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How Gamified Interactions Drive Users' Green Value Co-Creation Behaviors: An Empirical Study from China

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Abstract: To achieve the "double carbon" goal, green value co-creation has been paid more and more attention. However, the role of users in green value co-creation, which is a vital aspect, could be overlooked. Understanding the internal mechanism between gamified interactions and users' green value co-creation behaviors is crucial to motivating users' green value co-creation behaviors. This study collected data from 410 Ant Forest users by adopting a questionnaire survey. Subsequently, this study investigated the influence mechanism of gamified interactions on users' green value co-creation behaviors. The findings demonstrate that interactivity, cooperation, and competition are gamified interactions that positively affect users' green value co-creation behaviors. Emotional energy acts as a mediator between gamified interactions and users' green value co-creation behaviors. No relational distance was found to moderate the effect of gamified interactions on emotional energy. This study contributes to the current understanding of the relationship between gamified interactions and users' green value co-creation behaviors within the "double carbon" context. Furthermore, it offers theoretical guidance for Internet enterprises to enhance users' green value co-creation behaviors through gamified interactions.

Keywords: gamified interactions; users' green value co-creation behaviors; emotional energy; relational distance

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1. Introduction

With global warming posing a huge threat to human survival and development, China has assumed responsibility in tackling carbon emissions and has proposed the "double carbon" target, which is to achieve carbon peak by 2030 and carbon neutrality by 2060 [1–3]. In this context, Internet companies have begun to attach importance to green development and cooperate with their partners to co-create green value. Among them, e-commerce platforms have emerged as key players that engage a large user base through diverse gamified interactions, effectively guiding users' green behaviors and fostering collaboration between users and enterprises to create green value. Ant Forest, a prominent example, is dedicated to promoting public participation in low-carbon emissions reduction [4,5]. Ant Forest has achieved remarkable success and gained international recognition. It was awarded the "Champions of the Earth" by the United Nations on 19 September 2019 [6]. These business practices and prestigious accolades demonstrate the substantial practical value that individual users contribute to green value co-creation. The term 'green value co-creation' initially proposed refers to the active sharing of environmental ideas between a company and its partners and participation in one or more stages of production or consumption to create value [7]. Subsequently, green value co-creation is defined as a process involving the exchange of environmental ideas between customers and the company, with the involvement of customers potentially occurring at both the production and consumption stages to enhance the value co-creation [8]. The latter definition specifies 'customers'

from the previous definition's 'partners' and highlights that their participation can improve value co-creation. Furthermore, the academic community is actively researching the determinants of green value co-creation, focusing on various entities across different industries, and has also found it to be beneficial for green product innovation or green innovation [7–10]. Research shows that green innovation plays a pivotal role not only in fostering the sustainable development of enterprises but is also particularly significant for achieving environmental sustainability [11,12]. Therefore, studying the involvement of different partners or customers, such as individual users in green value co-creation, holds immeasurable benefits to environmental protection. However, research pertaining to the individual users' green value co-creation behaviors has been overlooked.

Users play a crucial role in creating green value [7]. At the practical level, Ant Forest has translated the green actions of over 500 million users into tree planting in China, underscoring the significance of users as a vital group in green value co-creation [6]. Simultaneously, following the service-dominant logic, enterprises integrate resources to accomplish value creation for their users [13]. However, the existing research on green value co-creation needs to pay more attention to the individual users. Therefore, it is crucial to prioritize users and consider them as a fundamental group in research to investigate the factors that influence user green value co-creation to enhance the implementation of green value co-creation. Additionally, gamified interaction has garnered considerable attention from the academic community due to its potent effectiveness and potential. Research has demonstrated that gamified interaction significantly impacts users' behaviors [14,15]. However, few studies investigate gamified interactions' effect on green value co-creation in e-commerce platform systems. Therefore, this study explores the influence of gamified interaction on users' green value co-creation behaviors and the underlying mechanism between the two from the user's perspective, aiming to enhance the overall green value.

The interaction ritual chains theory offers a theoretical foundation for elucidating the underlying mechanism of gamified interaction and users' green value co-creation behaviors. Interaction rituals consist of the following four primary components: group presence (at least two people in the same space), establishing boundaries for outsiders, a shared focus, and shared emotional experiences [16]. Simply put, the theory posits that interaction rituals generate ritual outcomes such as emotional energy, and emotional energy makes action ready [17]. Prior research in the field of information systems has investigated the influence of interaction on emotional energy [18,19] and behavioral outcomes [20,21]. However, there needs to be more exploration into the factors that influence users' green value behaviors, including gamified interaction.

