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Proposing a Value Field Model for Predicting Homebuyers' Purchasing Behavior of Green Residential Buildings: A Case Study in China

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Abstract: Understanding the motivations that stimulate homebuyers' green purchasing behavior can increase market demand for green products, especially considering the comparably low market share of green products worldwide. In this context, various studies have been conducted examining consumers' intentions to pay for green products. Nevertheless, there is still limited research on evaluating homebuyers' purchasing behavior toward green residential buildings. This study argues that the value of green residential buildings (GRBs) affects their adoption, and thus exerts an invisible force on homebuyers' purchasing behavior. It also finds that field theory provides a scientific perspective on this phenomenon. Thus, this paper proposes a value field model for evaluating homebuyers' GRB purchasing behavior based on physical field theory and psychology field theory. In particular, physical field theory provides the measurement formula, while psychological field theory explains the effect of the force stimulating homebuyers' purchasing intention, and ultimately influencing their purchasing behavior. The initial model consisted of a field source (green perceived value), target charge (GRB demand), distance (psychological distance), and value field factor. As the value field factor was calculated to be approximately equal to 1, the final model is a composite of a field source (green perceived value), target charge (GRB demand), and distance (psychological distance). The results validate the construction of the value field model on the basis of field theory. This research contributes to the body of knowledge by analyzing GRB value and provides a clearer understanding of how GRBs and the environment combine to fulfill homebuyers' requirements and influence their GRB purchasing behavior.

Keywords: Field theory; green residential building value; value field; purchasing behavior

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1. Introduction

The construction industry is one of the largest emitters of greenhouse gases and the energy consumed by this industry accounts for 40% of energy consumption worldwide [1,2]. The increased awareness of the built environment crisis is substantially changing the construction industry. Green building (GB) is one of the measures that have been put forward to mitigate the significant impacts of the building stock on the environment, society, and the economy. Despite many different definitions of GB, it is generally accepted as the design, construction, and operation of buildings with a maximum conservation of resources, protection of the environment, reduction of pollution, and healthy living environment [3]. Green building promotion in China has a profound global influence because of the construction boom as part of the rapid urbanization. Thus, promoting green buildings has become critical to sustainable development, especially in China [3]. The Chinese government has formulated GB codes and regulations and provides financial and nonfinancial incentives. For instance, the Chinese Ministry of Housing and Urban-Rural Development established databases for GB technologies, products, and materials named the "Technical Guidance for Green Building Promotion."

Green residential buildings (GRBs) are the result of green practices in the residential sector, which are especially important in China due to the high proportion of residential buildings. However, promoting GRBs faces greater challenges than commercial buildings [4]. Developers of green commercial buildings hold and operate buildings by themselves, thus evaluate the net benefit from the whole life-cycle perspective. On the contrary, GRBs are always sold to households after completion, making homebuyers' payment the only source of developers' rewards from green practice [5]. As most homebuyers lack the ability to calculate life-cycle benefits, the future benefits of green housing may not be fully understood in the transaction prices [6]. Such risks lead to the low market demand for GRBs, which hindered developers wanting to build green [3]. This potential market failure makes analyzing homebuyers' purchasing behavior of GRBs especially important in the Chinese green housing sector [4].

Research has indicated that a GRB's value can be defined as a measurement that represents the significance and importance of green properties in satisfying homebuyers' value requirements, which is a key explanatory factor in the decision to adopt a GRB [7,8]. However, current studies about green buildings mainly focus on environmental assessment tools and methods [9,10], technology and energy research [11,12], incentive measures and developmental policy [13,14], and local case studies [15]. Few researchers have paid adequate attention to the theoretical and empirical study of GRB value [16]. Additionally, although various empirical studies analyzed the drivers of homebuyers' acceptance of GRBs based on questionnaire surveys, case studies, and interviews [16], only a few studies had been conducted until very recently, and most of them were conducted on the purchasing behavior toward GRBs in developed nations [4,17]. Such research is lacking for developing nations, such as China, where the lack of broad acceptance of GRBs has become a major barrier to the GRB movement. Besides the factors that have been well documented by these studies (e.g., appeal and emotions, psychological influence, beliefs), this paper further examines how these factors work together to influence homebuyers' acceptance of GRBs.

The main theoretical contribution of the present research is the analysis of the driving force of homebuyers' purchasing behavior of GRBs based on the GRB value and field theory, which stress the relationship within the construct involving various factors. The purpose of this paper is to identify the prominent drivers of homebuyers' GRB purchasing behavior by answering the following research questions:

- What are the actual indicators that influence GRB purchasing behavior?
- What is the invisible driving force influencing homebuyers' GRB purchasing behavior?
- How can the invisible driving force with respect to the above factors be expressed?

To answer these questions, this paper proposes a value field model based on a literature review and further study using structural equation modeling. Furthermore, fuzzy synthetic evaluation was applied to gain further understanding of the proposed model. The model sheds light on how well GRBs function and affect the homebuyers. Moreover, we expect that the study's results will provide clear directives for housing developers and policymakers regarding what approaches will be more effective in motivating the market demand for GRBs.

The academic literature has employed terms such as "GRB purchasing," "adoption or acceptance of GRBs," and "GRBs acquisition" to express consumers' GRB purchasing behavior. In this paper, adoption or acceptance of GRBs will be utilized. The remainder of this paper is organized as follows: Section 2 presents the research background, Section 3 discusses the value field model, Section 4 describes the research methodology (including data collection, data analysis, and case study), Section 5 describes the results and discussions, and Section 6 provides concluding remarks.

2. Background

2.1. Green Purchasing Behavior

Green purchasing behavior generally includes buying environmentally-friendly products, supporting green organizations, and adopting sustainable consumption practices [18]. In seeking to explain green purchasing behavior, earlier research focused on the structure of ecological concerns, the underlying influencing indicators (demographic, personality, knowledge, values, attitude), and the relationship between ecological concerns and green purchasing behavior [19]. The theory of reasoned action (TRA) [20] and the theory of planned behavior (TPB) [21] are the two prominent theories followed by most of the studies. However, studies have found that environmental attitudes do not always affect purchasing behavior and this phenomenon is generally referred to as the attitude–behavioral gap [22]. Green purchasing behavior is complex and is influenced by a multitude of factors, especially for GRBs. For example, consumer GRB purchasing behavior may be affected by peer opinion [23]. Such behavior could be also influenced by the promotion by governments and green organizations. Yu et al. [24] argued that if governments and green corporations provide subsidies or promotions, consumers will be inclined to "go green". The features of green products (e.g., low pollution, recycled materials) may also arouse consumers' feeling of doing something good for the environment [25]. Additionally, the overall environment for the development of GBs, such as the economy and social attitudes, also plays an important role in affecting consumers' green purchasing behavior [26]. Nevertheless, the above studies have neither considered all the aspects of the influencing factors comprehensively nor analyzed how these factors work together to affect consumers' green purchasing behavior.

2.2. Green Residential Building Value

Value is a complex concept that carries a wide variety of meanings depending on the values and requirements of the homebuyers, the context in which value exists, and the type of value being discussed [27]. A dilemma that early value theorists and researchers faced was whether value (noun) should be investigated from the perspective of the entity being evaluated (e.g., "How much value does the entity have?") or from the perspective of the person doing the valuing (beliefs).

The fundamental objective of any infrastructure, including GRBs, is to deliver value to humans [28]. Value delivered by a specific construction project influences society in a broad sense and provides benefits for future generations. Moreover, value delivered by particular projects also affects those judgments concerning future projects and contributes to the long-term improvement of the construction sector's performance [29]. Thus, it is meaningful to understand GRB value from the perspective of homebuyers in an effort to understand the underlying motivations shaping people's attitudes and behaviors toward their environment. However, there is still no clarity or consensus about the definition of GRB value. Womack et al. pointed out that the definition of value can be meaningful only when it is defined from the consumers' perspective [30]. Hence, in construction projects, value can be viewed from the homebuyer's or end-user's perspective. Based on past research [31], GRB value can be defined as a measure that represents the significance and importance of green properties in satisfying end-users' value requirements. It has been regarded as a key exploratory factor in explaining decision-making [8]. In this sense, GRB value serves as a connecting link between GRBs and homebuyers.

Research on GB value has focused on different aspects between Western countries and China. In developed countries, studies about GB value mainly focused on its price. For example, Georg Fröch pointed out that a sustainable project's value is the combination of the market value and the sustainable features [32]. Aizenman and Jinjarak stated that green building's value is associated with economic benefits [33]. Thus, the related research on the valuation of green buildings are also price-focused [34]. Only a few researchers focused on the utility value of green buildings including two aspects, namely the green building's properties and consumers' features. Generally, transportation [35], the natural environment [36], and the humanity environment [37] are important contributors to a green building's value. As for the aspect of consumers' features regarding their views toward green buildings, salary and family life-cycle stage were two critical factors [38]. However, most of these studies have only considered a single factor, instead of the interaction of multiple variables, including individual, green building, and the environment. There are also limited studies on the linking role of GRB value between GRBs and homebuyers.

Research has also indicated that one of the major factors in the performance gap of GRBs is homebuyers' purchasing behavior [38]. Homebuyers are essential to understanding the value of buildings and facilitating value-sensitive decision-making in order to maximize the collective value of buildings. To narrow the performance gap and increase the GRB value, there is a need to construct a model that can state what affects purchasing behavior and how GB value contributes to such behavior.

2.3. Field Theory

Field theory originates in the physical sciences and continues to develop in the social sciences and other disciplines. This theory asserts that there exists an invisible force between matter and matter, just as in the case of a magnetic field, electromagnetic field, or gravitational field [39]. In physics, a field is a physical quantity that has a value for each point in space and time [40]. Physics field theory can be measured with Equation (1):

$$\mathrm{F} = K\,\frac{PQ}{R^2} \quad (1)$$

where F is the field force, K is the dielectric constant, P is the electric quantity of field source, Q is the the electric quantity of target charge, and R is the distance between P and Q.

