendly production processes can significantly impact consumer awareness and choices. Companies that proactively communicate their sus tainability efforts through marketing, labeling, and online platforms build trust with consumers.

Figure 3. The work of exploring the factors that consumers will consider when purchasing such products.

Table 1. Consumers (subjects) to participate in research.

No.	Gender	Background	Age	Experience in Purchasing Green Furniture
1	male	mechanical engineer	35	purchased eco-friendly tables and chairs twice
2	male	product designer	42	purchased eco-friendly tables and chairs three times
3	female	housewife	55	purchased eco-friendly tables once and chairs twice
4	female	bank clerk	38	purchase eco-friendly chairs twice
5	male	product manager	47	purchased an eco-friendly table twice
6	female	store salesperson	50	purchased eco-friendly tables and chairs once

2. Ask the subject to write down the factors that consumers take into account when purchasing sustainable products.

Following successful recruitment, by asking subjects to observe photos of sustainable products (green furniture) provided by researchers, each participant was guided through the process of articulating the factors that influenced their decisions to purchase sustainable products. The researchers provided a set of specially designed "Impactor Factors Cards", which facilitated a structured approach to recording these influences. Participants were instructed on the proper use of these cards and encouraged to express their thoughts and considerations in a detailed manner. This step was crucial to ensuring that the collected data would be comprehensive and reflective of the nuanced aspects influencing sustainable purchasing decisions. The clear and systematic nature of this process aimed to enhance the reliability and validity of the data obtained from each participant. In this study, we furnish consumers with "reference pictures of sustainable products," specifically focusing on green furniture, as depicted in Figure 2. Additionally, consumers are supplied with "Impactor Factors Cards", as illustrated in Figure 4.

3. Organize the factors that consumers take into account when purchasing sustainable products.

Subsequently, researchers implemented a meticulous strategy to collect and compile the factors noted by participants on the impactor factors cards. A standardized data-collection protocol was followed, wherein trained researchers systematically reviewed each card, ensuring accurate transcription of the factors expressed by the subjects. The data-collection process included categorizing and organizing the identified factors to facilitate subsequent analysis. To maintain the integrity of the findings, any ambiguities or uncertainties in the collected data were clarified through follow-up communication with the participants. This rigorous approach to data collection aimed to provide a solid foundation for the subsequent stages of analysis and interpretation, ultimately contributing to a comprehensive understanding of the factors influencing sustainable product purchasing decisions. Table 2 shows the factors that consumers take into account when purchasing green furniture. It can be seen that there are five cognitive aspects behind consumers purchasing sustainable products. Moreover, there are eighteen impactor factors related to five cognitive aspects.

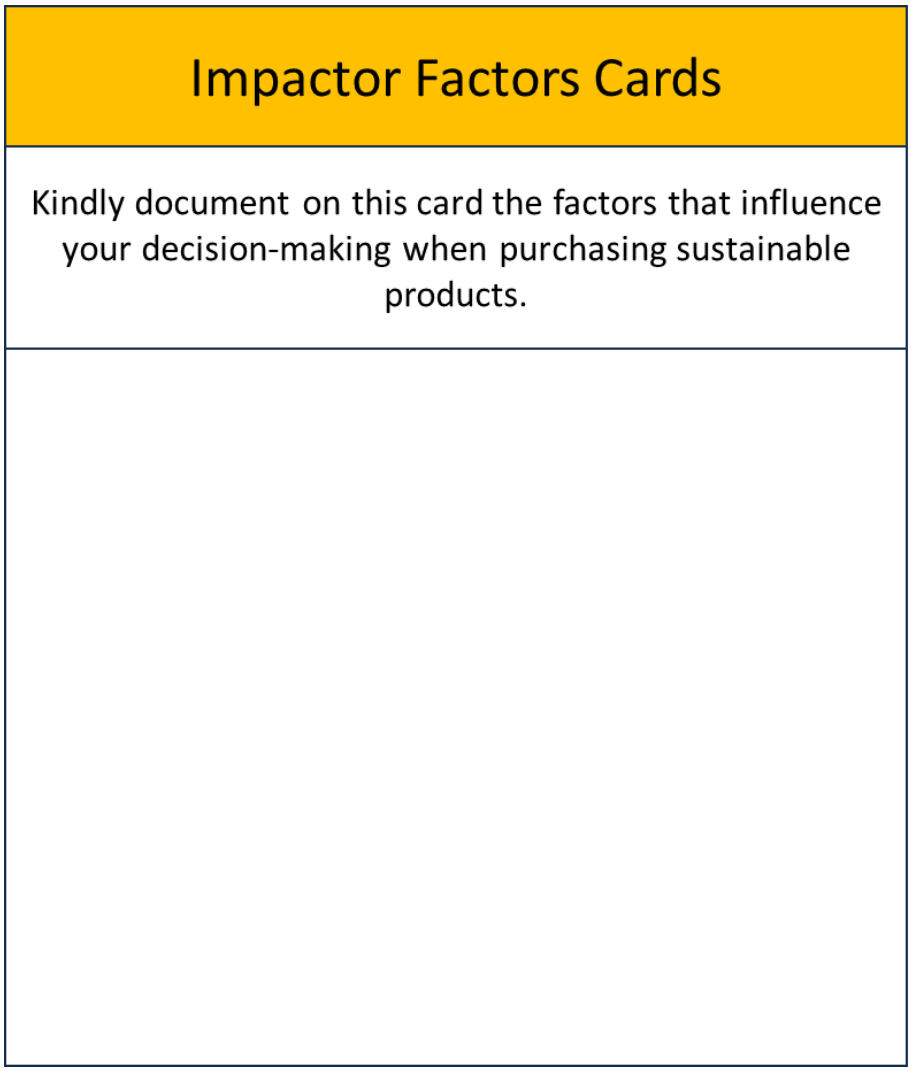


Figure 4. Impactor factors cards.

Table 2. The factors that consumers take into account when purchasing green furniture.

Cognitive Dimensions	No.	Definition	Impactor Factors	No.	Content
Awareness	[A]	Consumers need to be aware of environmental and social issues associated with product production. This awareness prompts them to seek sustainable alternatives.	Perception	[A1]	How consumers perceive sustainability and its importance in their daily lives can impact their choices. Positive perceptions of sustainability, such as associating it with ethical practices and responsibility, may drive preference for sustainable products.
			Values Alignment	[A2]	Consumers are likely to consider sustainable products when these align with their personal values and beliefs. Brands and products that reflect consumers' ethical and environmental values are more likely to be chosen over alternatives.
			Cultural Influence	[A3]	Cultural factors, including societal norms and trends, play a role in shaping consumer awareness of sustainability. As sustainable practices become more ingrained in cultural values, consumers may prioritize products that align with these evolving norms.
			Corporate Transparency and Communication	[A4]	Consumers are increasingly interested in the practices and values of the companies they support. Transparent communication from companies about their commitment to sustainability, ethical sourcing, and environmentally friendly production processes can significantly impact consumer awareness and choices. Companies that proactively communicate their sustainability efforts through marketing, labeling, and online platforms build trust with consumers.

Table 2. *Cont.*

Cognitive Dimensions	No.	Definition	Impactor Factors	No.	Content
Knowledge	[B]	Knowledge about sustainable practices, certifications, and the overall environmental impact of products empowers consumers to make informed decisions in favor of sustainability.	Education	[B1]	Access to accurate information about sustainable product choices. Consumer knowledge regarding certifications and labels indicating sustainability.
			Product Information	[B2]	Availability of clear and transparent information about a product's lifecycle and sourcing. Knowledge of the company's commitment to sustainability and ethical practices.
			Critical Thinking	[B3]	Consumers' ability to critically evaluate marketing claims and greenwashing tactics. Knowledge of the broader environmental and social implications of product choices.
			Certifications and Standards	[B4]	Knowledge of credible sustainability certifications and standards can act as a strong influencer for consumers seeking environmentally friendly products. Recognized certifications, such as Fair Trade, USDA Organic, or Energy Star, provide assurance to consumers that the product meets specific environmental and ethical criteria.
erceived Value	[C]	Consumers often evaluate the perceived value of sustainable products. This includes considerations such as durability, ethical sourcing, and the long-term impact of the product on the environment and society.	Product Transparency	[C1]	Consumers are more likely to consider sustainable products when there is clear and comprehensive information about the product's environmental impact, sourcing, and production processes.
			Brand Reputation	[C2]	The perceived commitment of a brand to sustainability, along with its ethical practices and track record, can significantly influence consumers' perceptions of value and their decision to choose sustainable products.
			Innovative Eco-friendly Features	[C3]	Products that integrate innovative and eco-friendly features, such as renewable materials, energy efficiency, or minimal carbon footprint, may be perceived as having higher value by consumers who prioritize sustainability.
			Affordability and Long-Term Benefits	[C4]	While the initial cost of sustainable products might be higher, consumers are more likely to consider them if they believe the long-term benefits, such as durability, energy savings, or reduced environmental impact, justify the initial investment.
Personal Values	[D]	Individual values and beliefs play a crucial role. Consumers who prioritize environmental and social responsibility are more likely to choose sustainable products aligning with their personal values.	Ethical Alignment	[D1]	Consumers may prioritize sustainable products that align with their ethical values. This includes considerations such as fair labor practices, social responsibility, and adherence to ethical standards in production.
			Environmental Consciousness	[D2]	Individuals who value environmental sustainability are likely to choose products that have a minimal ecological impact. Factors such as eco-friendly packaging, reduced carbon footprint, and sustainable sourcing of materials may influence their purchasing decisions.
			Social Impact	[D3]	Some consumers focus on the social benefits of a product. They may be more inclined to choose items that contribute positively to society, such as those produced by companies with a commitment to community development or charitable initiatives.
			Quality and Longevity	[D4]	A cognitive aspect of personal values may involve a preference for durable and high-quality products. Consumers valuing longevity over disposability may opt for sustainable items that are built to last, reducing the need for frequent replacements.
Emotional Connection	[E]	Emotional responses, such as guilt or satisfaction, can influence purchasing decisions. Consumers may feel a sense of responsibility or accomplishment when choosing sustainable products, which can drive their choices.	Authenticity	[E1]	Consumers are increasingly drawn to sustainable products that reflect genuine commitment to ethical practices. The cognitive aspect of authenticity plays a crucial role in establishing an emotional connection, as individuals seek products that align with their values and beliefs.
			Transparency	[E2]	Cognitive awareness regarding the transparency of a brand's supply chain and production processes greatly influences emotional connections. Consumers are more likely to choose sustainable products when they can easily access information about the environmental and social impact of the product's lifecycle.
			Storytelling	[E3]	Effective communication through storytelling engages the emotional and cognitive aspects of consumers. Brands that share compelling narratives about their commitment to sustainability, detailing their journey and mission, create a stronger emotional connection, influencing purchasing decisions positively.
			Positive Associations	[E4]	Emotional connections are often built through positive associations with a brand. Cognitive aspects, such as memories and emotions linked to a product, play a significant role in decision-making. Sustainable products that evoke positive emotions and experiences are more likely to be chosen by consumers.