In summary, this study explores the influence of gamified interaction on users' green value co-creation behaviors, and the mechanism between the two, based on the interaction ritual chains theory and from the user's perspective. The questionnaire survey method is employed for data collection. This study contributes to advancing research on gamified interactions and users' green value co-creation behaviors. Moreover, it aims to offer practical value by providing management insights into whether Internet enterprises need to adopt gamified interaction and how to use it to guide users' green value co-creation behaviors.

2. Literature Review

2.1. Green Value Co-Creation

The concept of green value co-creation was initially introduced by Chang (2019) [7], which is the active sharing of environmental ideas between a company and its partners and participation in one or more stages of production or consumption to create value. Green value co-creation can be divided into green co-production and green use value. Green co-production refers to the collaborative process with enterprises in the development of green innovation, and green use value is defined as the experiences of customers or companies in learning how to use, repair, and maintain green products [7]. The participants in green value co-creation encompass enterprises and groups of users [7,13]. Thus, drawing on the definitions of green value co-creation and value co-creation behaviors [7,22], and taking the

user's perspective into account, this study defines users' green value co-creation behaviors as a positive behavior when users share the environmental concept of the enterprise and participate in one or more production or consumption stages to create value, with the primary value generated being the green use value.

Researchers are gradually embarking on the exploration of the antecedents and outcomes of green value co-creation. As shown in Table 1, existing studies primarily employ survey methods and have found that the influencing factors of green value co-creation mainly include green motives, distance with customers, green business strategies, green competencies, green practices, and green dynamic capabilities, etc. Meanwhile, green value co-creation positively influences green product innovation performance, firm performance, green product innovation, and green innovation, etc.

Table 1. Research on green value co-creation.

Antecedents	Outcome Variables	Research Object	Method (Sample)	Main Findings	Source
Green motives: instrumental motives, relational motives, moral motives	Green product innovation performance	Manufacturing companies	Survey (n = 157)	Moral motives positively influence green co-production and green value-in-use. Instrumental motives, alongside moral motives, enhance green product innovation performance.	[7]
Distance with customers: cognitive proximity, social proximity	Green product innovation	Chemical industry	Survey (n = 211)	Social and cognitive proximity can foster green co-production and elevate the performance of green product innovation.	[9]
Green business strategies and green competencies	Green innovation	Manufacturing firms	Survey (n = 319)	Green competencies and green business strategies positively impact green value co-creation and green innovation. Green value co-creation enhances firms' green innovation.	[10]
Green practices and green dynamic capabilities	Green innovation	Production concerns	Survey (n = 370)	Green practices and green dynamic capabilities positively affect green value co-creation, which in turn can enhance a firm's green innovation.	[8]
Green market pressure	Firm performance, green dynamic capability	High-tech manufacturing companies	Survey (n = 274)	Green market pressure positively influences green value co-creation, which subsequently bolsters the firm's performance.	[23]
Green dynamic capabilities, innovative finance, green innovation strategy	Green innovation	University teachers	Survey (n = 330)	Green innovation strategy positively influences green value co-creation, which can enhance green innovation among Chinese teachers.	[24]
Green motive, sustainability-oriented values, green dynamic capabilities, green practices	Green innovation	Manufacturing industry	Survey (n = 449)	Green value co-creation mediates the relationship between green motive, sustainability-oriented values, green dynamic capabilities, and green practices on green innovation.	[25]
Green practices, green dynamic capabilities	Green innovation	Employees in small- and medium-sized enterprises	Survey (n = 245)	Green value co-creation plays a significant mediating role in linking green practices and green dynamic capabilities with green innovation.	[26]

Note: Green value co-creation can be divided into green co-production and green value-in-use in the first three papers in the table.

Studies on green value co-creation are primarily concentrated on tangible enterprises. Studies on organizational green value co-creation lay the theoretical groundwork and foster development within the societal context. However, the present research overlooks the role of users and lacks exploration into users' green value co-creation behaviors, and users are vital participants in green value co-creation.