The field concept was first applied by Lewin in 1939 [41] to consider relationships in an attempt to concern the individual's behavioral transactions with their internal and external environment in psychology. One of the fundamental statements of psychological field theory can be stated as follows: any behavior or any other change in a psychological field depends only on the psychological field at that time [41]. Lewin's field theory can be expressed using Equation (2):

$$\mathrm{B} = f(p, e) \quad (2)$$

where B represents the behavior, p represents the person, and e represents the environment [42]. "Person" refers to an individual's needs, beliefs, values, and abilities, as well as his perception of his relations to the environment [43]. The "environment," it should be noted, is a person's conscious and unconscious environment [43].

Although physics field theory and psychology field theory are different in terms of equations, physics field theory has connections with psychology field theory (Figure 1). First, the entity emphasized in physics field theory is also the basis of psychology field theory. Second, the inter-relationship studied in physics field theory explains the interaction between the person and their environment in psychology field theory. Third, Equation (2) suggests that behavior is the result of the individual interacting with their environment, which is actually shaped by the forces within the field, as measured by Equation (1).

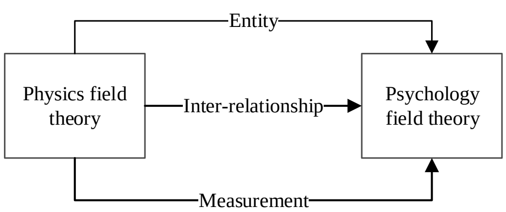

Figure 1. Connection between physics field theory and psychology field theory.

The increasing trend where field theory has been applied in various disciplines in recent years makes the clarification of field theory only the more important. The clear clarification of field theory is conducive to its better application in new aspects. However, the scholars who have been advancing this field for many years have not successfully made the essence of this theory clear. In fact, physics and philosophy do not seem to have done much analytical work concerning the meaning of field. Specifically, if one proceeds in physics from a special law or theory (such as the law of the free-falling body) to more general theories (such as the Newtonian laws) or still more general theories (such as the equations of Maxwell), one does not finally come to field theory. In other words, "field" theory is not a theory in the usual sense. Essentially, field theorists in the non-physical subjects have attempted to consider field theory as the set of factors that are conceived as mutually interdependent [42]. That is to say, "field" as it is employed in the social and psychological sciences does not refer to theories about physical phenomena, for example, gravitational or electromagnetic phenomena; rather it refers to a method focusing on the relations of the components in a system and building scientific constructs [44].

3. Value Field Model

3.1. Understanding the Value Field

The statement that the field focuses on the relations among the components within a system suggests that "field" pertains to the invisible force between matter and matter. GRB value also exerts a force on homebuyers. Thus, the introduction of the term "value field" (VF) provides a scientific perspective for explaining the relations between GRBs and homebuyers. Having knowledge and a clear understanding of a value field is an initial step in constructing the model. As such, there are reasonable grounds for the introduction of the term.

Recent research points to a shift from focusing on the building itself to the interaction between buildings and homebuyers. VF is proposed under such a research trend in the construction industry, where there is a need for holistic and comprehensive tools, skills, and techniques for analyzing the relationship between GBs and homebuyers. Based on the principles of psychology field theory, GRB value acts as the connection between GRBs and homebuyers, affecting homebuyers' adoption of GRBs. It can be measured using the force formula in Equation (1). The relationships among field theory, GRB, and homebuyers can be illustrated with Figure 2. A GRB consists of the building and its influencing environment. As shown in the figure, the value acts as the relation variable between GRBs and homebuyers. It exerts a force on homebuyers, encouraging them to purchase GRBs. Field theory provides a measuring method to find the strength of this force.

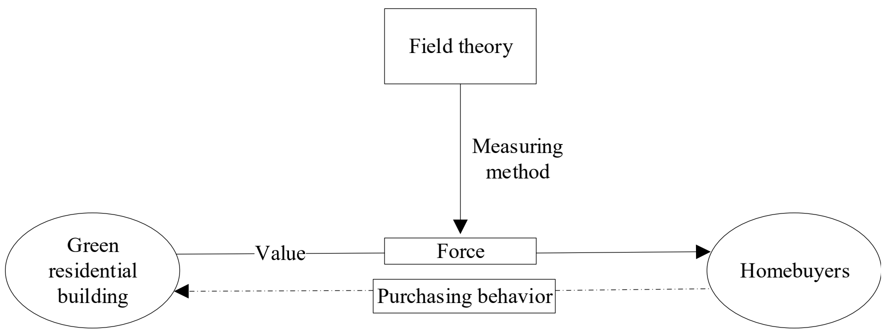

Figure 2. Relationship among field theory, green residential building (GRB), and homebuyers.

It should be clear that the environment brings together organizations, disciplines, and stakeholders with divergent value systems and influences. Thus, GRBs, the environment, and homebuyers constitute a system (see Figure 3). As shown in Figure 3, the environment (e.g., more convenient traffic and living facilities) is the synthesized attribute of GRB value besides the buildings' own characteristics, which are represented by a value field factor (K). A GRB affects homebuyers' green building purchasing behavior by satisfying the homebuyers' requirements. It is represented by attribute P in Equation (1). Moreover, homebuyers' GRB purchasing behavior has an external effect on the environment and homebuyers' demand for GRB, which are represented by attribute Q in Equation (1). The distance between homebuyers and GRBs is represented by attribute R of the value field.

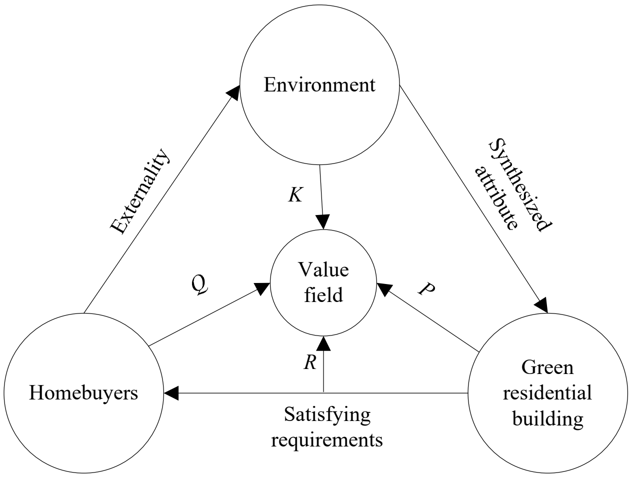

Figure 3. The system of green residential buildings, environment, and individual.

Based on the above analysis, the concept of a value field can be stated as a method that is used to calculate the effect between a human and a GRB with the system of GRBs, homebuyers, and environment.

The value field has the following merits: (1) entirety: GRBs, humans, and environment are viewed as an entity; (2) interactivity: GRB, being a platform, has multi-dimensional interactions with humans and the environment; (3) concreteness: being an invisible hand, the effect of GRBs on homebuyers can be expressed using field theory; (4) reasonability: the value of GRBs refers to a measure of the degree to which GRBs satisfy homebuyers' requirements, which can be regarded as the effect of green buildings on homebuyers. It plays the same role as the field, acting as an invisible hand, which suggests the rationality of term "value field."

3.2. Components of the GRB Value Field Model

A GRB value field is an application of a field in the building context. In physics, a field force is used to describe the influence of the field source on a target charge. Similarly, a value field force (F) expresses the interaction force between GRBs and homebuyers. As described in the physical Equation (1), a field force is determined by the electric quantity of the field source (P), the electric quantity of the target charge (Q), the distance (R), and dielectric constant (K). The data to find the dielectric constant (K) is selected objectively from official reports and statistical yearbooks about national economic and social development. Thus, the dielectric constant (K) must be calculated first in order to ascertain the overall environment for GRB development.

(1) Dielectric Constant (K)

Specifically, the dielectric constant (K) in the GRB value field refers to the synthesized attributes in the living environment contributing to the GRB value field and can be referred to as the value field factor. The selection of the items represented by the value field factor (K) arises from a study of the logistics field factor. Jin explained the logistics field factor as representing the attributes of the regional economy and logistics industrial environment [44]. It consists of five indicators, namely infrastructure, economic development level, logistics demand, industrial scale, and informatization level. The items represented by the value field factor can be constructed based on the building field factor introduced by Li [45], consisting of the transportation development level, economic development level, society development level, and housing demand. As shown in Table 1, 12 indicators of these four items were adapted to assess the living environment condition.

Table 1. Value field factor.

Items	Indicators
Transportation development level	Number of civilian vehicles per capita (K11), number of buses per capita (K12), total rail mileage (K13)
Economic development level	Disposable income per capita (K21), GDP (K22), GDP growth rate (K23)
Society development level	Engel coefficient (K31), unemployment rate (K32), homebuyer population (K33)
Housing demand	Residential sales price (K41), residential sales area (K42), living space per capita (K43)

Six cities in China with a high development of GBs were selected: Beijing, Shanghai, Guangzhou, Shenzhen, Nanjing, and Tianjin. The original data used to find the value field factor was obtained from official reports, statistical yearbooks about national economic and social development, and related academic studies, as shown in Appendix A. For the convenience of comparison and calculation, the non-dimensionality of indicators are required to eliminate the influence of the dimension. The calculated equation and dimensionless variables of the value field factor are shown in Appendix A.

In order to avoid the interference of a subjective factor, this study applied the variation coefficient method to obtain the objective weight of the index. The weights of the indicators of K can be found in Appendix A. Based on the weights, the comprehensive evaluation value of K (Table 2) can be calculated using the following equation:

$$K = \sum_{y=1}^{Y} B_y \left(\sum_{x=1}^{X} C_{xy} S_{xy} \right), \tag{3}$$

where B_y is the weight of K_y, C_{xy} are the weights of K_{xy}, and S_{xy} are the dimensionless variables of the original data.

Table 2. Comprehensive evaluation value of K.

	Beijing	Shanghai	Guangzhou	Shenzhen	Nanjing	Tianjin
K	1.1556	1.1864	0.8949	1.0762	0.9641	0.7230

As shown in Table 2, the comprehensive evaluation value of K was approximately 1 in the selected cities. The value of K reflects the building development environment. For example, the value of K was equal to 0.9641 in Nanjing, which suggests that the building development environment in Nanjing is desirable.

(2) Hypotheses Development

As the value of the dielectric constant (K) was approximately 1, the value field model was modified to include the field source (P), electric quantity of target charge (Q), and distance (R).