4.3. Using AHP to Analyze the Factors Influencing Consumer's Decision-Making Behaviors in Purchasing Sustainable Products

The third phase in the hybrid-approach framework involves using AHP to analyze consumers' decision-making behaviors in purchasing sustainable products. This research endeavors to employ AHP as a tool to gain insights into consumers' decision-making behaviors when selecting sustainable products. Here is the framework (Figure 5) for using AHP to analyze consumers' decision-making behaviors in purchasing sustainable products.

1. Construction and design of the AHP-assessment questionnaire

In the realm of consumer behavior and sustainability, understanding the factors influencing individuals' decisions to purchase sustainable products is crucial. The AHP-assessment questionnaire serves as a valuable tool for unraveling these decision-making behaviors. The following steps outline the meticulous construction and design of the AHP-assessment questionnaire, with a specific emphasis on incorporating factors that significantly impact consumers' choices when it comes to sustainable product purchases.

A. Step 1 is to define the scope and objectives.
   Before delving into the construction process, it is imperative to clearly define the scope and objectives of the AHP-assessment questionnaire. In our research, we identify the specific aspects of consumer decision-making in purchasing green furniture that warrant investigation. This initial step sets the foundation for a targeted and effective questionnaire.
B. Step 2 is the identification of factors.
   Utilizing the factors derived from the second phase of the hybrid-approach framework, we aim to identify and enumerate the elements that exert significant influence on consumers' choices to select sustainable products. These elements include environmental concerns, ethical considerations, product affordability, brand reputation, and other relevant aspects. In this study, we employ Tabel 2's impact factors. The factors (A1–A4, B1–B4, C1–C4, D1–D4, and E1–E4) serve as influential elements for hierarchy construction.
C. Step 3 is hierarchy construction.

Establish a hierarchical structure for the identified factors, emphasizing the relationships and dependencies between them. The hierarchy may consist of the main criteria, sub-criteria, and alternative choices. This hierarchical arrangement ensures a systematic and organized approach to capturing the complexities of consumer decision-making behaviors. In this study, a hierarchical structure illustrating the identified factors for influencing individuals' decisions to purchase green furniture is presented in Figure 6.

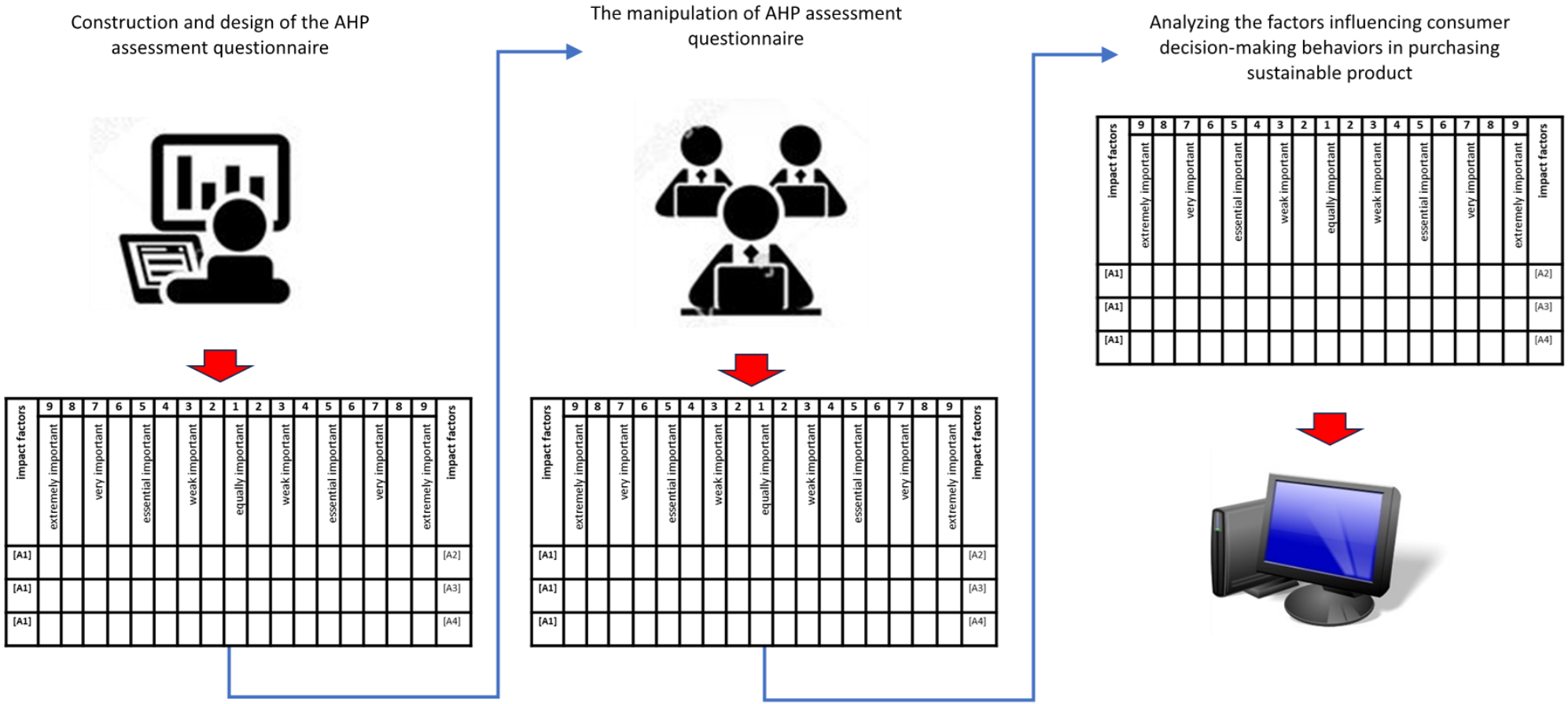


Figure 5. The framework for using AHP to analyze consumer's decision-making behaviors.

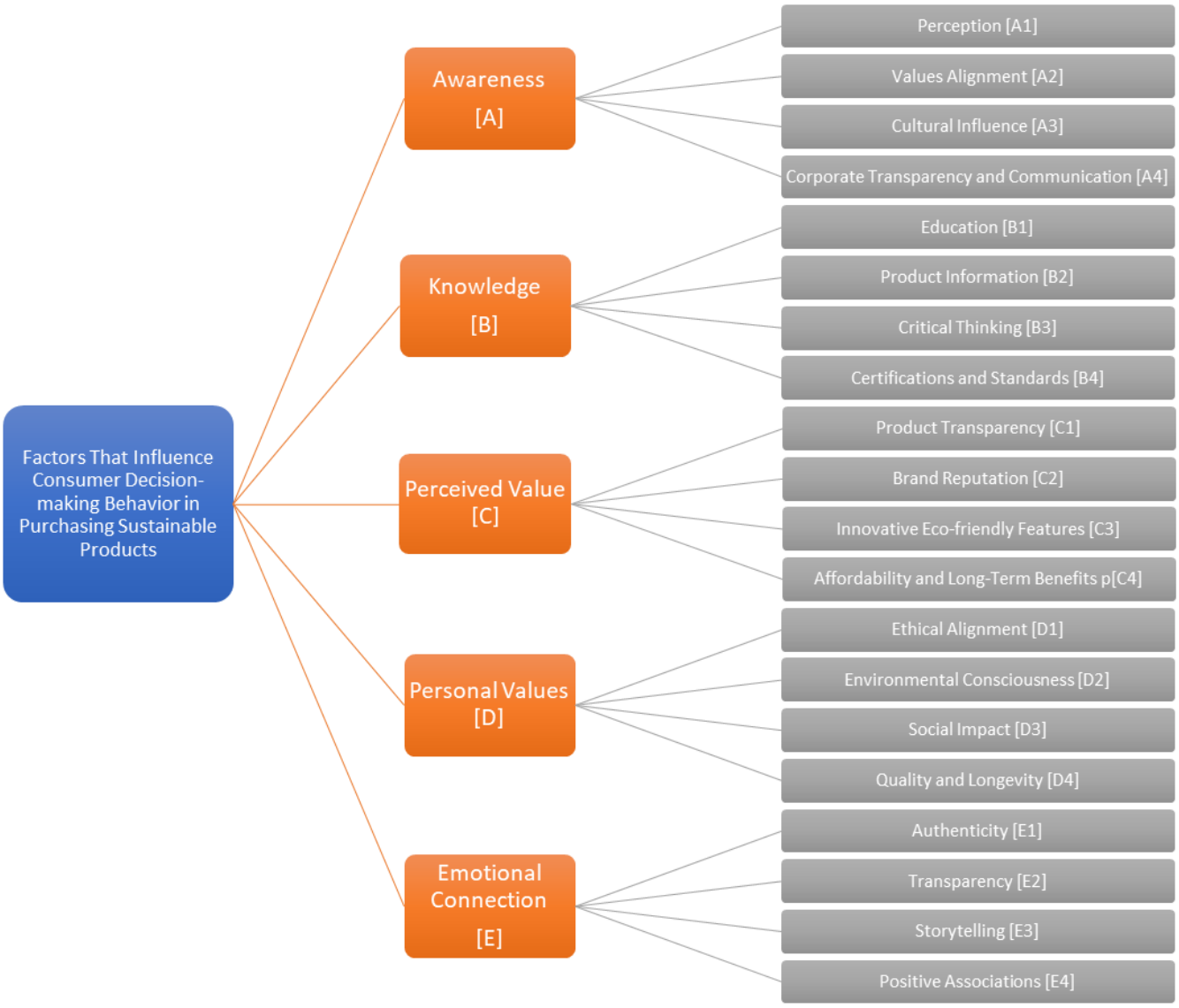


Figure 6. Hierarchy construction for the factors.