2.2. Gamified Interactions

Gamification represents the integration of game design elements into non-game settings [27]. Gamified interaction refers to a phenomenon of companies using gamification to create engaging experiences with their customers [28]. Gamification is an overarching concept that includes the general practice of integrating game elements into non-game contexts. On the other hand, "gamified interaction" denotes a more specific application of this approach within the realm of interactive design, particularly aiming to elevate the quality and depth of engagement between users and the system. Based on the research background, the gamified elements examined in this study are classified as social elements [29]. As a result, gamified interaction primarily centers around the interaction between users and these social gamified elements. In combination with the realistic research context, this study defines gamified interaction as the interaction between users and gamified elements in the gamified system that give them the opportunity to establish or manage social relationships with other users to achieve some goals.

Gamified interactions can positively influence intent, performance, and behavior. Specifically, in business management, gamified interactions mediate the relationship between cognitive and emotional brand engagement and brand usage intent [30]. In education, gamified interactions can enhance users' learning performance through social presence and perceived social support [31]. Recent studies have applied gamified interactions to environmental protection and have shown that gamified interactions can directly stimulate low-carbon behavior in users; moreover, cooperative interactions trigger users' normative, hedonic, and gain motivations for embracing low-carbon behaviors, while competitive interactions primarily drive motivated hedonic and gain goals [14]. Hence, gamified interactions can not only directly generate positive impacts but also yield positive results through different mechanisms. Furthermore, decomposing gamified interactions into distinct components will facilitate a more nuanced investigation of their impacts.

Based on a synthesis of the existing literature [14,32] and our definition of gamified interactions within this paper, we propose the following three distinct gamified interaction modes: interactivity, competition, and cooperation. Specifically, the existing literature categorizes gamified interactions into different types. In mobile learning, gamified interaction encompasses social interaction, competitive interaction, and team interaction [32]. A recent study indicated that gamified interaction involves cooperative and competitive interaction [14]. Additionally, elements of gamification, such as competition and interactivity, are known to enhance user interaction with business systems [33]. This paper posits that gamified interactions emphasize interaction between users and various gamified elements, such as interactivity, cooperation, and competition. Therefore, based on the research background, this study contends that gamified interaction can be categorized into the following three types: interactivity, cooperation, and competition. However, regarding environmental protection, few studies have systematically examined the impact of the three gamified interaction modes—interactivity, cooperation, and competition—on users' green value co-creation behaviors, which are an indispensable part of green value co-creation.

2.3. Interaction Ritual Chains Theory

The interaction ritual chains (IRC) theory posits that interaction rituals mainly comprise the following four elements: group presence (at least two individuals in the same physical space), establishing boundaries for outsiders, a shared focus, and shared emotional experiences. When effectively combined, these elements give rise to outcomes like emotional energy, thereby facilitating behavioral readiness [16]. Scholars have applied IRC theory in the study of various fields, including tourism [34], hospitality [35], and education [36].

The concept of emotional energy originates from the IRC theory. According to the IRC theory, emotional energy refers to a state of confidence, elation, power, enthusiasm, and initiative when an individual takes action [16]. Emotional energy can be characterized by intense or divisive emotions (such as excitement, delight, joy, and noise) and can also

be observed in behavioral intentions, such as active participation or vigorous physical activity [16]. In combination with the research context, this study defines emotional energy as follows: emotional energy is the positive energy state of an individual's emotions in a specific situation. It is a kind of emotion.

Interaction rituals can generate emotional energy, which in turn can motivate behavior. The general characteristic of emotional energy is that it promotes positive action [16]. Studies have shown that interaction rituals can generate emotional energy [37,38], and emotional energy positively affects individual behavior [38]. However, in the context of green value co-creation, the following question arises: can emotional energy mediate between gamified interactions and users' green value co-creation behaviors? This is the question that this study seeks to explore.

3. Research Hypothesis

In short, the theory of interaction ritual chains posits that interaction rituals can generate emotional energy, which in turn facilitates constructive behavior [16]. Therefore, based on the "interaction–emotional energy–behavior" framework, this study develops a conceptual model, as depicted in Figure 1. This study proposes nine hypotheses to investigate the relationship among gamified interaction, user' green value co-creation behaviors, emotional energy, and relational distance.