It should be noted that the value field is based on physics field theory and psychology field theory, where physics field theory provides the understanding of the relationships among the elements of the value field, psychology field theory illustrates the effect of value field, and GRBs are the research object. Thus, the selection of the GRB value field components should focus on homebuyers' requirements and the perceptions of GRBs.

① P—Green Perceived Value (GPV)

Customer perceived value has been applied as an important way of analyzing service quality, customer satisfaction, and consumer behavior. Many researchers have contributed to the development of customer perceived value from a green perspective [46,47]. For example, Chen and Chang introduced the concept of green perceived value (GPV) [47], which is the consumer's evaluation as influenced by their green expectations and needs. It has been shown to contribute to the development of the relationship between consumers and green products through green satisfaction [47]. Therefore, GPV is suitable for examining homebuyers' GRB purchasing behavior. In the value field, the "electric quantity" of the field source (GRB) acts as a positive element of the field force (i.e., the driving force of homebuyers' purchasing behavior). Hence, GPV is appropriate for representing the "electric quantity" of the field source (GRB)

Ashton et al. [48] and Ariffin et al. [49] defined the GPV of a GRB as the set of attributes related to the consciousness of the GRB value. However, it is a subjective and ambiguous concept, so there is inconsistency in its measurement. In this sense, measurement of the GPV is constructed on the basis of customer perceived value (CPV) measurements and existing GPV measurements. Yieh et al. argued that it is necessary to measure CPV from a multidimensional perspective by encompassing the meaning of objects and the feelings of customers [50]. Sweeney and Soutar adopted a social value scale and emotional value scale as measurements of the CPV [51]. Moreover, Zeithaml emphasized the economic dimension of the CPV [52], while Hartmann et al. highlighted the functional and emotional benefits in understanding the GPV [53]. GRBs play a vital role in achieving environmental benefits. Therefore, the environment value should also be considered as a measure of the GPV. This study adapted five items from the above studies, namely functional value (P1), economic value (P2), emotional value (P3), environmental value (P4), and social value (P5). The factors of each dimension are presented in Table 3.

Table 3. The factors of GPV dimensions.

Initial Dimensions	Factors
Functional value	A1 (High quality), A2 (Physical and mental health)
Economic value	A3 (Abandoning GRB because of the high price), A4 (GRB preference due to low maintenance cost), A5 (GRB preference due to low utilization cost)
Emotional value	A6 (Stimulation of purchase desire), A7 (Be relieved), A8 (Be in harmony with nature), A9 (Lifestyle and attitude reflection)
Green value	A10 (Ecological environment improvement), A11 (Environmental awareness promotion)
Social value	A12 (Sustainable development), A13 (Winning more praise), A14 (Creating a healthy image), A15 (Reflection of social responsibility sense)

Functional value (P1) considers that the GRB quality and performance are desirable [54]. Economic value (P2) refers to the homebuyers' perceived financial benefits [54]. Emotional value (P3) refers to the perceived GRB capability to arouse homebuyers' feelings [55]. Environmental value (P4) represents the homebuyers' perceptions of the utility of GRBs based on the perceived positive impact on the environment [56]. Social value (P5) stresses the benefits of the social image of GRB [57]. Therefore, the following hypotheses were formed:

Hypothesis 1 (H1). *The value field force is positively related to GPV.*

Hypothesis 2 (H2). *GPV, as a field source, can be analyzed in terms of functional value, economic value, emotional value, environmental value, and social value.*

② *Q*—GRB Demand

The "electric quantity" of homebuyers is reflected by homebuyers' demand, which is the initial factor influencing GRB development. This item is influenced by personal characteristics, including education, household size, age, and household annual income. Life attitude, environmental consciousness, and environmental behavior are also important factors of GRB demand. Thus, the following hypotheses were formed:

Hypothesis 3 (H3). *The value field force is positively related to GRB demand.*

Hypothesis 4 (H4). *GRB demand, as target charge, can be analyzed in terms of education, household size, age, household annual income, life attitude, environmental consciousness, and environmental behavior.*

③ *R*—Psychological Distance

Construal level theory (CLT) proposes that people mentally construe the same object or event at different levels of abstraction and mental representations, which in turn influences their understanding of the world [58]. CLT further posits that the construal level is a function of psychological distance. More specifically, CLT establishes that psychologically distant objects are construed in a more abstract and decontextualized manner; in contrast, psychologically proximate events are conceived in a more concrete and detailed way [58]. Agerström and Björklund argued that selfish motives and hedonic considerations are expressed at a more concrete construal level with a proximate psychological distance [59]. As homebuyers aimed at personal interests when purchasing a GRB, their GRB purchasing behavior can be classified as a behavior arising from selfish motives, and thus is associated with a proximate psychological distance. In other words, when objects or events are psychologically proximal to people, they are perceived in terms of a concrete construal, thus boosting purchasing behavior [60]. For example, if GRBs were psychologically proximal to homebuyers, homebuyers would be familiar with the GRB's image and the benefits GRBs bring to them. The GRBs would be a concrete object rather than an abstract one. In this context, homebuyers tend to purchase GRBs. Therefore, psychological distance was adopted to describe factors inhibiting consumers from purchasing GRBs. The items were adapted from existing studies [60–62] and also consider the characteristics of GRBs, i.e., cognitive distance, social distance, and spatial distance. Therefore, the following hypotheses were proposed:

Hypothesis 5 (H5). *The value field force is negatively related to psychological distance.*

Hypothesis 6 (H6). *Psychological distance, as distance between homebuyers and GRBs, can be illustrated in terms of cognitive distance, social distance, and spatial distance.*

Overall, the factors of these elements were selected based on psychology field theory, where the GPV and psychological distance represent homebuyers' conscious environment, the value field factor refers to homebuyers' unconscious environment, and the GRB demand refers to a person's need for GRBs. Although there are correlations among these variables, they do not conflict when assessing homebuyers' purchasing behavior, which is measured by the field force.

4. Research Methodology

There were three steps in this empirical study: data collection, data analysis, and case study. In step 1, data collection was done using a questionnaire survey. In step 2, data analysis involved two tasks, namely reliability analysis and factor analysis. In step 3, a case study is presented.

4.1. Data Collection

The present study used quantitative research to verify the proposed value field model. A questionnaire survey method was used, which mainly included homebuyers of Nanjing in Jiangsu province. Jiangsu accounts for nearly 30% of all GBs in China. The development of GBs in Jiangsu province reflects the polarity between the rapid development in southern Jiangsu and the lagging development in northern Jiangsu. Nanjing, as Jiangsu's provincial capital, has outstanding GB performance, in keeping with the rapid development of southern Jiangsu and as reflected by the comprehensive value of K. In this context, this study designed a measurement scale for the proposed value field model. The survey questionnaire was divided into four parts (as outlined below) with 48 items. In psychology field theory, an individual's behavior is the result of the force between the person and the environment. Thus, the contributors to the force can be selected from influencing factors of an individual's behavior, which are also the items of the questionnaire (Appendix B).

(1) Part 1 investigated the respondents' demographic characteristics, such as gender, age, and annual household income.
(2) Part 2 solicited a GPV factor scale with 15 items.

(3) Part 3 solicited a green life attitude factor scale including residential attitude, environmental attitude, and environmental habits.
(4) Part 4 solicited a psychological distance scale including social distance, cognitive distance, and spatial distance.

A preliminary investigation was conducted to check content validity. In total, six experts from real-estate companies and six academics for universities in the area of green building were invited to provide feedback. Based on their feedback, modifications were made to ensure content validity and consistency of the questionnaire. The survey was conducted using an online interface with several selected respondents who possess experience with GRBs, and with occupations ranging from university instructors to developers, contractors, and government officials. These participants were all considered to be potential consumers and homebuyers of GRBs. The results of the survey were found to verify the accuracy of the data. According to the statement that value can be meaningful only when it is defined from the consumers' perspective [32], these survey participants were the best positioned to assess GRB value.

The online surveys were carried out in WJX.cn, an online questionnaire survey platform in which respondents were independent and did not interfere with one another, thus ensuring the objectivity and reliability of the survey. Participants were invited to indicate their degree of agreement with statements pertaining to the presented scales using a five-point Likert scale. From a total of 300 questionnaires distributed online, 279 questionnaires were completed. After omitting questionnaires with incomplete answers and from other cities, the total number of valid questionnaires obtained was 223 (80.5%), which is suitable for social science research [63]. Out of the total sample of 223 respondents, 65.34% were male and 34.66% were female. The majority of respondents (87.73%) were from the age group between 28 and 39. A total of 54.87% had an undergraduate degree, while 38.63% had a postgraduate degree. The majority of respondents had an annual household income ranging between 100,000 CNY and 500,000 CNY.

4.2. Data Analysis

4.2.1. Reliability Analysis

As shown in Table 4, the Cronbach's alpha values for scales were all found to be higher than 0.7, which is the threshold value recommended in Umay's guideline [63]. Hence, all scales had a high reliability and could therefore be considered to be a solid foundation for further studies. Umay has also suggested that any indicator with a corrected item-total correlation (CITC) value less than 0.4 should be omitted in order to enhance the overall reliability of the scale [63]. As shown in Table 4, the CITC value of A3 was less than 0.4 and the resulting Cronbach's alpha value when omitting A3 was 0.958 (exceeding the original scale's Cronbach's alpha). Thus, indicators B1, B2, B3, B4, B17, and C4 were also omitted due to the low CITC value, which were in bold in the table.

Table 4. Reliability analysis of the scale.