Figure 6 illustrates the factors influencing individuals' decisions to purchase green furniture, which can be categorized into five types: awareness, knowledge, perceived value, personal values, and emotional connection. Within the category of awareness, factors include perception, values alignment, cultural influence, corporate transparency, and communication. Factors related to knowledge encompass education, product information, critical thinking, certifications, and standards. Perceived value factors include product transparency, brand reputation, innovative eco-friendly features, affordability, and long-term benefits. Factors associated with personal values include ethical alignment, environmental consciousness, social impact, quality, and longevity. Lastly, emotional connection factors consist of authenticity, transparency, storytelling, and positive association. Within the awareness category, factors such as perception, values alignment, cultural influence, corporate transparency, and communication play crucial roles. Knowledge-related factors encompass education, product information, critical thinking, certifications, and standards. Perceived value is influenced by factors like product transparency, brand reputation, innovative eco-friendly features, affordability, and long-term benefits. Personal values are reflected in ethical alignment, environmental consciousness, social impact, quality, and longevity. Emotional connection factors include authenticity, transparency, storytelling, and

positive association, all of which contribute significantly to sustainable product purchasing decisions.

D. Step 4 is question formulation.

Formulate clear and concise questions that correspond to each criterion and sub-criterion in the hierarchy. Ensure that the language used is easily understandable by the target audience, fostering accurate and meaningful responses. The questions should be designed to elicit information that aids in the prioritization and evaluation of factors influencing sustainable product purchases. In our study, the question format of the AHP-assessment questionnaire is depicted in Figure 7. Furthermore, Table 3 provides the definition and explanation of the AHP-assessment scale.

E. Step 5 is pilot testing.
Before finalizing the questionnaire, conduct pilot testing with a small sample of the target demographic. This step helps identify any ambiguities, redundancies, or potential issues with the wording of questions. Adjustments can be made based on feedback received during the pilot testing phase to enhance the questionnaire's clarity and effectiveness.

F. Step 6 is finalization.
Incorporate insights from the pilot testing phase and finalize the AHP-assessment questionnaire (Appendix A). Ensure that the questions align with the established hierarchy, providing a robust framework for analyzing consumer decision-making behaviors in purchasing sustainable products.

impact factors	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	impact factors
	extremely important		very important		essential important		weak important		equally important		weak important		essential important		very important		extremely important	
[A1]																		[A2]
[A1]																		[A3]
[A1]																		[A4]

Figure 7. Example of question.

Table 3. AHP-assessment scale definition and explanation.

Assessment Scale	Definition	Explanation
1	equal important	Both factors are equally important
3	weak important	Based on personal experience and judgment, I think one of the factors is slightly more important than the other.
5	essential important	Based on personal experience and judgment, I strongly prefer a certain factor.
7	very important	In fact, I am very biased towards liking a certain factor.
9	extremely important	There is evidence to determine that one factor is extremely important compared to two factors.
2, 4, 6, 8	compromise value of adjacent scales	When compromise is required

2. The manipulation of the AHP-assessment questionnaire

The AHP-assessment questionnaire involves a systematic and organized approach to ensure accurate and reliable results. Follow these steps:

A. Step 1 is preparation.

- Review the questionnaire by familiarizing the AHP-assessment questionnaire to understand its components and objectives;
- Select participants by identifying and inviting relevant participants who possess knowledge of the subject matter. The phrase "knowledge of the subject matter" refers to understanding what sustainable products are or having experience purchasing sustainable products.

B. Step 2 is the introduction.

- Explain purpose by clearly communicating the purpose and significance of the AHP assessment;
- Provide instructions by offering detailed instructions on how to complete the questionnaire.

C. Step 3 is distribution.

- Distribute questionnaires by handing out the assessment questionnaires to participants;
- Ensure understanding by confirming that the participants comprehend the questions and criteria.

D. Step 4 is completion.

- Individual assessment entails instructing participants to independently evaluate and rank the provided criteria and alternatives;
- Time management is through setting a reasonable time limit for completing the questionnaire to maintain focus.

E. Step 5 is collection.

- Collect responses by gathering completed questionnaires promptly and ensuring each participant has submitted their assessment.

F. Step 6 is data compilation.

- Organize responses by arranging collected data in a systematic manner;
- Verify completeness by confirming that all necessary information is available and accurate.

G. Step 7 is a consistency check.

- Review responses by examining individual responses for consistency and logical coherence;
- Address discrepancies by communicating with participants to resolve any discrepancies or unclear responses.

3. Analyzing the factors influencing consumer decision-making behaviors in purchasing sustainable products

Analyzing the AHP-assessment questionnaire filled out by subjects requires a systematic and rigorous approach. Begin by organizing the collected data in a structured format, ensuring accuracy and completeness. Calculate the weighted scores for each factor based on the responses, utilizing the established scale or scoring system. Aggregate the scores to determine the overall priorities of the factors influencing sustainable product purchasing decisions. Conduct a sensitivity analysis to assess the robustness of the results and identify potential variations. Interpret the findings in the context of the research objectives, drawing conclusions that contribute to a comprehensive understanding of the factors driving sustainable purchasing decisions. Here are the steps for constructing consumer decision-making behaviors in purchasing sustainable products, utilizing the results obtained from the AHP-assessment questionnaire.

A. Step 1 is analyzing the AHP-assessment questionnaire results.
The researcher can begin by thoroughly examining the results obtained from the AHP-assessment questionnaire. This process allows for the identification and categorization of key data points and preferences expressed by consumers regarding sustainable products.

B. Step 2 is organizing the decision-making criteria.
After analyzing the AHP-assessment questionnaire results, we systematically outline and organize the decision-making criteria that impact consumers when purchasing sustainable products. Subsequently, we prioritize these criteria based on their significance, as indicated by the assessment responses.

C. Step 3 is establishing the decision hierarchy.
Construct a decision hierarchy that encapsulates the identified criteria, placing them in a structured order reflecting their hierarchical importance. This hierarchy will serve as a foundation for understanding the interrelationships among various decision-making factors. In the context of this study, we employ Equation (1) to precisely define the decision hierarchy.

$$A = [a_{ij}] = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ a_{21} & 1 & & a_{2n} \\ \vdots & & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & 1 \end{bmatrix} \quad (1)$$

$$a_{ij} = 1, i, j = 1, 2, \cdots, \mathrm{n}$$

D. Step 4 is assigning weight to the criteria
In order to assign suitable weights to each decision-making criterion using the quantitative data obtained from the AHP assessment, we conduct the step involving converting the qualitative preferences expressed by consumers into numerical values. This conversion reflects the relative importance of each criterion. Equation (2) is then utilized to represent the relative importance of each criterion in this context.

$$A = [a_{ij}] = \begin{bmatrix} \frac{W_1}{W_1} & \frac{W_1}{W_2} & \cdots & \frac{W_1}{W_n} \\ \frac{W_2}{W_1} & \frac{W_2}{W_2} & & \frac{W_2}{W_n} \\ \vdots & & \ddots & \vdots \\ \frac{W_n}{W_1} & \frac{W_n}{W_2} & \cdots & \frac{W_n}{W_n} \end{bmatrix} \quad (2)$$

where a_{ij} represents the ratio between the two factors, $a_{ij} = \frac{W_i}{W_j}$

W_i and W_j are, respectively, the weights of factors, i, j = 1,2, $\cdots$, n

E. Step 5 is calculating the consistency ratio.

In order to maintain the consistency of the decision hierarchy, the process involves evaluating the stability of pairwise comparisons conducted by respondents in the AHP. Adjustments to the hierarchy are made as necessary to attain an acceptable level of consistency, utilizing Equations (3) and (4).

$$\lambda'_{max} = \frac{1}{n}\left(\frac{W'_1}{W_1} + \frac{W'_2}{W_2} + \ldots + \frac{W'_n}{W_n}\right) \quad (3)$$

$$C.I. = \frac{\lambda'_{max} \; - \; n}{n \; - \; 1} \quad (4)$$

F. Step 6 is developing decision-making behaviors.
In this step, Equations (1)–(4) will be employed to analyze the results of the AHP-assessment questionnaire. The objective is to discern consumer decision-making

behaviors in the context of purchasing sustainable products. In the context of green furniture, we employed Power Choice version 4.1 AHP software to analyze the data collected from consumers who completed the AHP-assessment questionnaire.

G. Step 7 is documenting behaviors and insights.
We document the identified decision-making behaviors and insights derived from the analysis of the AHP-assessment results in this step. By offering a comprehensive overview of consumer preferences and tendencies, we aim to highlight the importance of factors that influence their choices in favor of sustainable products.

H. Step 8 is validating behaviors with additional data.
Cross-reference the constructed decision-making behaviors with external sources or supplementary data to validate the reliability and accuracy of the identified consumer preferences. Adjust the behaviors as needed based on the insights gained.

I. Step 9 is drawing conclusions and recommendations.
Draw conclusive findings (Table 4) from the constructed consumer decision-making behaviors and provide recommendations for businesses and marketers looking to align their strategies with sustainable product preferences. Summarize the implications and actionable insights derived from the AHP-assessment results. Table 5 illustrates that, in the context of green furniture, the AHP identified five pivotal factors that affect consumers' decisions to buy sustainable products. These factors are cultural influence (A3), critical thinking (B3), innovative eco-friendly features (C3), environmental consciousness (D2), and authenticity (E1).