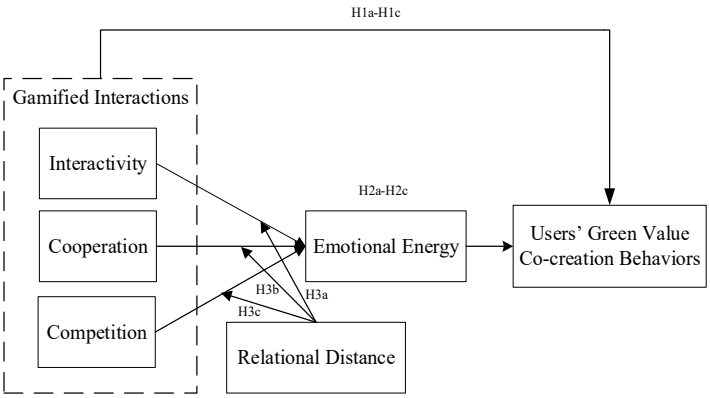

Figure 1. The conceptual model.

3.1. Gamified Interaction and Users' Green Value Co-Creation Behaviors

This study categorizes gamified interaction into three types, interactivity, cooperation, and competition, based on previous research [39,40] and the context of this study. The aim is to investigate the association between gamified interaction and users' green value co-creation behaviors.

Interactivity refers to the communication between individuals and others in the process of accomplishing the goal of the target system [39]. It is the core gamification element [41], containing various forms like comments and conversations [39]. Interactivity promotes users' continuous use of information systems to exhibit pro-environmental behaviors [4]. In addition, interactivity in games can motivate users to participate in co-creation [42]. Furthermore, gamification refers to the integration of game design elements into non-game contexts [27]. Therefore, we contend that interactivity can stimulate co-creation behaviors among users. Based on our analysis, this study posits the following hypothesis:

H1a.: *Interactivity positively influences users' green value co-creation behaviors.*

Cooperation refers to the behavior of individuals working towards a common goal [43]. It is considered one of the core gamification elements [41], allowing individuals to form teams through gamification elements to pursue objectives collectively within the system [39]. Cooperation can foster mutual assistance among users [44]. Moreover, it establishes a favorable social environment for team members, facilitating teamwork toward

achieving common goals [45]. Cooperation is a prevalent form of gamified interaction, supported by research demonstrating its positive impact on encouraging users' energy-saving behaviors [46]. Furthermore, it not only promotes low-carbon behavior among consumers but also encourages the standardization of such behavior [14]. In summary, this study posits that cooperation can stimulate users' green value co-creation behaviors. Therefore, the following hypothesis is proposed:

H1b.: *Cooperation positively influences users' green value co-creation behaviors.*

Competition refers to the idea of challenging and competing with others, with the result that one player or group of players may win and the other players lose [29]. Competition is a prevalent gamification element [47] and one of its fundamental components [41]. It also fosters multi-user engagement through competitive elements [48]. In green environmental protection, the competitive gamification element plays a crucial role in enhancing users' intrinsic motivation toward energy-saving behaviors [41]. Additionally, competition within gamification can incentivize users to adopt pro-environmental behaviors [4,14,49]. Thus, this study presents the following hypothesis:

H1c.: *Competition positively influences users' green value co-creation behaviors.*

3.2. The Mediating Role of Emotional Energy

Within gamified contexts, interactivity, cooperation, and competition can elicit positive emotional energy in users, and emotional energy promotes behavior. Specifically, online interactivity can motivate users to generate emotional energy [50]. Similar findings have also been confirmed in gamification systems. For example, interpersonal interactivity can positively affect the emotions of consumer engagement [51]. Additionally, research has demonstrated that cooperation can foster positive user emotions within gamified scenarios, including enthusiasm and curiosity [52,53]. Likewise, competition in the form of badges, leaderboards, points, and levels has the capacity to stimulate users' emotional energy [54]. As a crucial component of gamified interactions, competition positively influence users' emotions [49,55,56]. This finding is further corroborated in studies involving children. For instance, within the context of gamified interactions, competition can elicit positive emotions, such as happiness, curiosity, and enthusiasm, in children [52]. Moreover, emotions affect user behavior [49]. Recent research has indicated that emotions mediate the relationship between gamification and pro-environmental behavior [49]. Emotional energy is essentially an emotion. Therefore, we posit that gamified interactions positively influence users' emotional energy, and emotional energy is beneficial to behavior.