Scale	Indicator	Description of Indicator	Final Indicator	CITC	Cronbach's Alpha		
					Scale after Deleting the Indicator	Original Scale	Whole Model
Green perceived value (*P*—the electric quantity of field source)	A1	High quality	A1	0.642	0.945	0.947	0.941
	A2	Physical and mental health	A2	0.656	0.945		
	A3	Abandoning GRB because of the high price		**0.093**	**0.958**		
	A4	GRB preference due to low maintenance cost	A4	0.674	0.945		
	A5	GRB preference due to low utilization cost	A5	0.663	0.945		
	A6	Stimulation of purchase desire		0.798	0.942		
	A7	Be relieved	A7	0.822	0.941		
	A8	Be in harmony with nature	A8	0.851	0.941		
	A9	Lifestyle and attitude reflection	A9	0.820	0.941		
	A10	Ecological environment improvement	A10	0.816	0.941		
	A11	Environmental awareness promotion	A11	0.842	0.941		
	A12	Sustainable development	A12	0.789	0.942		
	A13	Winning more praise	A13	0.813	0.941		
	A14	Creating a healthy image	A14	0.791	0.942		
	A15	Reflection of social responsibility sense	A15	0.772	0.942		
GRB-demand (*Q*—the electric quantity of target charge)	B1	Education		**0.109**	**0.869**	0.864	
	B2	Households		**0.041**	**0.879**		
	B3	Age		**−0.020**	**0.873**		
	B4	Household annual income		**0.042**	**0.874**		
	B5	Green energy	B5	0.602	0.851		
	B6	Water saving apparatus	B6	0.677	0.848		
	B7	Energy reduction	B7	0.709	0.847		
	B8	Ventilation	B8	0.707	0.848		
	B9	Noise barrier	B9	0.695	0.849		
	B10	Green	B10	0.603	0.853		
	B11	Green material	B11	0.685	0.850		
	B12	Less environmental pollution	B12	0.741	0.847		
	B13	Changing lifestyle	B13	0.657	0.850		
	B14	Active access to environmental information	B14	0.578	0.853		
	B15	Worried about environmental pollution	B15	0.757	0.847		
	B16	Active participation in environmental protection activity	B16	0.665	0.850		
	B17	Utilities of disposable products		**−0.025**	**0.877**		
	B18	Resource savings	B18	0.395	0.860		
	B19	Purchase energy conservation appliances	B19	0.564	0.854		
	B20	Purchase environmental detergent	B20	0.413	0.859		
Psychological distance (*R*)	C1	Influenced by people around	C1	0.468	0.868	0.872	
	C2	Influenced by developers	C2	0.538	0.864		
	C3	Influenced by the government	C3	0.394	0.871		
	C4	Influenced by families' suggestions		**0.243**	**0.878**		
	C5	Influenced by friends' suggestions	C5	0.516	0.865		
	C6	Realization of GRB	C6	0.551	0.863		
	C7	Realization of resource savings	C7	0.643	0.858		
	C8	Realization of living comfort	C8	0.703	0.854		
	C9	Realization of environmental protection	C9	0.659	0.857		
	C10	Realization of the high price	C10	0.635	0.858		
	C11	Realization of low utilization cost	C11	0.667	0.856		
	C12	Road access	C12	0.503	0.866		
	C13	Improved public transport	C13	0.559	0.863		

4.2.2. Exploratory Factor Analysis

Exploratory factor analysis (EFA) was conducted before proceeding to the confirmatory factor analysis (CFA) [64]. The objective of an EFA is to identify a set of underlying dimensions [65]. The ratio of the sample size to the number of variables was found to be 5.44, exceeding the acceptable ratio of 5.00 [66]. This suggested that the sample size was large enough to conduct EFA. Prior to the factor analysis, the Kaiser–Meyer–Olkin (KMO) index and Bartlett's sphericity were calculated in order to test the suitability of the data for factor analysis. As shown in Table 5, the KMO value was found to be 0.911, exceeding the acceptable level (0.5), suggesting that the common variance among the indicators was high. The Bartlett's sphericity value, meanwhile, was found to be 8044.256 with a significance level of 0.000, indicating that the population correlation matrix was not all the same. Therefore, the collected data were suitable for exploratory factor analysis.

Table 5. KMO and Bartlett's test [67].

Kaiser–Meyer–Olkin Measure		**0.911**
Bartlett's test of sphericity	Approx. chi-square	8044.256
	df	820
	Sig.	0.000

EFA was conducted with principal component analysis to identify the underlying dimensions. The varimax orthogonal rotation method was used to obtain the factor loading value, which explained the contribution of individual indicators to each underlying dimension. Considering the recommendation of many studies that factor loadings should be greater than 0.5 to ensure better results [68], there were three conditions under which indicators were omitted:

(1) Factor loadings of all the common factors were less than 0.5 [68];
(2) Factor loadings greater than 0.5 occurred for more than two common factors;
(3) Factor loadings of more than two common factors had small differences from each other.

In scale 1, two dimensions were obtained with eigenvalues greater than 1, with 14 indicators remaining (Table 6). Based on the above conditions for factor omission, indicator A6 in scale 1 was omitted since its factor loadings on the two dimensions were all found to be greater than 0.5. The redefined dimensions—"perceived value of benefit" and "perceived value of cost, comprising 13 indicators, could explain 73.346% of the data. In scale 2, four dimensions, with eigenvalues greater than 1 were obtained, which could explain 77.325% of the data. They were redefined as "eco-friendliness", "environmental awareness", "energy conservation" and "environmental protection behavior." In scale 3, three dimensions (i.e., "cognitive distance", "social distance", and "spatial distance") were obtained with eigenvalues greater than 1, explaining 73.392% of the data.

Table 6 contains the details of the three scales and the initial statistics of the 40 indicators. The total variance explained by each indicator is listed in the factor loading column. The percentage of variance and the cumulative percentage of variance are also indicated in Table 6.

Table 6. Factor structure and principal factor extraction and varimax rotation on value field scales.

Number Item	Factor Loading	Percentage of Variance Explained	Cumulative Percentage of Variance Explained
Scale 1 Green Perceived Value (GPV)			
D1 perceived value of benefit		65.439	65.439
A1	0.563		
A2	0.600		
A7	0.741		
A8	0.815		
A9	0.794		
A10	0.813		
A11	0.883		
A12	0.781		
A13	0.811		
A14	0.832		
A15	0.823		
D2 perceived value of cost		7.907	73.346
A4	0.909		
A5	0.908		
Scale 2 Green Residential Building-demand (GRB-d)			
D3 eco-friendliness		50.872	50.872
B8	0.762		
B9	0.793		
B10	0.852		
B11	0.862		
B12	0.744		
D4 environmental awareness		10.267	61.139
B13	0.822		
B14	0.843		
B15	0.666		
B16	0.776		
D5 energy conservation		8.516	69.656
B5	0.819		
B6	0.863		
B7	0.805		
D6 environmental protection habit		7.669	77.325
B18	0.816		
B19	0.641		
B20	0.792		
Scale 3 Psychological Distance (PD)			
D7 cognitive distance		44.152	44.152
C6	0.854		
C7	0.898		
C8	0.903		
C9	0.833		
C10	0.847		
C11	0.738		
D8 social distance		20.202	64.354
C1	0.808		
C2	0.810		
C3	0.677		
C5	0.845		
D9 spatial distance		10.718	75.073
C12	0.920		
C13	0.906		

4.2.3. Validation of the Proposed Model

Structural equation modelling (SEM) was then applied to validate the proposed model, which consists of a measurement model and a structural model. In this study, the measurement model captures the relationships among nine dimensions and three scales, while the structural model shows the potential relationships between the three scales and value field force. EFA (Exploratory factor analysis) and CFA (confirmatory factor analysis) contain the measurement component, while path analysis solves the structural aspect.

In this regard, validity analysis was first required to test whether a given measurement was well-founded. Validity measures were of two main types: content validity and construct validity. The measurement scales were constructed mainly based on previous studies. The items were discussed and adjusted by academics and professional experts, and they were considered appropriate. Thus, it could be deduced that the scales had enough content validity [69]. The construct validity of the survey instrument was examined by means of factor analysis.

CFA was then conducted to test whether the observed variables fit the measurement model [70]. In EFA, three scales were identified as latent variables, which would be confirmed using CFA. A CFA-based measurement was run through LISREL 8.7 (This software is developed by Scientific Software International Inc, Lincolnwood, IL 60712, United States.) using several goodness-of-fit statistics, including goodness-of-fit index (GFI), chi-square degrees of freedom (χ^2/DOF), comparative fit index (CFI), adjusted GFI (AGFI), and root-mean-square error of approximation (RMSEA). As seen in Table 7, the actual observed data met the requirement of each measuring criteria threshold, which meant the model was reasonable. Accordingly, the nine groupings identified can be regarded as observed variables in the SEM.

Table 7. Confirmatory factor analysis results.

Indices	Acceptable Level	Source	Green Perceived Value	GRB Demand	Psychological Distance
χ^2/DOF	<5.0	[71]	0.28	0.34	1.97
GFI	≥0.9	[72]	0.94	1.00	0.91
CFI	≥0.95	[73]	0.93	1.00	0.95
p-Value	≥0.05	[74]	1.00	1.00	1.00
AGFI	≥0.8	[75]	0.92	0.99	0.92
RMSEA	≤0.05	[74]	0.049	0.00	0.075

The software LISREL 8.7 was utilized to estimate the degree of accuracy of the model. In Figure 4, the arrows and path coefficients show the contributions of the dimensions and the observed variables (dimensions) to the value field force (F). The figure includes both the measurement and structural components, showing the relationships between F, the three scales, and the observed variables (nine groupings). Overall, the model was found to have a good fit, with the fit indices as follows: χ^2/DOF = 2.2, GFI = 0.90, CFI = 0.92, AGFI = 0.91, and RMSEA = 0.048. Moreover, all the pathways were found to be significant. Based on the analysis, the correlations between the three scales and the observed variables were verified using the empirical data. The model was thus shown to be suitable for assessing GRB value.

4.3. A Case Study in China

In order to further understand how a value field model could be applied to evaluate homebuyers' GRB purchasing behavior, a case study was conducted in Nanjing, China. The method utilized in the case study was a fuzzy synthetic evaluation. A fuzzy synthetic evaluation is commonly used to make an overall evaluation of complex systems with factors that are difficult to quantify, and it permits the incorporation of various parameters into the evaluation process [76]. The main procedures are the following five steps:

(1) Establishment of the Factor Set

The factor set, indicated by U, is a collection of terms affecting the evaluation object:

$$\mathrm{U} = \{u_1,\ u_2, \cdots, u_m\}, \tag{4}$$

where m is the number of influencing terms.