Table 4. Consumers' decision-making behaviors and the important factors.

Cognitive Dimensions	No.	Impactor Factors	Index		Whole		C.I. Value	C.R. Value
			Weight	Order	Weight	Order		
Awareness [A]	[A1]	Perception	0.275	3	0.110	4	0.02	0.034
	[A2]	Values Alignment	0.316	2	0.121	2		
	[A3]	Cultural Influence	0.369	1	0.139	1		
	[A4]	Corporate Transparency and Communication	0.223	4	0.020	16		
Knowledge [B]	[B1]	Education	0.291	2	0.049	8	0.02	0.034
	[B2]	Product Information	0.132	3	0.023	15		
	[B3]	Critical Thinking	0.584	1	0.105	3		
	[B4]	Certifications and Standards	0.083	4	0.018	17		
Perceived Value [C]	[C1]	Product Transparency	0.281	3	0.037	14	0.01	0.017
	[C2]	Brand Reputation	0.235	4	0.012	20		
	[C3]	Innovative Eco-friendly Features	0.385	1	0.052	7		
	[C4]	Affordability and Long-Term Benefits	0.332	2	0.034	13		
Personal Values [D]	[D1]	Ethical Alignment	0.185	4	0.016	18	0.00	0.00
	[D2]	Environmental Consciousness	0.452	1	0.078	5		
	[D3]	Social Impact	0.267	2	0.049	9		
	[D4]	Quality and Longevity	0.263	3	0.042	12		
Emotional Connection [E]	[E1]	Authenticity	0.42	1	0.073	6	0.00	0.00
	[E2]	Transparency	0.272	3	0.046	10		
	[E3]	Storytelling	0.287	2	0.045	11		
	[E4]	Positive Associations	0.144	4	0.013	19		

Table 5. The significant factors.

Cultural Influence [A3]
Critical Thinking [B3]
Innovative Eco-friendly Features [C3]
Environmental Consciousness [D2]
Authenticity [E1]

4.4. Using DNNs to IDENTIFY the Factors Influencing Consumer Decision-Making Behaviors in Purchasing Sustainable Products

Here is a framework (Figure 8) of the descriptions for converting a consumer's decision-making behaviors in purchasing sustainable products obtained from the AHP-assessment questionnaire into DNNs technology for learning prediction. By following this framework, we can effectively convert significant factors from the AHP-assessment questionnaire results into a DNNs model for predicting the importance of significant factors.

A. Step 1 is data collection and preprocessing.
   - Gathering the important factors: Begin by gathering key factors. In the case of this research on green furniture, collect these factors according to their weights, as indicated in Table 4, derived from the AHP analysis. The noteworthy factors collected are presented in Table 5;
   - Gathering the data for training and verifying: Start by collecting responses for the identified key factors. In this research case of green furniture, we gathered 150 pieces of data to train and validate the DNNs model, aiming to identify the factors that influence consumers' decision-making behaviors. The 150 pieces of data represent the response scores of each subject to crucial factors listed in Table 4, such as awareness, knowledge, perceived value, personal evaluation, proportion of values, and emotional connection. Out of the 150 pieces of data, 142 are available for analysis. The information provided is derived from the evaluation conducted with 150 consumers experienced in purchasing eco-friendly furniture. Their objective was to assess the five significant factors outlined in Table 5. Among this subset, 120 pieces will be used for model training, while the remaining 22 pieces will be employed for model verification.

B. Step 2 is feature extraction.
   Identify pertinent features within the questionnaire data that significantly contribute to comprehending the key factors influencing decision-making behaviors in the purchase of sustainable products. These identified features will function as input variables for the DNNs model, constituting the input layer of the said model [36,49]. In the context of this research on green furniture, awareness, knowledge, perceived value, personal evaluation of the proportion of values, and emotional connection will serve as input variables (comprising the input layer) for the DNNs model.

C. Step 3 is data encoding.
   Encode categorical variables and convert textual responses into numerical representations suitable for DNNs input. This step is crucial for ensuring the model can effectively learn behaviors from the data.

D. Step 4 is model architecture design.
   Develop the architecture of the DNNs. Define the number of layers, neurons in each layer, and activation functions. Consider using techniques such as dropout and batch normalization to enhance the model's generalization capabilities. According to Cybenko [50], Horink et al. [51], and Zhang et al. [52], the hidden layer of the DNNs model is set to one layer. The number of neurons in this hidden layer was tested under four conditions: 7, 8, 9, and 10. In the DNNs model, the input layer neurons were set to five, while the output layer neurons were set to one. Among them, each of the five neurons in the input layer corresponds to five input variables, namely awareness, knowledge, perceived value, personal evaluation of the proportion of

values, and emotional connection. One neuron in the output layer is set to two situations: "important" and "unimportant". The model of DNNs is illustrated in Figure 9.

E. Step 5 is training the DNNs.
Split the dataset into training and validation sets. Train the DNNs using the training set, adjusting the model parameters iteratively to optimize performance. Monitor the validation set for overfitting and adjust the model accordingly. The training results of the DNNs determining the importance of factors are displayed in Table 6. Table 6 shows the training results and verification results of DNNs determining the importance of factors. It can be seen that machine-learning algorithms, particularly DNNs, exhibit remarkable predictive power by effectively capturing complex nonlinear effects of predictor variables. This is evident in the analysis of data from multiple experiments, where the number of neurons in a hidden layer varies (Table 6). For instance, when the number of neurons is seven, eight, or nine, and the learning rate varies between 0.01 and 0.3, the training and testing root mean square errors (RMSE) of the DNNs demonstrate clear patterns. As the number of neurons increases, the RMSE tends to decrease, indicating improved model performance. Similarly, as the learning rate increases, the RMSE initially decreases, indicating faster learning. But, it then increases, suggesting overfitting. These findings highlight the ability of ML algorithms to capture the intricate relationships within data, enabling accurate predictions even in complex scenarios.

F. Step 6 is hyperparameter tuning.
Fine-tune the hyperparameters, such as learning rate, batch size, and the number of epochs, to achieve optimal model performance. Utilize techniques like grid search or random search to efficiently explore the hyperparameter space. As suggested by Rumelhart et al. [53], in this research on green furniture, the learning rate of our DNNs model will be tested at 0.01, 0.1, 0.2, and 0.3. In terms of network training criteria, we use the RMSE (root mean squared error) value of the training data, with the condition being less than or equal to 0.0001. In this case, the maximum training iterations are set to 1000. The network mode with the smallest RMSE value among the training data will be considered the best.

G. Step 7 is model validation.
Validate the trained DNNs using a separate test dataset not used during training or validation. Ensure the model generalizes well to unseen data, reflecting its ability to predict decision-making behaviors in real-world scenarios. The verification results of DNNs determining the importance of factors are displayed in Table 6. Table 6 displays the results indicating that DNNs exhibit the lowest training RMSE value (0.040181) and testing RMSE value (0.043179) when the hidden layer comprises nine neurons and the learning rate is set at 0.2. These findings suggest that DNNs demonstrate optimal learning effectiveness under the specified conditions of a hidden layer with nine neurons and a learning rate of 0.2.

H. Step 8 is the interpretability analysis.
Conduct an interpretability analysis to understand how the DNNs make predictions based on the consumer's decision-making behaviors. This step enhances transparency and provides insights into the factors influencing the model's decisions. In this instance, it is evident from Table 6 that DNNs exhibit a high level of accuracy in predicting the significance of factors that influence consumers' decision-making behaviors in purchasing sustainable products.

I. Step 9 is deployment and continuous monitoring.
Deploy the trained DNNs into a production environment. Implement continuous monitoring to track their performance over time and update the model as needed based on evolving decision-making behaviors or changes in the sustainable product landscape. In this case, it is evident that the hybrid approach exhibits high accuracy in assessing the importance of factors that influence consumers' decision-making

behaviors when purchasing sustainable products. This indicates that the hybrid approach serves as a valuable tool for evaluating the significance of influencing factors, and it is effective in practice. Table 7 illustrates that, in the context of green furniture, DNNs predict that the factors with significant impacts on consumers' purchases of sustainable products are cultural influence (A3), critical thinking (B3), innovative eco-friendly features (C2), and environmental consciousness (D2).

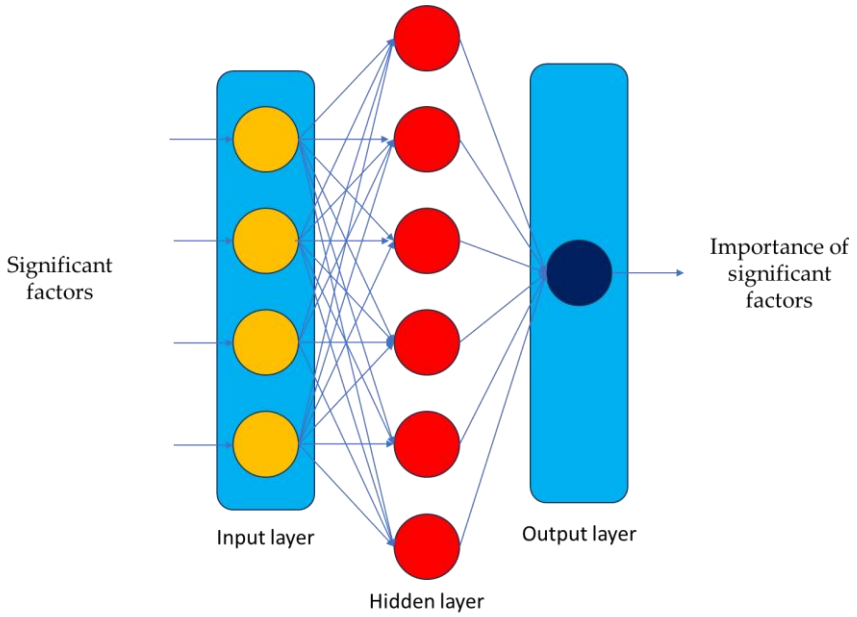


Figure 8. The framework for using DNNs to identify the importance of factors.