Interaction positively affects users' emotional energy, which in turn affects users' behaviors. Specifically, competition, as a form of gamified interaction, has been found to positively influence emotions, which in turn impact user behavior [49]. Drawing from the interaction ritual theory, the study examined the role of interaction rituals in disseminating "expression culture". The study elucidates how interaction fosters the development of positive emotional energy and its significant impact on behavior [57]. Similarly, scholars employing the same theory have discovered that interaction can generate emotional energy, consequently positively influencing individual behavior [58]. This finding has also been validated in work environments, where emotional energy is an intermediary between interaction rituals and employee behavior [59]. Furthermore, interaction can foster group identity formation among multiple users, leading to the generation of emotional energy [19]. The emotional energy subsequently plays a constructive role in influencing user behavior [60]. Moreover, live interactions elicit feelings of joy and happiness in individuals [37]. In value co-creation, gamified social emotion mechanisms positively influences the value creation of dialogue, access, transparency, and risk, and customer emotion plays a pivotal role in embracing platforms in the business–business–consumer (B2B2C) ecosystem [61]. Therefore, this study postulates that gamified interactions can generate emotional energy,

subsequently influencing behavior. Thus, this study postulates that gamified interactions can stimulate users' emotional energy, which in turn affects behavior. In summary, this study posits the following hypotheses:

H2.: *Emotional energy plays an intermediary role between interactivity (H2a), cooperation (H2b), competition (H2c), and the user's green value co-creation behavior; that is, interactivity, cooperation, and competition enhance the user's emotional energy and then promote users' green value co-creation behaviors.*

3.3. The Moderating Effect of Relational Distance

Relational distance refers to the degree to which people feel socially close to another person, often embodied in the spatial metaphor of proximity [62]. Relational distance can be divided into two categories (close and distant). Individuals in closely related groups know more about each other compared to those in distantly related groups [63]. Moreover, individuals within the closely related group exhibit higher levels of trust and cooperation towards one another [62]. In the event of a group service failure, consumers with close relationships prioritize the interests of others and develop a stronger sense of closeness towards fellow group members [64]. Similarly, people tend to have more frequent interactions with people with whom they are closer (people with closer distance), more pleasant emotional connections, stronger intimacy drives, and greater awareness of each other's personality traits [62]. Consequently, individuals are more inclined to view individuals with close relationships, including family members and close friends, as members of the same interaction ritual, while those with distant relationships, like strangers, are excluded from this categorization [62]. In summary, people exhibit varying responses to different relational distance, including emotions. In addition, emotional energy is also an emotion. Therefore, we speculate that relational distance also plays a moderating role in the impact of gamified interaction on users' emotional energy.

Building upon the classification of relational distances (close, intermediate, and distant) [62], combined with the study scenario, this study categorizes relational distance into intimate relationships and non-intimate relationships. Intimate relationships comprise familial connections, close relatives, romantic partners, and close friends, whereas non-intimate relationships encompass ordinary acquaintances, colleagues, and unfamiliar individuals. In the context of intimate relationships, users are able to feel stronger intimacy, have stronger feelings for the people in close relationships, and their emotional energy is more easily stimulated when engaging in gamified interactions. In the case of non-intimate relationships, users feel a lower degree of intimacy, and their emotions for non-intimate-relationship people are weaker, and gamified interaction may have less impact on their emotional energy. Gamified interaction in this study includes interactivity, cooperation, and competition. Therefore, we argue that relational distance (intimate and non-intimate) has a mediating role between gamified interactions and emotional energy. Thus, we put forth the following hypotheses:

H3a.: *Relational distance positively moderates interactivity, affecting emotional energy.*

H3b.: *Relational distance positively moderates the influence of cooperation on emotional energy.*

H3c.: *Relational distance positively moderates the influence of competition on emotional energy.*

4. Research Method

4.1. Participants

This study used Ant Forest platform users as the research object. Ant Forest is a virtual and real platform created for community users using digital technologies in China [65]. The low-carbon actions performed by Ant Forest users can be converted into virtual "green energy". Once a user's accumulated "green energy" reaches a specific threshold, they can