A comprehensive evaluation of homebuyers' purchasing behavior toward GRB was set as the target level, comprising three scales with nine dimensions and 40 secondary indicators. Table 8 shows the comprehensive index evaluation system for the value assessment problems. The factor set in each scale, including the indices in Table 8, can be expressed as:

$$U_1^1 = \{U_{10}^1, U_{11}^1, U_{12}^1, U_{13}^1, U_{14}^1, U_{15}^1, U_{16}^1, U_{17}^1, U_{18}^1, U_{19}^1, U_{19+}^1\},$$
$$U_2^1 = \{U_{20}^1, U_{21}^1\},$$
$$U_1^2 = \{U_{10}^2, U_{11}^2, U_{12}^2, U_{13}^2, U_{14}^2\},$$
$$U_2^2 = \{U_{20}^2, U_{21}^2, U_{22}^2, U_{23}^2\},$$
$$U_3^2 = \{U_{30}^2, U_{31}^2, U_{32}^2\},$$
$$U_4^2 = \{U_{40}^2, U_{41}^2, U_{42}^2\},$$
$$U_1^3 = \{U_{10}^3, U_{11}^3, U_{12}^3, U_{13}^3, U_{14}^3, U_{15}^3\},$$
$$U_2^3 = \{U_{20}^3, U_{21}^3, U_{22}^3, U_{23}^3\},$$
$$U_3^3 = \{U_{30}^3, U_{31}^3\}.$$

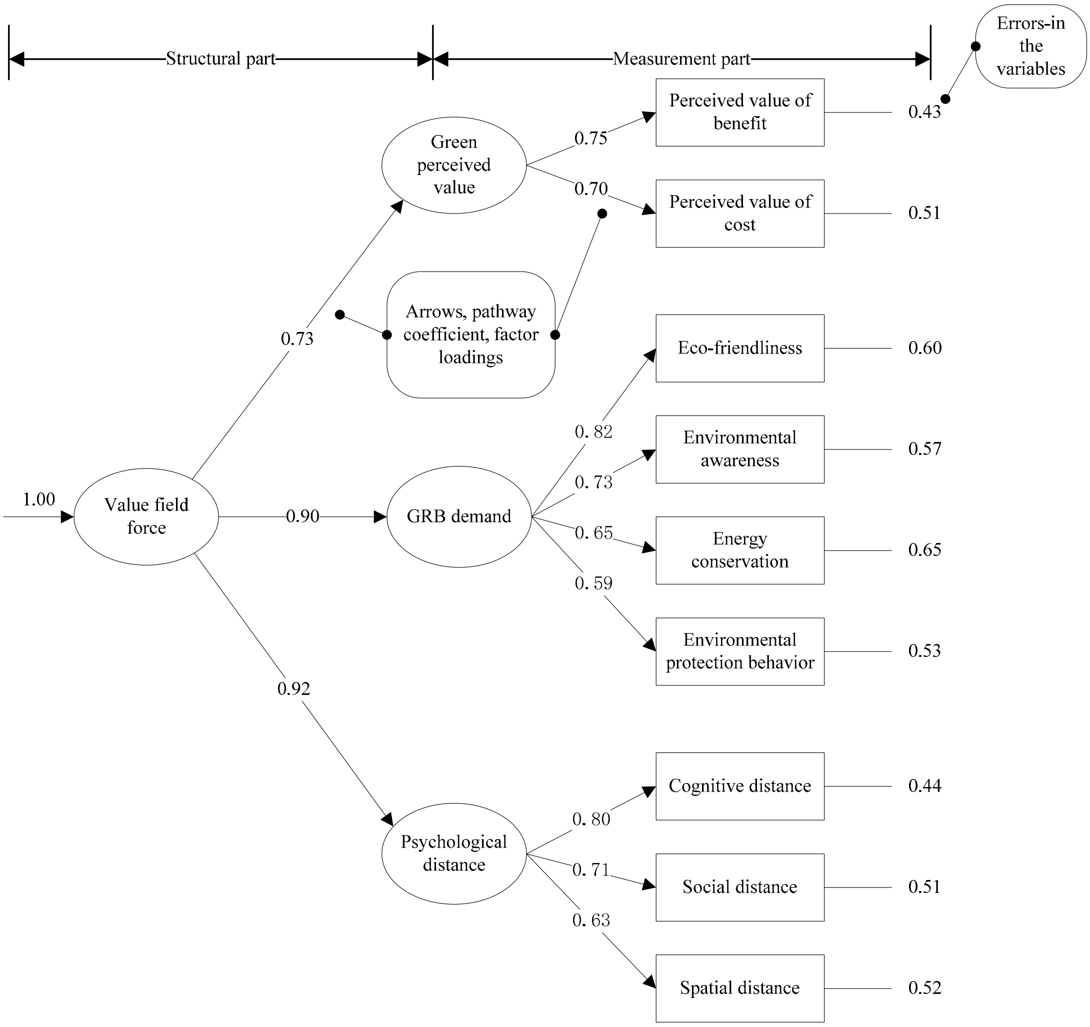

Figure 4. Loading estimates in the structural equation modelling (SEM).

Table 8. Factor set in each scale, including the indices.

Scale	First-Level (Factor Set, Weight)	Second-Level	Weight
GPV (U^1)	Perceived value of benefits (U^1_1, 0.892)	High quality (U^1_{10})	0.043
		Physical and mental health (U^1_{11})	0.062
		Be relieved (U^1_{12})	0.066
		Be in harmony with nature (U^1_{13})	0.089
		Lifestyle and attitude reflection (U^1_{14})	0.087
		Ecological environment improvement (U^1_{15})	0.099
		Environmental awareness promotion (U^1_{16})	0.127
		Sustainable development (U^1_{17})	0.088
		Winning more praise (U^1_{18})	0.101
		Creating a healthy image (U^1_{19})	0.117
		Reflection of social responsibility sense (U^1_{19+})	0.120
	Perceived value of cost (U^1_2, 0.108)	GRB preference due to low maintenance cost (U^1_{20})	0.496
		GRB preference due to low utilization cost (U^1_{21})	0.504
GRB-demand (U^2)	Eco-friendliness (U^2_1, 0.658)	Ventilation (U^2_{10})	0.172
		Noise barrier (U^2_{11})	0.192
		Green (U^2_{12})	0.249
		Green material (U^2_{13})	0.230
		Less environmental pollution (U^2_{14})	0.157
	Environmental awareness (U^2_2, 0.133)	Changing lifestyle (U^2_{20})	0.280
		Active access to environmental information (U^2_{21})	0.304
		Worried about environmental pollution (U^2_{22})	0.170
		Active participation in environmental protection activity (U^2_{23})	0.246
	Energy conservation (U^2_3,0.110)	Green energy (U^2_{30})	0.339
		Water saving apparatus (U^2_{31})	0.354
		Energy reduction (U^2_{32})	0.308
	Environmental protection behavior (U^2_4,0.099)	Resource savings (U^2_{40})	0.383
		Purchase energy conservation appliances (U^2_{41})	0.256
		Purchase environmental detergent (U^2_{42})	0.361
Psychological Distance (U^3)	Cognitive distance (U^3_1, 0.588)	Realization of GRB (U^3_{10})	0.223
		Realization of resource savings (U^3_{11})	0.223
		Realization of living comfort (U^3_{12})	0.217
		Realization of environmental protection (U^3_{13})	0.2
		Realization of the high price (U^3_{14})	0.212
		Realization of low utilization cost (U^3_{15})	0.147
	Social distance (U^3_2, 0.269)	Influenced by people around (U^3_{20})	0.267
		Influenced by developers (U^3_{21})	0.256
		Influenced by the government (U^3_{22})	0.204
		Influenced by friends' suggestion (U^3_{23})	0.273
	Spatial distance (U^3_3, 0.143)	Road access (U^3_{30})	0.507
		Improved public transport (U^3_{31})	0.493

(2) Establishment of the Assessment Set

The assessment set, indicated by V, is a collection of the assessment results of the evaluated object:

$$\mathrm{V} = \{v_1,\ v_2, \cdots, v_n\}, \tag{5}$$

where v_n is the level of assessment standard.

Then the assessment standard is given a value according to:

$$\mathrm{S} = \{s_1,\ s_2, \cdots, s_n\}. \tag{6}$$

According to the Likert scale, the assessment set could be regarded as having five levels. Thus, the value of the assessment sets were expressed as:

$$\mathrm{S} = \{1,\ 2,\ 3,\ 4,\ 5\}.$$

(3) Fuzzy Evaluation of a Single Factor

A fuzzy matrix, indicated by L, is a collection in which each factor is assessed to determine the membership grade in the assessment set:

$$L = \left(l_{ij}\right)_{mn} = \begin{bmatrix} l_{11} & \cdots & l_{1n} \\ \vdots & \ddots & \vdots \\ l_{m1} & \cdots & l_{mn} \end{bmatrix}, \tag{7}$$

where l_{ij} is the membership degree of u_i in v_j, reflected by a number between 0 and 1.

l_{ij} can be calculated by means of a fuzzy statistical method using:

$$l_{ij} = w_{ij}/n, \tag{8}$$

where w_{ij} is the number of evaluators who grade the u_i as v_j, and n is the total number of evaluators.