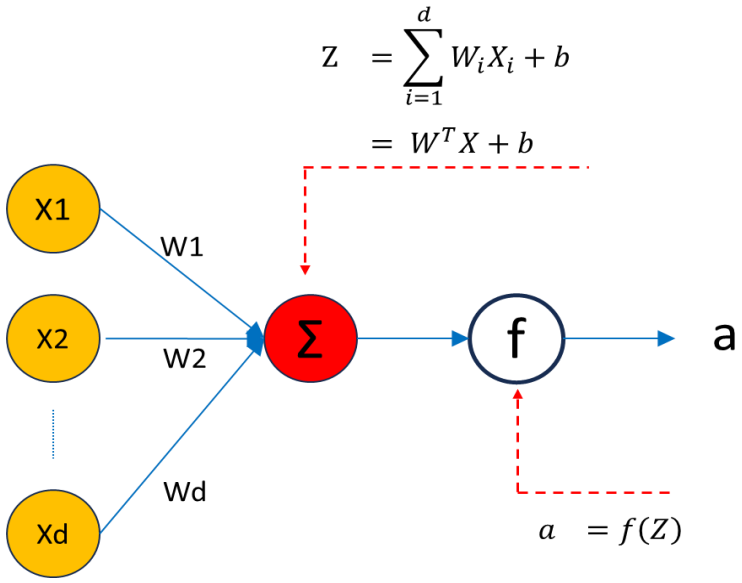


Figure 9. The architecture of DNNs.

Table 6. Training results and verification results of DNNs determining the importance of factors.

Number of Neurons in This Hidden Layer	Learning Rate	Training RMSE	Testing RMSE
7	0.01	0.062155	0.063179
	0.1	0.053871	0.057982
	0.2	0.042351	0.043527
	0.3	0.044213	0.052183
8	0.01	0.062738	0.062432
	0.1	0.053179	0.058943
	0.2	0.052322	0.053174
	0.3	0.051339	0.052114
9	0.01	0.062909	0.063760
	0.1	0.054813	0.052213
	* 0.2	0.040181	0.043179
	0.3	0.043332	0.523851
10	0.01	0.063419	0.062149
	0.1	0.051823	0.052179
	0.2	0.043158	0.053117
	0.3	0.042179	0.044892

* For the best training effect.

Table 7. The importance of significant factors.

Cultural Influence [A3] *
Critical Thinking [B3] *
Innovative Eco-friendly Features [C3] *
Environmental Consciousness [D2] *
Authenticity [E1]

* An important impact on consumers purchasing sustainable products.

4.5. Verifying

A hybrid approach employs a comprehensive strategy to discern the significance of the factors influencing consumer decision-making behavior in the acquisition of sustainable products. The primary function of this approach is to identify key aspects that play a crucial role in shaping consumer preferences toward sustainable choices. To validate the efficacy of the hybrid approach, a specific case is utilized, focusing on environmentally friendly shoes (Figure 10). The verification process involves executing the hybrid approach specifically in this case, examining the intricacies of consumer decision-making regarding eco-friendly footwear. Through this single execution, the effectiveness of the hybrid approach in revealing insights into the importance of factors influencing consumer behavior is evaluated. The outcome of this verification process yields crucial findings, providing a comprehensive understanding of the pivotal considerations that sway consumers toward the purchase of environmentally friendly shoes.



Figure 10. The photos of environmentally friendly shoes.

Table 8 outlines the significant factors that influence consumers to purchase environmentally friendly shoes. There are six key factors that impact consumers' decisions to buy such shoes: sustainability and eco-friendly materials, transparent and ethical manufacturing practices, durability and longevity, carbon footprint and reduced emissions, certifications and eco-labels, and innovative design and fashion appeal. The importance of these six factors is illustrated in Table 9, which indicates that consumers consider sustainability and eco-friendly materials, transparent and ethical manufacturing practices, durability and longevity, carbon footprint and reduced emissions, certifications, and eco-labels as crucial elements when making environmentally conscious footwear purchases. The inspiration and significance of the five important considerations that influence consumers to purchase environmentally friendly shoes lie in their collective impact on fostering sustainable consumer behavior [54]. First, sustainability and eco-friendly materials, such as recycled plastic, organic cotton, or plant-based alternatives, appeal to the growing environmental consciousness among consumers [55]. This awareness extends to the entire lifecycle of a product, as highlighted by the second consideration—transparent and ethical manufacturing practices [56]. Brands that prioritize fair labor conditions, reduce their carbon footprint, and minimize waste generation build trust with environmentally conscious consumers. This is further validated by certifications like Fair Trade or B Corp status [57]. Emphasizing durability and longevity, the third factor, aligns with a sustainable mindset, reducing the need for frequent replacements and lowering overall resource consumption [58]. Additionally, addressing consumers' concerns about the carbon footprint, the fourth factor, shows a commitment to environmental responsibility, capturing the attention of those looking to minimize their own impact [59]. Finally, recognizable certifications and eco-labels, the fifth factor, provide a tangible and trustworthy way for consumers to identify environmentally friendly products, influencing their purchasing decisions [60]. Together, these considerations underscore the importance of aligning consumer choices with sustainability principles in the footwear industry.

Table 8. The significant factors of environmentally friendly shoes.

No.	Significant Factors	Content
1	Sustainability and Eco-Friendly Materials	Consumers are increasingly conscious of the environmental impact of their purchases. Shoes made from sustainable and eco-friendly materials, such as recycled plastic, organic cotton, or plant-based alternatives like bamboo or cork, are likely to attract environmentally conscious consumers. Highlighting these materials in marketing and product descriptions can significantly influence purchasing decisions.
2	Transparent and Ethical Manufacturing Practices	Consumers are more interested in the entire lifecycle of a product, including how it was manufactured. Brands that prioritize transparency and adopt ethical manufacturing practices, such as fair labor conditions, reduced carbon footprint, and minimal waste generation, can build trust with environmentally conscious consumers. Certifications like Fair Trade or B Corp status can further validate a brand's commitment to ethical practices.

Table 8. *Cont.*

No.	Significant Factors	Content
3	Durability and Longevity	Emphasizing the durability and longevity of environmentally friendly shoes can appeal to consumers looking to make sustainable choices. If a pair of shoes is well-made and designed to last, it aligns with a more sustainable mindset by reducing the need for frequent replacements, thereby lowering overall resource consumption.
4	Carbon Footprint and Reduced Emissions	Consumers are increasingly concerned about the carbon footprint that is associated with the products they buy. Brands that actively work to reduce their carbon emissions, whether through sustainable sourcing, energy-efficient manufacturing processes, or carbon-offset programs, can capture the attention of environmentally conscious consumers who are looking to minimize their own carbon footprint.
5	Certifications and Eco-Labels	Recognizable certifications and eco-labels, such as the Global Organic Textile Standard (GOTS) or the Forest Stewardship Council (FSC) certification, provide a quick and easy way for consumers to identify environmentally friendly products. Including such certifications on shoe labels or marketing materials can boost consumer confidence and influence their decision to purchase.
6	Innovative Design and Fashion Appeal	The misconception that environmentally friendly products lack style or trendiness is fading away. Brands that invest in innovative design and prioritize fashion appeal alongside sustainability can attract a broader consumer base. By demonstrating that eco-friendly shoes can be both stylish and conscientious, brands can break down barriers and encourage more consumers to choose environmentally friendly options.

Table 9. The importance of significant factors of environmentally friendly shoes.

Sustainability and Eco-Friendly Materials *
Transparent and Ethical Manufacturing Practices *
Durability and Longevity *
Carbon Footprint and Reduced Emissions *
Certifications and Eco-Labels *
Innovative Design and Fashion Appeal

* An important impact on consumers purchasing sustainable products.

5. Discussion

5.1. The Inspiration of the Factors Influencing Consumers' Decision-Making Behaviors to Buy Sustainable Products

The innovative hybrid approach has shed light on pivotal factors that significantly influence consumers when making choices to purchase sustainable products. These key determinants delve beyond the surface, revealing a profound interplay of elements that resonate with conscious consumerism. The meanings of the factors influencing consumers' decision-making behaviors to buy sustainable products are the following aspects.

1. At the forefront, perception emerges as a crucial factor. The way consumers perceive a product's sustainability is instrumental in their decision-making process. This goes hand in hand with values alignment, where consumers seek products that align with their personal values and ethical beliefs [61]. The hybrid approach recognizes that understanding and resonating with consumers on a values level is pivotal in fostering long-term loyalty;
2. Critical thinking plays a pivotal role in this landscape, encouraging consumers to question and evaluate the sustainability claims of products [62]. The hybrid approach recognizes the importance of nurturing a consumer base that thinks critically about the environmental implications of their purchases;