apply for planting a real tree in the Ant Forest environmental protection public welfare mini-program in the area that urgently needs ecological restoration. This process is akin to how consumers earn points after making purchases, which can then be exchanged for gifts from merchants. In Ant Forest, users can participate in various gamified interactions, which is an essential factor for Ant Forest to attract numerous users to participate continuously [4,5]. In detail, Ant Forest incorporates gamified elements such as interactivity, cooperation, and competition (see Figure 2). Figure 2 is a screenshot taken by the authors from Ant Forest. The figure consists of three parts: left, center, and right. As shown in Figure 2, users can engage in communication through various functions, such as sending and leaving messages (to facilitate interactivity). They correspond to the right side of the square box in the left image and the left side of the square box in the center image, respectively. Additionally, competition can be reflected in the two rectangles on the left. These two rectangles (from top to bottom) represent the comparison between the grams of green energy collected from friends and the grams of green energy collected by friends, as well as the forest leaderboards (from top to bottom, including daily, weekly, and total rankings; today's energy board, and the board for the most energy collected by friends). Additionally, Ant Forest features a cooperative mechanism that allows users to participate in "co-species" (to achieve cooperation). Cooperation is reflected in the "watering" on the right side of the center image and the "co-species" in the right image. In conclusion, Ant Forest stands out as the most prominent example of a gamified interactive platform [4,5].

Figure 2. The gamified interactions (interactivity, cooperation, and competition) of Ant Forest.

4.2. Measures

To collect representative data, this study used a questionnaire survey method to carry out the research [66]. Before the formal investigation, a preliminary investigation was performed to assess the reliability and validity of the questionnaire. We recruited Ant Forest users from the offline community of the Ant Forest platform on Alipay as study participants and collected data through online research. The formal questionnaire used was finally determined. This study was divided into two scenarios and divided into two groups according to the actual situation. Finally, we disseminated the questionnaire online, collected the data, and utilized SPSS 24.0 and Mplus 8.3 for data analysis.

Participants were instructed to read the following passage as part of the situational manipulation: "Before starting the questionnaire, please open Alipay and access the Ant Forest platform. Your objective is to plant at least one tree in Ant Forest. In collecting green energy, there is a person who leaves the strongest impression on you, referred to as 'M'. All the questions below are for the most impressive M. There are no right or wrong answers. Please respond truthfully and in sequential order, based on your genuine sentiments". Following a thorough reading of the materials, participants proceeded with completing the questionnaire.

In total, 449 questionnaires were collected from 9 October 2022, to 22 November 2022. After meticulously reviewing the questionnaires, 410 valid questionnaires were retained (with 200 people in the intimate relationship group and 210 people in the non-intimate relationship group), discarding those with irregular, incorrect, or incomplete responses to the test questions. Table 2 presents the demographic characteristics of the participants.

Table 2. Descriptive statistics of research samples.

Variables	Items	Frequency	%
Gender	Male	192	46.8
	Female	218	53.2
Age (years)	18–22	184	44.9
	23–32	196	47.8
	33–42	26	6.4
	43–52	3	0.7
	53–65	1	0.2
Occupation	Student	218	53.2
	Teacher	66	16.1
	Employees of government agencies or institutions	8	2.0
	Corporate/corporate staff	49	12.0
	Individual industrial and commercial households	6	1.4
	Unemployed people	3	0.7
	Retired personnel	1	0.2
	Other	59	14.4
Working years	<1	250	61.0
	1–3	86	21.0
	3–5	36	8.8
	5–10	18	4.4
	>10	20	4.8
Use frequency	Now and then	128	31.2
	At times	84	20.5
	Frequently	140	34.2
	Always	25	6.1
	Every time	33	8.0
Average monthly income (RMB)	<1000	155	37.8
	1001–3000	98	23.9
	3001–5000	87	21.2
	5001–10,000	48	11.7
	10,000–20,000	14	3.4
	>20,000	8	2.0

4.3. Variable Definitions and Measurement

The present study employed a model that incorporated the following six variables: interactivity, cooperation, competition, emotional energy, users' green value co-creation behaviors, and relational distance. Referencing the relevant literature and in conjunction with the context of this study, we have defined and measured these six variables (see Table 3). Of note, relational distance represents a categorical variable, whereas the remaining five were adapted based on relevant measures from the relevant literature. The measures used in this study were evaluated by experts. Moreover, items from the English scale were translated into Chinese using the "translation–back translation" technique. The seven-point Likert scale was employed to measure the above five variables, with one representing "strongly disagree" and seven representing "strongly agree".

Table 3. Survey measurements and their references.