To determine the level of the evaluation factors in the assessment set, the membership function should be calculated for all factors in all three dimensions using Equations (7) and (8). In this study, ten experts were invited to assess the factors. Thus, in the U^1 scale, the membership functions of U_1^1 and U_2^1 were calculated as follows:

$$L_{U_1^1} = \left\{ \begin{matrix} 0 & 0 & 0.1 & 0.65 & 0.25 \\ 0 & 0 & 0.1 & 0.45 & 0.45 \\ 0 & 0.05 & 0.25 & 0.55 & 0.15 \\ 0 & 0 & 0.15 & 0.5 & 0.35 \\ 0 & 0 & 0.15 & 0.65 & 0.2 \\ 0 & 0 & 0.15 & 0.55 & 0.3 \\ 0 & 0 & 0.15 & 0.5 & 0.35 \\ 0 & 0 & 0.1 & 0.5 & 0.4 \\ 0 & 0 & 0.35 & 0.6 & 0.05 \\ 0 & 0 & 0.15 & 0.55 & 0.3 \\ 0 & 0 & 0.15 & 0.55 & 0.3 \end{matrix} \right\}, L_{U_2^1} = \left\{ \begin{matrix} 0.05 & 0.2 & 0.4 & 0.1 & 0.25 \\ 0 & 0.3 & 0.3 & 0.3 & 0.1 \end{matrix} \right\}.$$

In the U^2 scale, the membership functions of U_1^2, U_2^2, U_3^2, and U_4^2 were calculated to be:

$$L_{U_1^2} = \left\{ \begin{matrix} 0 & 0 & 0.15 & 0.55 & 0.3 \\ 0 & 0 & 0.15 & 0.5 & 0.35 \\ 0 & 0 & 0.1 & 0.7 & 0.2 \\ 0 & 0 & 0.1 & 0.6 & 0.3 \\ 0 & 0 & 0.1 & 0.7 & 0.2 \end{matrix} \right\}, L_{U_2^2} = \left\{ \begin{matrix} 0 & 0 & 0.3 & 0.55 & 0.15 \\ 0 & 0.05 & 0.3 & 0.55 & 0.1 \\ 0 & 0.05 & 0.05 & 0.7 & 0.2 \\ 0 & 0.05 & 0.15 & 0.6 & 0.2 \end{matrix} \right\},$$

$$RL_{U_3^2} = \left\{ \begin{matrix} 0 & 0 & 0.2 & 0.5 & 0.3 \\ 0 & 0 & 0.1 & 0.65 & 0.25 \\ 0 & 0 & 0.05 & 0.55 & 0.4 \end{matrix} \right\}, L_{U_4^2} = \left\{ \begin{matrix} 0 & 0 & 0.05 & 0.5 & 0.45 \\ 0 & 0 & 0.15 & 0.6 & 0.25 \\ 0 & 0 & 0.15 & 0.65 & 0.2 \end{matrix} \right\}.$$

In the U^3 scale, the membership functions of U_1^3, U_2^3, and U_3^3 were calculated to be:

$$L_{U_1^3} = \left\{ \begin{matrix} 0 & 0 & 0.35 & 0.5 & 0.15 \\ 0 & 0 & 0.15 & 0.6 & 0.25 \\ 0 & 0 & 0.2 & 0.6 & 0.2 \\ 0 & 0 & 0.2 & 0.55 & 0.25 \\ 0 & 0 & 0.15 & 0.6 & 0.25 \\ 0 & 0.05 & 0.5 & 0.35 & 0.1 \end{matrix} \right\}, L_{U_2^3} = \left\{ \begin{matrix} 0 & 0.05 & 0.55 & 0.4 & 0 \\ 0 & 0.2 & 0.35 & 0.45 & 0 \\ 0 & 0.05 & 0.25 & 0.7 & 0 \\ 0 & 0 & 0.5 & 0.45 & 0.05 \end{matrix} \right\},$$

$$L_{U_3^3} = \left\{ \begin{array}{ccccc} 0 & 0.05 & 0.45 & 0.35 & 0.15 \\ 0 & 0 & 0.5 & 0.35 & 0.15 \end{array} \right\}.$$

(4) Establishment of the Weight

Weight is an important factor in fuzzy synthetic evaluations since they indicate the influence of the terms on the evaluation object. The common factor variance contribution rate has been proven to be an objective tool for acquiring the weights of different indices [77]. The method can be illustrated as follows:

$$a_{U_j^p} = \frac{c_j}{\sum_{j=1}^{n} c_j}, \quad (9)$$

where $a_{U_1^n}$ is the weight of the common factor j (first level) in scale p, c_j is the variance contribution rate of the common factor j, and n is the number of common factors. Furthermore:

$$a_{pj}' = \frac{c_j'}{\sum_{j=1}^{m} c_j'} \quad (10)$$

where a_{pj}' is the weight of the indicator of the common factors in scale p and c_j' is the contribution rates of the indices in the result of factor analysis score coefficient matrix.

Weights for the evaluation factors of first level and second level are shown in Table 8.

(5) Fuzzy Evaluation of Three Scales

The fuzzy evaluation matrix comprehensively reflects the overall influences of all the indices. The fuzzy synthetic evaluation matrix can be obtained using:

$$\mathrm{B} = A \cdot R = (a_1, a_2, \cdots, a_n) \begin{bmatrix} r_{11} & \cdots & r_{1n} \\ \vdots & \ddots & \vdots \\ r_{m1} & \cdots & r_{mn} \end{bmatrix}, \quad (11)$$

where B is the evaluation result.

For either combustion condition, a real assessment value is obtained following the fuzzy synthetic evaluation:

$$Z = B \cdot S^T = \begin{pmatrix} r_1 & r_2 & r_3 & r_4 & r_5 \end{pmatrix} \cdot \begin{pmatrix} s_1 \\ s_2 \\ s_3 \\ s_4 \\ s_5 \end{pmatrix}, \quad (12)$$

where Z is the evaluation score, which reflects the evaluation of the actual case. More details on Equations (4)–(12) have been stated by Zadeh [78]. According to the factor sets and the weight of each factor presented in Table 8, a comprehensive evaluation of the value of GRBs in Nanjing was conducted, and the evaluation sequence was performed proceeding from low-level to high-level.

The first-level index was assessed using the measured weights ($W_{U_i^n} = \left\{ W_{U_{i0}^n}, W_{U_{i1}^n}, \cdots, W_{U_{im}^n} \right\}$) to calculate the U_i^n fuzzy matrix as follows:

$$B_{U_i^n} = W_{U_i^n} \cdot R_{U_i^n} = \left\{ W_{U_{i0}^n}, W_{U_{i1}^n}, \cdots, W_{U_{im}^n} \right\} \cdot \left\{ \begin{array}{ccc} r_{11} & \cdots & r_{1n} \\ \vdots & \ddots & \vdots \\ r_{m1} & \cdots & r_{mn} \end{array} \right\} = \left(B_{U_1^n}, B_{U_2^n}, \cdots, B_{U_m^n} \right), \quad (13)$$

where U_i^n is the first-level index, n is the number of dimensions, and m is the number of indicators in the first-level index. For example, the evaluation of the fuzzy matrix for the perceived value of benefit in the GPV dimension was:

$$\begin{gathered} B_{U_1^1} = W_{U_1^1} \cdot R_{U_1^1} \\ = (0.043,\ 0.062,\ 0.066,\ 0.089,\ 0.087,\ 0.099,\ 0.127,\ 0.088,\ 0.101,\ 0.117,\ 0.120) \times \\ \left\{ \begin{array}{ccccc} 0 & 0 & 0.1 & 0.65 & 0.25 \\ 0 & 0 & 0.1 & 0.45 & 0.45 \\ 0 & 0.05 & 0.25 & 0.55 & 0.15 \\ 0 & 0 & 0.15 & 0.5 & 0.35 \\ 0 & 0 & 0.15 & 0.65 & 0.2 \\ 0 & 0 & 0.15 & 0.55 & 0.3 \\ 0 & 0 & 0.15 & 0.5 & 0.35 \\ 0 & 0 & 0.1 & 0.5 & 0.4 \\ 0 & 0 & 0.35 & 0.6 & 0.05 \\ 0 & 0 & 0.15 & 0.55 & 0.3 \\ 0 & 0 & 0.15 & 0.55 & 0.3 \end{array} \right\} \\ = (0,\ 0.003,\ 0.167,\ 0.546,\ 0.283). \end{gathered}$$

Following the same method, the results of other first-level indices were assessed to be:

$$B_{U_2^1} = (0.025,\ 0.250,\ 0.350,\ 0.201,\ 0.174),$$

$$B_{U_1^2} = (0,\ 0,\ 0.118,\ 0.613,\ 0.269),$$

$$B_{U_2^2} = (0,\ 0.360,\ 0.221,\ 0.588,\ 0.156),$$

$$B_{U_3^2} = (0,\ 0,\ 0.119,\ 0.569,\ 0.313),$$

$$B_{U_4^2} = (0,\ 0,\ 0.112,\ 0.580,\ 0.309),$$

$$B_{U_1^3} = (0,\ 0.007,\ 0.300,\ 0.664,\ 0.250),$$

$$B_{U_2^3} = (0,\ 0.075,\ 0.424,\ 0.488,\ 0.014),$$

$$B_{U_3^3} = (0,\ 0.025,\ 0.475,\ 0.35,\ 0.15).$$

After the evaluation of the fuzzy matrix for the first-level indices, for the evaluation of the overall level in each dimension, the fuzzy matrix B_{U^i} was calculated using:

$$B_{U^i} = \left\{ \begin{array}{c} B_{U_1^i} \\ B_{U_2^i} \\ \vdots \\ B_{U_m^i} \end{array} \right\}, \tag{14}$$

where $B_{U_m^i}$ is the evaluation results of first-level index m in dimension i.

Therefore:

$$B_{U^1} = \begin{pmatrix} 0 & 0.003 & 0.167 & 0.546 & 0.283 \\ 0.025 & 0.250 & 0.350 & 0.201 & 0.174 \end{pmatrix},$$

$$B_{U^2} = \begin{pmatrix} 0 & 0 & 0.118 & 0.613 & 0.269 \\ 0 & 0.360 & 0.221 & 0.588 & 0.156 \\ 0 & 0 & 0.119 & 0.569 & 0.313 \\ 0 & 0 & 0.112 & 0.580 & 0.309 \end{pmatrix},$$

$$B_{U^3} = \begin{pmatrix} 0 & 0.007 & 0.300 & 0.664 & 0.250 \\ 0 & 0.075 & 0.424 & 0.488 & 0.014 \\ 0 & 0.025 & 0.475 & 0.35 & 0.15 \end{pmatrix},$$

where B_{U^1}, B_{U^2}, and B_{U^3} are the evaluation results of the first-level index for the GPV, GRB demand, and distance dimensions, respectively.