3. Innovative eco-friendly features take center stage as consumers are drawn to products that not only align with their values but also incorporate cutting-edge eco-friendly technologies [63]. The hybrid approach acknowledges the significance of innovation in creating products that resonate with environmentally conscious consumers;
4. Ethical alignment and environmental consciousness underscore the hybrid approach's holistic understanding. Consumers are increasingly seeking products that not only uphold conventional ethical standards but also contribute positively to the environment [64]. This dual focus caters to the evolving preferences of conscious consumers;
5. Social impact emerges as a compelling factor, with consumers preferring products that contribute positively to society [22]. The hybrid approach recognizes that consumers are not only motivated by personal benefits but also by a desire to make a positive impact on the broader community;
6. In the realm of sustainability-focused consumer behavior, the notion of price holds a unique position. While conventionally viewed as a crucial factor in purchasing decisions, our study's findings reveal a surprising revelation: price was not prominently featured among the considerations of consumers inclined towards sustainability. This anomaly can be attributed to a compelling rationale: individuals who prioritize sustainability in their purchasing choices are often willing to pay a premium for products that align with their environmental and ethical values. Consequently, while price undoubtedly retains its importance as a consideration, it may not hold the primary position for this particular consumer segment. Instead, factors such as environmental impact, ethical sourcing practices, and product quality emerge as paramount in shaping the decision-making process of sustainability-minded consumers. These elements tend to overshadow the significance of price, suggesting that, for this demographic, the broader impacts and ethical dimensions of their purchases carry greater weight than the financial aspect alone. This revelation sheds light on the complex interplay of values, preferences, and priorities that underpin sustainable consumption patterns, highlighting the multifaceted nature of consumer behavior in this domain. To support the findings mentioned in the paragraph, several documents can be referenced.
    - Consumer surveys are surveys on consumer behavior toward sustainable products that can offer direct evidence of the factors that influence purchasing decisions. For example, Nguyen, et al. (2020) investigated sustainable consumer behavior, the state of the sustainable fashion industry, environmental awareness, and the gap between environmental awareness and consumer actions [65]. Such a survey may indicate that price is not the primary consideration for consumers who prioritize sustainability;
    - Market-research reports are reports that analyze consumer trends and preferences in sustainable products and can also provide valuable insights. For instance, Yusoff et al. (2023) conducted a systematic review and proposed a research agenda on the drivers of green purchasing behavior [66]. Such a report highlights the increasing significance of sustainability factors compared to price in purchasing decisions;
    - Case studies are case studies of companies that have successfully marketed sustainable products that can provide insights into consumer behavior. For example, Witek (2020) conducted a study on green marketing, focusing on the environmentally friendly attributes of products and their impact on purchasing decisions [67]. This study may demonstrate how emphasizing environmental and ethical values can outweigh price concerns;
    - Academic studies comprise academic research in the field of sustainable consumption that can offer theoretical frameworks and empirical evidence supporting the notion that sustainability-minded consumers prioritize factors other than price. For example, Hazaea et al. (2022) conducted research on green purchasing and past, present, and future trends [68].

- Industry publications are publications in the sustainability and consumer goods industries that may discuss trends and strategies related to pricing and consumer behavior. These sources can provide additional context and support for the findings.

These documents support the paragraph's findings by demonstrating that, in the realm of sustainability-focused consumer behavior, price is not the primary factor influencing purchasing decisions. Instead, factors such as environmental impact, ethical sourcing practices, and product quality are of greater importance to sustainability-minded consumers. This evidence suggests a shift in consumer priorities towards broader impacts and ethical dimensions, highlighting the complexity of sustainable consumption patterns.

In conclusion, one possible way forward could be to explore a combined approach that examines how different factors influence consumer choices toward sustainable products. This approach might consider areas like perception, values, and education. It has the potential to provide businesses with valuable information as they navigate the growing interest in sustainable options.

5.2. The Difference in Effectiveness between the Innovative Hybrid Approach and Conventional Methods in Identify the Key Factors

This text aims to elucidate the nuanced differences between the hybrid approach and conventional methods, shedding light on the importance of factors influencing consumers to choose sustainable products. First, the effectiveness of the innovative hybrid approach in discerning the importance of factors influencing consumer decision-making behavior in the realm of sustainable product purchases stands in stark contrast to the limitations of existing methods. This discrepancy arises primarily from the hybrid approach's ability to holistically incorporate various facets, such as perception, values alignment, education, product information, critical thinking, and product transparency. Unlike conventional approaches that may focus on singular aspects, the hybrid approach recognizes the intricate interplay of these elements in shaping consumer choices, providing a more comprehensive understanding of the decision-making landscape.

One of the noteworthy distinctions lies in the hybrid approach's capacity to unravel hidden meanings within consumer preferences. By simultaneously considering factors like brand reputation, innovative eco-friendly features, ethical alignment, environmental consciousness, and social impact, this approach unveils the nuanced layers that underlie consumer decision-making. These hidden meanings, often overlooked by more conventional methods, offer valuable insights into the complex interconnections among different factors and their relative significance in driving sustainable product choices.

Furthermore, the implications of these differences extend to the strategic implications for businesses. The hybrid approach can not only analyze key factors reliably but also predict important factors that could influence consumers to buy sustainable products. For instance, understanding how authenticity, transparency, and storytelling converge can provide a roadmap for crafting compelling narratives that resonate with environmentally conscious consumers. This strategic advantage allows businesses to tailor their marketing efforts more effectively, aligning with the multifaceted nature of consumer preferences in the sustainable product domain.

In summary, the hybrid approach's efficacy in discerning the importance of factors influencing consumer decision-making behavior surpasses that of existing methods by embracing a perspective. The hidden meanings and implications of these differences lie in the intricate connections between various factors, offering businesses unparalleled insights into the dynamic landscape of sustainable product choices and enabling them to navigate this terrain strategically and authentically.

To support the argument outlined in the paragraph, several studies can be examined to showcase the effectiveness of the hybrid approach compared to conventional methods for understanding and influencing consumer behavior towards sustainable products.

- Research Study on Consumer Behavior in Sustainable Product Purchases by Pal, et al., (2021) investigated the antecedents of consumer-electronics IoT-device purchase decisions through a mixed-methods study [69]. This study provides empirical evidence of how the hybrid approach outperforms conventional methods in discerning factors influencing consumer decision-making behavior. By analyzing a diverse range of factors such as perception, values alignment, education, product information, critical thinking, and product transparency, the study illustrates how the hybrid approach offers a more comprehensive understanding of the decision-making landscape. This aligns with the argument that the hybrid approach holistically incorporates various facets, unlike conventional methods that may focus on singular aspects;
- Market Analysis Report on Sustainable Product Purchases by Ashwini (2023), along with others, conducted research on the development of a new conceptual model, namely the "Consumers' Purchase Intention towards Eco-friendly Bags" [70]. The market-analysis report highlights the nuanced distinctions brought about by the hybrid approach in unraveling hidden meanings within consumer preferences. Through the simultaneous consideration of factors like brand reputation, eco-friendly features, ethical alignment, environmental consciousness, and social impact, the report demonstrates how the hybrid approach unveils the complex interconnections among different factors influencing sustainable product choices. This supports the argument that the hybrid approach uncovers hidden meanings often overlooked by conventional methods, providing valuable insights into consumer decision-making;
- Case Study on Marketing Strategies for Sustainable Products by Sweta Leena Hota (2024) once discussed the impact of sustainable marketing strategies on consumer behavior [71]. The case study delves into the strategic implications of the differences between the hybrid approach and conventional methods for businesses. By identifying key factors and elucidating their relative weights and interactions, the case study illustrates how understanding authenticity, transparency, and storytelling can inform the crafting of compelling narratives that resonate with environmentally conscious consumers. This corroborates the argument that the strategic advantage offered by the hybrid approach enables businesses to tailor their marketing efforts effectively to align with multifaceted consumer preferences in the sustainable product domain.

In summary, these documents provide concrete evidence that supports the argument that the hybrid approach stands out from conventional methods by offering a more comprehensive understanding of consumer behavior toward sustainable products. Through empirical research, market analysis, and case studies, the effectiveness and strategic implications of the hybrid approach are underscored, highlighting its significance in today's consumer landscape focused on sustainability.

5.3. Contributions of Hybrid Methods to Knowledge Advancement

Hybrid-methods research is a methodological approach that integrates qualitative and quantitative data collection and analysis techniques to offer a more exhaustive and nuanced comprehension of research inquiries. This surpasses conventional single-method designs and furnishes a deeper understanding of intricate phenomena.

Hybrid-methods research yields several significant contributions to knowledge advancement. 1. The first is triangulation; by triangulating findings from various data sources, hybrid-methods research enhances the credibility and reliability of the research. 2. The second is comprehensiveness; hybrid-methods research fosters a more comprehensive understanding of research questions by leveraging the strengths of both qualitative and quantitative data. 3. The third is contextualization; hybrid-methods research contextualizes quantitative findings by offering qualitative insights into the meaning and relevance of the data. 4. The fourth is explanation; hybrid-methods research elucidates quantitative findings by providing qualitative insights into the underlying mechanisms and processes that engender the data. 5. The fifth is theory development; hybrid-methods research aids in

theory development by supplying rich, contextualized data that can refine existing theories or engender new ones.

Hybrid-methods research has been applied to investigate a broad spectrum of topics, including 1. education, by assessing the efficacy of educational interventions, determining factors influencing student achievement, and exploring the experiences of students and teachers; 2. healthcare, by evaluating the effectiveness of healthcare interventions, identifying factors impacting patient outcomes, and examining the experiences of patients and healthcare providers; and 3. business, by analyzing the effectiveness of marketing campaigns, identifying factors influencing customer satisfaction, and investigating the experiences of employees and customers.

Hybrid-methods research stands as a potent instrument for advancing knowledge. Increasingly embraced across diverse disciplines, this approach amalgamates qualitative and quantitative data collection and analysis techniques to furnish a more comprehensive understanding, thus gaining popularity in research endeavors.

5.4. Potential Limitations or Challenges Encountered during the Research Process and Recommendations for Future Research Directions

While the hybrid approach presents a promising strategy for understanding consumer behavior toward sustainable products, it may face several limitations or challenges. One potential challenge is the complexity of integrating multiple factors. Balancing various elements, such as perception, values alignment, education, and product information, could be challenging, requiring a nuanced and comprehensive approach. Additionally, the hybrid approach's effectiveness may depend heavily on the availability and accuracy of data related to consumer behavior, which could pose challenges in certain contexts or industries. During the research process, potential limitations or challenges may have included accessing and analyzing data related to consumer behavior toward sustainable products. Ensuring the reliability and validity of the data, especially in the context of the hybrid approach, could have been challenging. Additionally, integrating and interpreting findings from diverse sources and methodologies may have posed challenges to synthesizing a cohesive understanding of consumer decision-making behavior.