Constructs	Items	References
Interactivity (IN)	IN1: Ant Forest facilitates interaction with M. IN2: Ant Forest gives me the opportunity to interact with M. IN3: Ant Forest facilitates communication with M. IN4: Ant Forest allows the exchange of information with M.	[39]
Cooperation (COO)	COO1: I am more than happy to help M collect energy, water plants, or plant trees together with M. COO2: If there is an opportunity, I will often help M collect energy, water plants, or plant trees together with M. COO3: I frequently help M collect energy, water plants, or plant trees together with M. These tree-planting activities are meaningful to me.	
Competition (COM)	COM1: Ant Forest gives me the opportunity to compete with M. COM2: I am able to compare my performance with that of M in Ant Forest. COM3: I can threaten the status of M by my active usage in Ant Forest.	
Emotional Energy (EE)	EE1: Whether online or offline, I can be enthusiastic about M in Ant Forest. EE2: I feel able to be sensitive to the needs of M. EE3: I will spend time and energy following M's activities in Ant Forest. EE4: I will put myself in M's position to experience and understand the mood.	[67]
Users' Green Value Co-creation Behaviors (GVCC)	GVCC1: If M needs help, I will assist him/her in resolving any issues encountered while using Ant Forest. GVCC2: I will recommend M to try the low-carbon lifestyle advocated by Ant Forest. GVCC3: Having M as a friend in my Ant Forest motivates me to choose a low-carbon lifestyle in order to collect more energy. GVCC4: Ant Forest not only allows me to realize my tree-planting aspirations but also enhances my relationship with M. GVCC5: If Ant Forest conducts a questionnaire survey regarding user experience, inquiries, or improvements, I will share it with M so that Ant Forest can understand our thoughts. GVCC6: In Ant Forest, it is easy for me to water M's plants or "steal" M's energy. GVCC7: If I learn that Ant Forest has added a new section called "Magical Ocean", I will participate. GVCC8: If I activate the "Magical Ocean" feature in Ant Forest, I will invite M to do the same.	[7]

In combination with the realistic research context, this study defines gamified interaction as the interaction between users and gamified elements in the gamified system that give them the opportunity to establish or manage social relationships with other users to achieve some goals. This study focuses on three types of gamified interactions. The measurement of interactivity, cooperation, and competition in gamified interaction was conducted using an established scale [39]. Among them, interactivity refers to the communication between individuals and others in the process of accomplishing the goal of the target system [39]. Given this paper's focus on social gamification and the subject of the study being Ant Forest [39], the emphasis on gamified interactions in this paper is the interaction between users and gamified elements within the gamified system, which is consistent with the chosen research subject. Therefore, this literature is considered to provide a basis for the three types of gamified interactions we aim to measure. In line with the research context, the interactivity scale consisted of four items (Cronbach's $\alpha = 0.868$). Cooperation refers to the behavior of individuals working towards a common goal [43]. The cooperation scale comprised three items (Cronbach's $\alpha = 0.885$). Competition refers

to the concept of challenging and competing with others, with the potential outcome that one player or group of players may win while others may lose [29]. The competition scale comprises three items (Cronbach's α = 0.855) [39] (see Table 3).

Emotional energy is the positive energy state of an individual's emotions in a specific situation; it is a form of emotion [16]. Based on an established scale [67] and the research questions, four items (Cronbach's α = 0.792) were used to assess emotional energy (see Table 3). Relational distance refers to the degree of social closeness people feel towards another person, often represented metaphorically by spatial proximity [62]. In this study, relational distance is a categorical variable.

Users' green value co-creation behaviors are defined as positive behaviors where users embrace the environmental ethos of an enterprise and engage in one or more stages of production or consumption to create value, with the primary value generated being the green use value [7,22]. The green value co-creation behavior scale used in this study is modified from the scale used by the related literature [7]. In accordance with the definition of users' green value co-creation behaviors in this study (focused on green use value) and the research context, we retained eight items measuring green value-in-use. Additionally, considering the research context, such as Ant Forest's advocacy for a low-carbon lifestyle, we have ultimately derived eight items (Cronbach's α = 0.901) suitable for the context of this study.

5. Data Analysis and Results

This study utilized SPSS 24.0 and Mplus 8.3 to examine the conceptual model. Common method bias checks, reliability and validity assessments, descriptive statistical analyses, and correlation coefficient tests were performed using SPSS 24.0. Meanwhile, Mplus 8.3 was utilized to perform confirmatory factor analysis, as well as tests of mediating and moderating effects.