The weight of the first-level indices in each dimension must be used for the calculation of the overall value level in each dimension. The weights were calculated to be $W_{U^i} = \left\{W_{U^i_1}, W_{U^i_2}, \cdots, W_{U^i_m}\right\}(i = n)$, and the fuzzy matrix $\overline{B_{U^i}}$ was defined as $\overline{B_{U^i}} = W_{U^i} \cdot B_{U^i}$.

Thus, the fuzzy matrices of all dimensions were calculated to be:

$$\overline{B_{U^1}} = (0.003,\ 0.030,\ 0.187,\ 0.509,\ 0.051),$$

$$\overline{B_{U^2}} = (0,\ 0.048,\ 0.131,\ 0.602,\ 0.262),$$

$$\overline{B_{U^3}} = (0,\ 0.028,\ 0.358,\ 0.572,\ 0.172).$$

These were then multiplied by the numerical value of the assessment standard in order to measure the overall assessment results of the three dimensions:

$$Z_{U^1} = B_{U^1} * S^T = 2.915,$$

$$Z_{U^2} = B_{U^2} * S^T = 4.207,$$

$$Z_{U^3} = B_{U^3} * S^T = 4.278.$$

5. Results and Discussions

This section presents the findings of: (1) the measurement component of the model, (2) the structural component of the model, and (3) a comprehensive evaluation of case study. Each series of findings is followed by detailed discussions that present the implications of the findings for research and practice.

5.1. Measurement Component of the Model

The latent variable describing the GPV scale was measured using D1 and D2. The greater influence resulted from perceived value of benefit (D1 (0.75)). It indicated that consumers' overall evaluation of GRB shed light on their motivation to adopt GRBs, supported by previous studies [79,80]. For instance, Wang et al. suggested that perceived value significantly influences consumers' intention to adopt bicycle sharing [80]. The findings fully supported the role of the perceived value of benefit in determining homebuyers' purchasing behavior insofar as it affects consumer trust [81]. Among all the value dimensions in the perceived value of benefit, green value (A10, A11) was found to have the greatest effect, followed by the social and emotional values, while functional value was found to have the least influence. Green value, it should be noted, was the most attractive feature of a GRB. It revealed that today's homebuyers are keenly aware of the current environmental problems and thus desire to become involved in the green building movement [52,82]. Furthermore, the internal motivation is a predominant factor for promoting GRB [83,84], due to the features of social value and emotional value. However, the influence of functional value (A1, A2) was found to be not as large as green value, social value, or emotional value. It suggested that homebuyers were more tolerant of a GRB's undesirable quality and performance. On the other hand, the other motivation underlying homebuyers' desire for GRB was cost savings for energy and water.

The latent variable representing the GRB-demand scale was measured using D3–D6. The most significant factors were D3 (0.82) and D4 (0.73). Eco-friendliness (D3) denoted homebuyers' demand for GRB environmentally friendly features. It suggested that homebuyers who pay more attention to a GRB's eco-friendly technologies, such as ventilation, noise barriers, and green materials, have a stronger preference for GRBs. Improving the greenness of GRBs served as an important method to attract homebuyers' attention for GRBs. Moreover, individual consciousness about environmental protection is another important factor affecting homebuyers' purchasing behavior of GRBs. This was confirmed by the attitude–behavior correspondence [85], in which the environmental attitude can guide pro-environmental intention and behavior [86]. It implied that effective measures can be taken to increase consumers' environmental awareness and to advocate environmental protection habits.

The latent variable describing the psychological distance scale was measured using D7–D9. The most significant variable was cognitive distance (D7 (0.80)). It stressed the important role of the knowledge of sustainability in shaping homebuyers' intention to adopt GRBs. In the context of GRBs, the more knowledge homebuyers possessed, the smaller the recognition distance was. Furthermore, social distance (D8 (0.71)) ranked the second place in fostering homebuyers' acceptance of GRB. The social distance between consumers and GRBs represents the influence from the majority and the authoritative parties (e.g., developers and government). This can be explained by social trust and has been defined as the willingness to rely on those who are within homebuyers' social circles or have the expertise and responsibility to make decisions [87]. Usually, people do not have sufficient knowledge of GRBs to make decisions and take actions accordingly. In this circumstance, individuals tend to make decisions based on professional judgments or familiar opinions based on social trust.

5.2. Structural Component of the Model

The structural component of the model is presented in Figure 4. The three scales were verified to be significant in the proposed model. Based on the analysis of the model, the most significant influence on the homebuyers' purchasing behavior of GRBs was the psychological distance scale because the path coefficient referred to the importance of one factor on another factor. This signifies a highly significant level of the critical factor and the priority of scale 2 over the key factors of GRB purchasing behavior. The scale shows that GRB-demand had a similar importance degree with the psychological distance scale. It emphasized the leading position of homebuyers' demand in affecting their purchasing behavior toward GRBs. Obviously, demand is the driving force for the market development. As the important role of homebuyers in growing the GRB movement, their attitude toward GRBs and purchasing intention will in turn influence GRB value, which can be externalized through homebuyers' acceptance of GRBs. Therefore, resident-oriented thinking is urgently needed.

5.3. Comprehensive Evaluation of the Case Study

The value field force (F) is defined as the invisible driving force influencing homebuyers' GRB purchasing behavior, which presents the level of preference. Using the certified model, the driving force of purchasing GRB in Nanjing was calculated to be: $F = 0.9641 \times \frac{2.915 \times 4.207}{4.278} = 2.764$.

The degree of driving force is classified according to the score of field force, taking the following steps:

The values of GPV, GRB-demand, and psychological distance were determined to be integers ranging from 1 to 5 (1, 2, 3, 4, 5).

② The value field factor reflects the housing market environment, and was found to be approximately 1 according to the calculation in Section 3.

③ Based on Equation (1) and the statements above, there were found to be 125 possible field force scores for the GRB value.

④ All field force scores of the value field were ranked in order from smallest to largest.

⑤ All values were graded according to scoring frequency from one to five. Therefore, every 25 values were in the same internal, namely [0.2, 1], (1, 2], (2, 3.33], (3.33, 6], and (6, 25]. Grades corresponding to the five intervals are shown in Table 9.

Table 9. Grades corresponding to the five intervals.

Grade	Very Low	Relatively Low	Medium	Relatively High	Very High
Internal	[0.2, 1]	(1, 2]	(2, 3.33]	(3.33, 6]	(6, 25]

It shows that the driving force influencing homebuyers' GRB purchasing behavior in Nanjing was on the upper-medium level.

The market for GRBs in Nanjing was reflective of the current state of GRBs in China. Although national and provincial strategies promoting GBs have been proposed, including legislation, regulation, and technological innovations [88], few measures have been implemented to enhance homebuyers' willingness to purchase GBs. This may be due to a failure on the part of government and other stakeholders (e.g., developers, experts) to understand that desirable performance and benefits are sufficient to convince homebuyers to adopt GBs. In this context, the present study has focused on the homebuyers of GRBs.

From a methodological perspective, this study may provide impetus for the application of field theory in other contexts. The findings can also inform efforts by policy-makers to develop resident-oriented policies and by developers to promote the GRB movement. While the study's setting is China, the findings may also provide valuable implications for other developing countries.

Despite the theoretical and practical implications of this research, it is also important to recognize its limitations. First, the data collected from the questionnaire survey was subjective since individuals' knowledge of GRBs varies due to educational background, occupation, socio-economic status, etc. Second, the impact level of the factors identified in this study may differ in different regions and countries. Thus, future research should explore the importance of the identified factors in multi-regional contexts. In addition, comparative studies using the field force concept could be conducted in different regions.

6. Conclusions

The increasingly urgent environmental situation and low market demand for GBs has prompted an increased focus on homebuyers' GB consumption. To address this gap, theoretical and empirical research was conducted for the purpose of developing a value field model for evaluating a homebuyer's GRB purchasing behavior. The proposed model of the GRB value field was based on field theory and analyzed the force of GRBs on homebuyers in terms of the GRB value. In the process of constructing the proposed model, a scale referred to as the value field factor (K) was analyzed based on the existing logistic field factor and was calculated to be approximately 1. Thus, the proposed model incorporated "green perceived value", "GRB-demand", and "psychological distance" with 40 indicators identified through a questionnaire survey and statistical analysis. The results showed that the GRB value exerts an invisible driving force on homebuyers' GRB purchasing behavior, named as a value field force. Overall, the psychological distance had the most significant influence on homebuyers' GRB purchasing behavior, followed by the GRB demand, and lastly, the green perceived value. The scale of psychological distance was comprised of three dimensions, "cognitive distance," "social distance," and "spatial distance". These dimensions negatively influenced homebuyers' purchasing behavior regarding GRBs according to the SEM results. It also indicated that eco-friendliness, environmental awareness, energy conservation, and environmental protection behavior in the GRB-demand scale positively affected homebuyers' behavior. Furthermore, the perceived value of benefit and perceived value of cost comprised the scale "green perceived value." Among the above factors, cognitive distance, eco-friendliness, and perceived value of benefit were the three most significant ones to motivate homebuyers to adopt GRBs.

The findings suggest that resident-oriented policies should be developed to motivate homebuyers' purchasing behavior. Resident-oriented policies should focus on the GRB demand determinants. GRB demand relies on consumers' environmental awareness and environmental protection habits. Thus, to enhance homebuyers' environmental protection awareness, communication and education regarding environmental problems and the importance of environmental protection should be established and directed toward homebuyers, and policies targeting psychological distance determinants (cognitive distance and social distance) are also needed. Cognitive distance refers to knowledge of GRBs, which has been regarded as an efficient method of increasing homebuyers' acceptance of GRBs, considering that in the current situation, homebuyers care more about price and location of the residence. In fact, many homebuyers do not know whether their housing has a green building label or not. Educating them with knowledge of GRBs makes the green building label become a selling point. Given that social distance is associated with social trust, social distance can be reduced by enhancing social trust. When knowledge of GRBs is low, a high degree of social trust can convince homebuyers to adopt GRBs. Several measures should thus be implemented for improving social trust. The aforementioned methods regarding homebuyers' education and communication can also be effective in fostering trust among homebuyers. The education and communication may make GRB popular among the public, and homebuyers may thus be affected by the positive GRB market atmosphere. Moreover, active information-sharing increases the credibility of the government and related organizations, which can affect homebuyers' attitudes toward GRBs. In addition, the findings imply that developers of GRBs need to improve their marketing strategies to meet consumer demand. They can investigate their targeted consumers' psychological and social factors and gain a clear understanding of the degree to which consumers have a positive attitude towards GRBs. For people who exhibit little or no interest in GBs, marketers should ascertain the amount they are willing to pay under the win-win principle. For ecologically concerned consumers, developers could offer more information about GRBs as an effective strategy to improve the GPV.