Future research could focus on addressing the identified limitations and challenges of the hybrid approach. This could involve developing more sophisticated methodologies for integrating and analyzing multiple factors, as well as exploring innovative data-collection techniques. Additionally, future research could aim to validate the findings of the hybrid approach across different consumer segments and cultural contexts to enhance its generalizability and applicability. Expanding the research to include a more extensive and diverse sample of consumers could add depth and relevance to the discussion section. Additionally, future studies could explore the long-term impact of the hybrid approach on consumer behavior and market trends. This could involve longitudinal studies or comparative analyses with Conventional methods to assess the effectiveness and sustainability of the hybrid approach over time.

6. Conclusions

This study explores technical information and the standard operating procedure (SOP) considerations related to identifying the importance of factors influencing consumer decision-making behaviors when purchasing sustainable products. Our investigation specifically examines the impact of technologies, such as AHP and DNNs, on predicting these behaviors. The study's contribution lies in enhancing methodological frameworks that facilitate the identification of the importance of factors influencing consumer decision-making behaviors in sustainable product purchases. This is achieved through four key aspects: (1). conducting a critical literature review on the concept of consumer decision-making behaviors in purchasing sustainable products and the methodological frameworks for their development; (2). defining a methodological framework for identifying the importance of factors influencing consumer decision-making behaviors in purchasing

sustainable products and outlining the implementation method to provide designers and companies engaged in this prediction with a standardized ideation process; (3). presenting case studies on green furniture; and (4). offering suggestions and outlining future consumer decision-making behaviors in the purchase of green furniture, drawing insights from the perspective of sustainable product professionals. The findings of the study provide valuable insights into enhancing tools for creating sustainable products. They also offer guidance on how future professionals, concerned with understanding consumer decision-making behavior in purchasing sustainable products, can collaborate to maximize the benefits of sustainability in the development of strategies for sustainable products. Bridging the gap between these insights and practical manufacturing represents a significant research contribution to both the theoretical and practical aspects of sustainable product generation processes and sustainable product design.

The adoption of a hybrid approach to identify the factors influencing consumer decision-making behavior in the purchase of sustainable products has significant social and economic implications. This methodology integrates both quantitative and AI research methods, allowing for a comprehensive analysis of the diverse factors that shape consumer choices in favor of environmentally friendly purchases. Socially, this approach promotes a deeper understanding of the underlying motivations and attitudes driving sustainable consumerism, fostering awareness and informed decision making. Economically, businesses can leverage these insights to tailor their strategies, enhance product offerings, and meet the growing demand for sustainable products. The hybrid approach not only contributes to environmentally responsible consumer behavior but also presents opportunities for economic growth and innovation within the market for sustainable goods. Ultimately, this holistic understanding of consumer decision-making behavior is essential for creating a more sustainable and socially responsible marketplace.

Funding: This research received no external funding.

Institutional Review Board Statement: This paper does not involve medical experiments. The questionnaire survey for data collection has been approved by the Ethical Committee of the Engineering College, Chin-Yi University of Technology, on 14 July 2023; the number of authorization is 0097.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Due to privacy, study details data cannot be provided.

Conflicts of Interest: The author declares no conflict of interest.

Appendix A. AHP-Assessment Questionnaire

A. AHP questionnaire for assessing the "The factors of Awareness dimension [A] "

impact factors	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	impact factors
	extremely important		very important		essential important		weak important		equally important		weak important		essential important		very important		extremely important	
[A1]																		[A2]
[A1]																		[A3]
[A1]																		[A4]

B. AHP questionnaire for assessing the "The factors of Knowledge dimension [B] "

impact factors	9 extremely important	8	7 very important	6	5 essential important	4	3 weak important	2	1 equally important	2	3 weak important	4	5 essential important	6	7 very important	8	9 extremely important	impact factors
[B1]																		[B2]
[B1]																		[B3]
[B1]																		[B4]

C. AHP questionnaire for assessing the "The factors of Perceived Value dimension [C] "

impact factors	9 extremely important	8	7 very important	6	5 essential important	4	3 weak important	2	1 equally important	2	3 weak important	4	5 essential important	6	7 very important	8	9 extremely important	impact factors
[C1]																		[C2]
[C1]																		[C3]
[C1]																		[C4]

D. AHP questionnaire for assessing the "The factors of Personal Values dimension" [D]

impact factors	9 extremely important	8	7 very important	6	5 essential important	4	3 weak important	2	1 equally important	2	3 weak important	4	5 essential important	6	7 very important	8	9 extremely important	impact factors
[D1]																		[D2]
[D1]																		[D3]
[D1]																		[D4]

E. AHP questionnaire for assessing the "The factors of Emotional Connection dimension [E] "

impact factors	9 extremely important	8	7 very important	6	5 essential important	4	3 weak important	2	1 equally important	2	3 weak important	4	5 essential important	6	7 very important	8	9 extremely important	impact factors
[E1]																		[E2]
[E1]																		[E3]
[E1]																		[E4]

References

1. Bangsa, A.B.; Schlegelmilch, B.B. Linking sustainable product attributes and consumer decision-making: Insights from a systematic review. *J. Clean. Prod.* **2020**, *245*, 118902. [CrossRef]
2. Lagnaoui, T. CSR and Business Sustainability in the Finnish Textile Industry: A Path to a Sustainable Future. 2023. Available online: https://www.theseus.fi/handle/10024/793524 (accessed on 2 January 2024).
3. U.S. Organic Sales Soar to New High of Nearly $62 Billion in 2020. Available online: https://ota.com/news/press-releases/21755 (accessed on 2 January 2024).
4. Kararia, S. Sustainable Packaging: A Consumer's Perspective. 2023. Available online: http://urn.fi/URN:NBN:fi:jyu-202306203984 (accessed on 2 January 2024).
5. Abbas, Q. Sustainable Marketing in the Age of Environmental Consciousness. *JETIR* **2024**, *11*, 317–326.
6. Nguyen, T.N.; Lobo, A.; Greenlan, S. Pro-environmental purchase behaviour: The role of consumers' biospheric values. *J. Retail. Consum.* **2016**, *33*, 98–108. [CrossRef]
7. Guo, R.; Lee, H.L.; Swinney, R. Responsible sourcing in supply chains. *Manag. Sci.* **2015**, *62*, 2722–2744. [CrossRef]
8. Dropulić, B.; Krupka, Z. Are consumers always greener on the other side of the fence? Factors that influence green purchase intentions–the context of croatian and swedish consumers. *Mark.-Tržište* **2020**, *32*, 99–113. [CrossRef]
9. Steiner, B.E.; Peschel, A.O.; Grebitus, C. Multi-Product Category Choices Labeled for Ecological Footprints: Exploring Psychographics and Evolved Psychological Biases for Characterizing Latent Consumer Classes. *Ecol. Econ.* **2017**, *140*, 251–264. [CrossRef]
10. Savale, T.K.; Anand, B.; Varalaxmi, P.; Brahma, A.; Quaye, J.A. Green Marketing Strategies: Assessing Consumer Perception and Adoption of Eco-friendly Products. *Remit. Rev.* **2023**, *8*.
11. Borui, C. Sustainable Business Practices: A Case Study Approach. *Int. J. Open Publ. Explor.* **2014**, *2*, 20–26.
12. Kumar, P.; Ghodeswar, B.M. Factors affecting consumers' green product purchase decisions. *Mark. Intell. Plan.* **2015**, *33*, 330–347. [CrossRef]
13. Fligstein, N. The Spread of the Multidivisional Form Among Large Firms, 1919-1979. *Am. Sociol. Rev.* **1985**, *50*, 377–391. [CrossRef]
14. White, K.; Habib, R.; Hardisty, D.J. How to SHIFT consumer behaviors to be more sustainable: A literature review and guiding framework. *J. Mark.* **2019**, *83*, 22–49. [CrossRef]
15. Hynds, E.J.; Brandt, V.; Burek, S.; Jager, W.; Knox, P.; Parker, J.P.; Schwartz, L.; Taylor, J.; Zietlow, M. A Maturity Model for Sustainability in New Product Development. *Res.-Technol. Manag.* **2014**, *57*, 50–57. [CrossRef]
16. Canals, J. Managing corporate growth. 1999. *J. Open Publ. Explor.* **2014**, *2*, 138–145.
17. Wang, H.; Ma, B.; Bai, R. How Does Green Product Knowledge Effectively Promote Green Purchase Intention? *Sustainability* **2019**, *11*, 1193. [CrossRef]
18. Maniatis, P. Investigating factors influencing consumer decision-making while choosing green products. *J. Clean. Prod.* **2016**, *132*, 215–228. [CrossRef]
19. Kohavi, R.; Longbotham, R.; Sommerfield, D.; Henne, R.M. Controlled experiments on the web: Survey and practical guide. *Data Min. Knowl. Discov.* **2009**, *18*, 140–181. [CrossRef]
20. The Role of Qualitative Research in Identifying Consumer Insights. Available online: https://fastercapital.com/topics/the-role-of-qualitative-research-in-identifying-consumer-insights.html (accessed on 2 January 2024).
21. Larsen, N.M.; Sigurdsson, V.; Breivik, J. The use of observational technology to study in-store behavior: Consumer choice, video surveillance, and retail analytics. *Behav. Anal.* **2017**, *40*, 343–371. [CrossRef]
22. ElHaffar, G.; Durif, F.; Dubé, L. Towards closing the attitude-intention-behavior gap in green consumption: A narrative review of the literature and an overview of future research directions. *J. Clean. Prod.* **2020**, *275*, 122556. [CrossRef]
23. Gatersleben, B.; Steg, L.; Vlek, C. Measurement and Determinants of Environmentally Significant Consumer Behavior. *Environ. Behav.* **2002**, *34*, 335–362. [CrossRef]
24. Shocker, A.D.; Ben-Akiva, M.; Boccara, B.B.; Nedungadi, P. Consideration set influences on consumer decision-making and choice: Issues, models, and suggestions. *Mark. Lett.* **1991**, *2*, 181–197. [CrossRef]
25. Vargas, L.G. An overview of the analytic hierarchy process and its applications. *Eur. J. Oper. Res.* **1990**, *48*, 2–8. [CrossRef]
26. Vaidya, O.S.; Kumar, S. Analytic hierarchy process: An overview of applications. *Eur. J. Oper. Res.* **2006**, *169*, 1–29. [CrossRef]
27. Brunelli, M. *Introduction to the Analytic Hierarchy Process*; Springer: Berlin/Heidelberg, Germany, 2014.
28. Kulakowski, K. *Understanding the Analytic Hierarchy Process*; CRC Press: Boca Raton, FL, USA, 2020.
29. Saaty, T.L. Fundamentals of the Analytic Hierarchy Process. In *The Analytic Hierarchy Process in Natural Resource and Environmental Decision Making*; Springer: Dordrecht, The Netherlands, 2001; pp. 15–35.
30. Saaty, T.L. Decision making with the analytic hierarchy process. *Int. J. Serv. Sci.* **2008**, *1*, 83–98. [CrossRef]
31. Saaty, T.L. *Decision Making for Leaders: The Analytic Hierarchy Process for Decisions in a Complex World*; RWS Publications: Pittsburgh, PA, USA, 2001.
32. Saaty, T.L.; Vargas, L.G. *Models, Methods, Concepts & Applications of the Analytic Hierarchy Process*; Springer: New York, NY, USA, 2012.
33. Brown, R. *Rational Choice and Judgment: Decision Analysis for the Decider*; John Wiley & Sons: Hoboken, NJ, USA, 2005.
34. Hruška, R.; Průša, P.; Babić, D. The use of AHP method for selection of supplier. *Transport* **2014**, *29*, 195–203. [CrossRef]
35. Juang, B.H. Deep neural networks–a developmental perspective. *APSIPA Trans. Signal Inf. Process.* **2016**, *5*, e7. [CrossRef]

36. Chiroma, H.; Abdullahi, U.A.; Abdulhamid, S.M.; Alarood, A.A.; Gabralla, L.A. Progress on Artificial Neural Networks for Big Data Analytics: A Survey. *IEEE Access* **2018**, *7*, 70535–70551. [CrossRef]
37. Sze, V.; Chen, Y.; Yang, T.; Emer, J.S. Efficient Processing of Deep Neural Networks: A Tutorial and Survey. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR), Honolulu, HI, USA, 21–26 July 2017; Volume 105.
38. Miikkulainen, R.; Liang, J.; Meyerson, E.; Rawal, A.; Fink, D.; Francon, O.; Raju, B.; Shahrzad, H.; Navruzyan, A.; Duffy, N.; et al. 14—Evolving deep neural networks. In *Artificial Intelligence in the Age of Neural Networks and Brain Computing*, 2nd ed.; Academic Press: Cambridge, MA, USA, 2024; pp. 269–287.
39. Oh, S.E.; Sunkam, S.; Hopper, N. p-FP: Extraction, Classification, and Prediction of Website Fingerprints with Deep Learning. *Comput. Sci. Cryptogr. Secur.* **2018**. [CrossRef]
40. Hao, P.; Shi, K.; Tian, S.; Wu, F. Uncertainty-aware iterative learning for noisy-labeled medical image segmentation. *IET Image Process.* **2023**, *17*, 3830–3840. [CrossRef]
41. Gidaris, S.; Komodakis, N. Detect, Replace, Refine: Deep Structured Prediction for Pixel Wise Labeling. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR), Honolulu, HI, USA, 21–26 July 2017; p. 5248.
42. Selmy, H.A.; Mohamed, H.K.; Medhat, W. Big data analytics deep learning techniques and applications: A survey. *Inf. Syst.* **2023**, *120*, 102318. [CrossRef]
43. Ye, Y.; Zhang, X.; Sun, J. Automated vehicle's behavior decision making using deep reinforcement learning and high-fidelity simulation environment. *Transp. Res. Part C Emerg. Technol.* **2019**, *107*, 155–170. [CrossRef]
44. Ahmed, S.F.; Alam, M.S.B.; Hassan, M.; Rozbu, M.R.; Ishtiak, T.; Rafa, N.; Mofijur, M.; Shawkat Ali, A.B.M.; Gandomi, A.H. Deep learning modelling techniques: Current progress, applications, advantages, and challenges. *Artif. Intell. Rev.* **2023**, *56*, 13521–13617. [CrossRef]
45. Chou, Y.C.; Chuang, H.H.C.; Chou, P.; Oliva, R. Supervised machine learning for theory building and testing: Opportunities in operations management. *J. Oper. Manag.* **2023**, *69*, 643–675. [CrossRef]
46. Skiera, B.; Reiner, J.; Albers, S. Regression Analysis. In *Handbook of Market Research*; Springer: Cham, Switzerland, 2021.
47. Alexopoulos, E.C. Introduction to Multivariate Regression Analysis. *Hippokratia* **2010**, *14*, 23–28.
48. McDonald, R.P. *Factor Analysis and Related Methods*; Psychology Press: London, UK, 2014.
49. Yang, B. Factor analysis methods. In *Research in Organizations: Foundations and Methods*; Berrett-Koehler Publishers: Oakland, CA, USA, 2005.
50. Cybenko, C. Approximation by superpositions of a sigmoidal function. *Math. Control Signals Syst.* **1989**, *2*, 303–314. [CrossRef]
51. Horink, K. Approximation capabilities of multilayer feedforward networks. *Neural Netw.* **1991**, *4*, 251–257. [CrossRef]
52. Garbin, C.; Zhu, X.; Marques, O. Dropout vs. batch normalization: An empirical study of their impact to deep learning. *Multimed. Tools Appl.* **2020**, *79*, 12777–12815. [CrossRef]
53. Rumelhart, D.E.; Hinton, G.E.; Williams, R.J. Learning representations by back-propagating errors. *Nature* **1986**, *323*, 533–536. [CrossRef]
54. Joshi, Y.; Rahman, Z. Investigating the determinants of consumers' sustainable purchase behaviour. *Sustain. Prod. Consum.* **2017**, *10*, 110–120. [CrossRef]
55. Husu, F. Consumer Perceptions of the Environmental Sustainability of the Clothing Industry and Textile Fibres. Master's Thesis, University of Jyväskylä, Jyväskylä, Finland, 2020.
56. Gunasekaran, A.; Spalanzani, A. Sustainability of manufacturing and services: Investigations for research and applications. *Int. J. Prod. Econ.* **2012**, *140*, 35–47. [CrossRef]
57. Wang, F. Six dilemmas for customer loyalty and sustainability. In *Handbook of Research on Customer Loyalty*; Edward Elgar: Cheltenham, UK, 2022; pp. 258–273.
58. Carlsson, S.; Mallalieu, A. Design for Longevity: A Framework to Support Product Developers in Identifying Products' Optimal Lifetimes. 2021. Available online: https://hdl.handle.net/20.500.12380/302158 (accessed on 2 January 2024).
59. Mohammed, K.S.; Serret, V.; Ben Jabeur, S.; Nobanee, H. The role of artificial intelligence and fintech in promoting eco-friendly investments and non-greenwashing practices in the US market. *J. Environ. Manag.* **2024**, *359*, 120977. [CrossRef]
60. Dauvergne, P.; Jane, L. *Eco-Business: A Big-Brand Takeover of Sustainability*; MIT Press: Cambridge, MA, USA, 2013.
61. Carrington, M.J.; Neville, B.A.; Whitwell, G.J. Lost in translation: Exploring the ethical consumer intention–behavior gap. *J. Bus. Res.* **2014**, *67*, 2759–2767. [CrossRef]
62. Horne, R.E. Limits to labels: The role of eco-labels in the assessment of product sustainability and routes to sustainable consumption. *Int. J. Consum. Stud.* **2009**, *33*, 175–182. [CrossRef]
63. Katsikeas, C.S.; Leonidou, C.N.; Zeriti, A. Eco-friendly product development strategy: Antecedents, outcomes, and contingent effects. *J. Acad. Mark. Sci.* **2016**, *44*, 660–684. [CrossRef]
64. Tezer, A.; Bodur, H.O. The green consumption effect: How using green products improves consumption experience. *J. Consum. Res.* **2020**, *47*, 25–39. [CrossRef]
65. Nguyen, M.; Tong, T. Factors Affecting Consumer Behavior in Purchasing Sustainable Fashion Products. 2020. Available online: https://www.theseus.fi/bitstream/handle/10024/353231/My_Nguyen%20Trang_Tong.pdf?sequence=2&isAllowed=y (accessed on 2 January 2024).
66. Yusoff, N.; Alias, M.; Ismail, N. Drivers of green purchasing behaviour: A systematic review and a research agenda. *F1000Research* **2023**, *12*, 1286. [CrossRef] [PubMed]

67. Witek, L. Green Marketing: The Environmentally-Friendly Attributes of Products and Decision to Purchase. *Folia Oeconomica Stetin.* **2020**, *20*, 451–467. [CrossRef]
68. Hazaea, S.A.; Al-Matari, E.M.; Zedan, K.; Khatib, S.F.; Zhu, J.; Al Amosh, H. Green purchasing: Past, present and future. *Sustainability* **2022**, *14*, 5008. [CrossRef]
69. Pal, D.; Vanijja, V.; Zhang, X.; Thapliyal, H. Exploring the antecedents of consumer electronics IoT devices purchase decision: A mixed methods study. *IEEE Trans. Consum. Electron.* **2021**, *67*, 305–318. [CrossRef]
70. Ashwini, V.; Aithal, P.S. Development of a New Conceptual Model: Consumers' Purchase Intention towards Eco-friendly Bags. *Int. J. Manag. Technol. Soc. Sci.* **2023**, *8*, 154–195. [CrossRef]
71. Hota, S.L. Exploring the Impact of Sustainable Marketing Strategies on Consumer Behavior. *Int. J. Multidiscip. Res. Rev.* **2024**, *3*, 1–7.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.