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Data Availability: The data used to support the findings of this study are included within the article.

Appendix A.

Table A1. Transportation development level (2017).

Indicators (Unit)	Beijing	Shanghai	Guangzhou	Shenzhen	Nanjing	Tianjin
Number of civilian vehicles per capita (vehicle/thousand people)	0.0288	0.0156	0.0189	0.0311	0.0299	0.0222
Number of buses per capita (vehicle/ten thousand people)	11	7	10	14	14	8
Total rail mileage (km)	684.4	731.4	357.9	298.2	364.9	175.3

Table A2. Economic development level (2017).

Indicators (Unit)	Beijing	Shanghai	Guangzhou	Shenzhen	Nanjing	Tianjin
Disposable income per capita (yuan)	57,230	58,988	55,400	52,938	48,104	37,022
GDP (billion yuan)	28,000.4	30,133.86	21,503.15	22,438.39	11,715.10	18,595.38
GDP growth rate (%)	6.7	6.9	7	8.8	8.1	3.6

Table A3. Society development level (2017).

Indicators (Unit)	Beijing	Shanghai	Guangzhou	Shenzhen	Nanjing	Tianjin
Engel coefficient	21.5	35	32.1	32.5	40.4	30.6
Unemployment rate (%)	1.5	4.1	2.35	2.45	4	3.5
Homebuyers population (ten thousand people)	2170.7	2418.33	1449.84	1252.83	833.50	1556.87

Table A4. Housing demand (2017).

Indicators (Unit)	Beijing	Shanghai	Guangzhou	Shenzhen	Nanjing	Tianjin
Residential sales price (yuan/m^2)	24,550	24,866	18,000	56,800	16,640	15,812
Residential sales area (ten thousand m^2)	1133.9	1691.6	1232.51	417.93	710.43	1168.25
living space per capita (m^2 per capita)	32.38	35.3	35	24.47	36.5	30

Table A5. Dimensionless variables of the value field factor of GRBs.

	Beijing	Shanghai	Guangzhou	Shenzhen	Nanjing	Tianjin
K11	1.1795	0.6389	0.7741	1.2737	1.2246	0.9092
K12	1.0313	0.6563	0.9375	1.3125	1.3125	0.75
K13	1.5721	1.6800	0.8221	0.6850	0.8382	0.4027
K21	1.2690	1.3657	0.9746	1.0170	0.5310	0.8428
K22	0.9781	1.0073	1.0219	1.2847	1.1825	0.5255
K23	1.1088	1.1429	1.0734	1.0257	0.9320	0.7173
k31	0.6715	1.0932	1.0026	1.0151	1.2618	0.9558
K32	0.5028	1.3743	0.7877	0.8212	1.3408	1.1732
K33	1.3452	1.4986	0.8985	0.7764	0.5165	0.9648
K41	0.9402	0.9523	0.6894	2.1753	0.6373	0.6056
K42	1.0706	1.5972	1.1637	0.3946	0.6708	1.1031
K43	1.0033	1.0937	1.0844	0.7582	1.1309	0.9295

Note: $x^*_{ij} = \frac{x_{ij}}{\widetilde{x}}$, where x_{ij} is the original data, $\widetilde{x}$ is the the average of the original data, and x^*_{ij} are the dimensionless variables.

Table A6. Weights of the indicators of K.

	Variable	σ_i	$\bar{x}_i$	V_i	W_i
K1 (0.47)	K11	0.24	1.0000	0.24	0.25
	K12	0.25	1.0000	0.25	0.26
	K13	0.47	1.0000	0.47	0.49
K2 (0.21)	K21	0.27	1.0000	0.274	0.30
	K22	0.31	0.6250	0.502	0.55
	K23	0.14	1.0000	0.143	0.16
K3 (0.14)	K31	0.18	1.0000	0.18	0.21
	K32	0.32	1.0000	0.32	0.39
	K33	0.33	1.0000	0.33	0.40
K4 (0.18)	K41	0.54	1.0000	0.54	0.52
	K42	0.38	1.0000	0.38	0.36
	K43	0.13	1.0000	0.13	0.12

Note: (1) $V_i = \frac{\sigma_i}{\overline{x}_i}$, where V_i is the coefficient of the variation index, σ_i is the standard deviation, $\overline{x}_i$ is the average of the original data; (2) $W_i = \frac{V_i}{\sum_{i=1}^{n} V_i}$, where W_i is the weight of the variation coefficient.

Appendix B. Questionnaire about How Green Residential Building Value Affects Homebuyers' Purchasing Behavior

Dear Sir/Madam:

I am a PhD student from Southeast University. The questionnaire is about how green residential building values affects occupants. Please answer the following questions based on your real understanding and feeling about green residential buildings. The questionnaire survey is absolutely anonymous. Thanks for your help.

Part one—personal information

1. Gender

○ Male

- ○ Female

2. Age

- ○ 20–29 year old
- ○ 30–39 year old
- ○ 40–49 year old
- ○ 50–59 year old
- ○ 60 year old and above

3. Education

- ○ Junior school and below
- ○ High School
- ○ Junior College
- ○ Undergraduate
- ○ Postgraduate

4. Total annual household income

- ○ ≤¥100,000
- ○ ¥100,000–¥300,000
- ○ ¥300,000–¥500,000
- ○ ¥500,000–¥1,000,000
- ○ >¥1,000,000

5. Occupation

- ○ Civil servants
- ○ Technician
- ○ Officer
- ○ Teacher
- ○ Student
- ○ Worker
- ○ Freelance
- ○ Private owner
- ○ Others

6. Family member

- ○ Single
- ○ A family of two
- ○ A family of three
- ○ A family of four
- ○ A family of five and above

7. Working address

- ○ Gulou District
- ○ Xuanwu District
- ○ Qinhuai District
- ○ Jianye District

- ○ Yuhuatai District
- ○ Qixia District
- ○ Jiangning District
- ○ Pukou District
- ○ Luhe District
- ○ Gaochun District
- ○ Lishui District
- ○ Other cities ()

8. Residence address

- ○ Gulou District
- ○ Xuanwu District
- ○ Qinhuai District
- ○ Jianye District
- ○ Yuhuatai District
- ○ Qixia District
- ○ Jiangning District
- ○ Pukou District
- ○ Luhe District
- ○ Gaochun District
- ○ Lishui District
- ○ Other cities ()

9. Is agreen residential building your first choice when you plan a building purchase?

- ○ Yes
- ○ No

Green Perceived Value

	Strongly disagree	Fisagree	Uncertainty	Agree	Totally agree
Do you think GRBs are of high quality?					
Do you think a green building is good for health?					
Will you abandon GRBs because of the high price?					
Will you purchase a GRB because of low maintenance cost?					
Will you purchase a GRB because of low cost of water, electricity, and gas?					
Do you think GRBs stimulate your desire to buy a GRB?					
Do you feel comfortable when purchasing a GRB?					
Do you think purchasing a GRB can bring you a sense of harmony with nature?					
Do you think purchasing a GRB can reflect your lifestyle and attitude?					
Do you think purchasing a GRB can improve the ecological environment?					
Do you think purchasing a GRB can improve individual's environmental protection awareness?					
Do you think a GRB is good for the sustainable development of society?					
Do you think purchasing a GRB can win more praise?					
Do you think purchasing a GRB can help you establish a healthy image?					
Do you think purchasing a GRB can provide a sense of social responsibility?					

Green life attitude (GRB demand): Living attitude (LA), environmental protection attitude (EA), environmental protection habit (EH)

Living attitude

	Totally unimportant	Unimportant	General	Important	Very important

Do you think it is important to use green energy in residential buildings?

Do you think it is important to use water-saving appliances?

Do you think it is important to reasonably select and optimize a heating and air conditioning system to effectively reduce energy consumption?

Do you think it is important to have natural ventilation in your house?

Do you think it is important to apply sound insulation building material to effectively block noise from outside the house?

Do you think it is important to have a green residence community?

Do you think it is important to use green materials?

Do you think it is important for a residential building to cause less pollution and impact on the environment in use?

Environmental protection attitude

Strongly disagree Disagree Uncertainty Agree Totally agree

Are you willing to change your lifestyle to protect the environment?

Do you often pay attention to various environment issues and take the initiative to understand various environmental information?

Are you worried about the environmental pollution you meet?

Are you willing to actively participate in environmental protection activities?

Environmental protection habit

Totally not Seldom General Many times Always

Do you usually use disposable products (e.g., plastic bags, paper, towels, etc.)?

Do you save resources in ordinary life?

Are you inclined to buy energy-saving household appliances?

Do you usually buy non-toxic and non-phosphorous laundry powder, soap, and detergent?

Psychological Distance: Social distance (SOD), cognitive distance (CD), and spatial distance (SPD)

Social distance

Strongly disagree Disagree Uncertainty Agree Totally agree

Will you be influenced by people around you when choosing a residence?

Developers' publicity and promotion will affect your choice of green residential building

Government's incentive policies will encourage you to purchase a GRB

Families' suggestions will affect your choice of GRB

Suggestions from friends and colleagues will affect your choice of GRB

Cognitive distance

Unknown Don't know much Unsure Know Know well

Do you know about GRBs?

Do you know that GRBs can save resources?

Do you know that GRBs can improve residential comfort?

Do you know that GRB can protect the environment?

Do you know that the price of GRB is higher than an ordinary residential building in the same condition?

Do you know that the operating cost of a GRB is lower than an ordinary residential building in the same condition?

Spatial distance

Strongly disagree Disagree Uncertainty Agree Totally agree

The road around a GRB is more accessible

A GRB has perfect public transport

If you have any other suggestions for this questionnaire, please list them below:

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