5.1. Common Method Bias Test

Common method bias could emerge from the use of identical data sources or respondents, potentially affecting the study's validity. In this study, since the surveys were conducted online without geographical or group limitations for Ant Forest users, Harman's one-factor test was employed to assess the presence of common method bias [68]. The test revealed that the first factor's variance explanatory rate across all variables is 29.844%, below the threshold of 50% [69], indicating that common method bias is not a significant concern.

5.2. Reliability and Validity Assessment

The reliability test was conducted using SPSS 24.0 software, with Cronbach's alpha (α) coefficient serving as the indicator for reliability assessment (see Table 4). The α values for all variables ranged from 0.792 to 0.901, all above the threshold of 0.7 [70], indicating good reliability for each variable. The composite reliability (CR) for each variable fell between 0.821 and 0.920, all exceeding 0.7 [71]. Taken together, the tests of CR and α meet the recommended standards, suggesting a high degree of consistency between the observed variables and their respective latent variables, thereby passing the scale reliability test. The average variance extracted (AVE) values (from 0.591 to 0.718) were all greater than 0.500 [71], indicating the variables account for a minimum of 50 percent of the variance of its items. Therefore, it can be concluded that reliability and validity are achieved.

Table 4. Reliability and validity assessment.

Constructs	Items	α	FL	CR	AVE
INT	INT1	0.868	0.800	0.911	0.718
	INT2		0.873		
	INT3		0.863		
	INT4		0.852		
COO	COO1	0.885	0.798	0.855	0.663
	COO2		0.850		
	COO3		0.793		
COM	COM1	0.808	0.700	0.821	0.607
	COM2		0.839		
	COM3		0.791		
EE	EE1	0.792	0.700	0.865	0.616
	EE2		0.785		
	EE3		0.820		
	EE4		0.829		
GVCC	GVCC1	0.901	0.745	0.920	0.591
	GVCC2		0.752		
	GVCC3		0.773		
	GVCC4		0.804		
	GVCC5		0.750		
	GVCC6		0.739		
	GVCC7		0.779		
	GVCC8		0.802		

Note: α stands for Cronbach's alpha. FL stands for factor loading. CR stands for composite reliability. AVE stands for average variance extracted.

5.3. Multicollinearity Test

The variance inflation factors (VIFs) of each indicator are used to assess the presence of multicollinearity. The VIF values pertaining to interactivity, cooperation, competition, and emotional energy are 2.015, 1.803, 1.559, and 2.081, respectively, which ideally shows that VIF < 3 [70]. Therefore, multicollinearity among the variables is not a serious concern.

5.4. Confirmatory Factor Analysis

The study employed confirmatory factor analysis to assess each variable's discriminant and structural validity, and the results are presented in Table 5. Table 5 reveals that all fitting indices of the five-factor model meet the required standards: the sample set fitting index χ^2/df = 2.419 (ranging from 1 to 3 [72]), SRMR = 0.043 (less than 0.05 [73]), CFI = 0.947 and TLI = 0.939 (both greater than 0.9 [73–75]), and RMSEA = 0.059 (less than 0.06 [73]). These findings indicate good structural validity for each measurement tool. Furthermore, by comparing the results of the multi-factor model with other models, such as the one-factor model (χ^2/df = 21.134, SRMR = 0.399, RMSEA = 0.222, CFI = 0.147, and TLI = 0.132), the two-factor model (χ^2/df = 6.195, SRMR = 0.068, RMSEA = 0.113, CFI = 0.798, and TLI = 0.776), and the three-factor model (χ^2/df = 5.818, SRMR = 0.067, RMSEA = 0.108, CFI = 0.815, and TLI = 0.792), it is evident that the five-factor model exhibits superior fitting indices, suggesting good discriminant validity for each variable.

Table 5. Results of the confirmatory factor analysis.

Model	χ^2	*df*	χ^2/df	SRMR	RMSEA	CFI	TLI
Five-factor model: IN, COO, COM, EE, GVCC	481.437	199	2.419	0.043	0.059	0.947	0.939
Four-factor model: IN+COO, COM, EE, GVCC	764.574	203	3.766	0.049	0.082	0.895	0.881
Three-factor model: IN+COO+COM, EE, GVCC	1198.483	206	5.818	0.067	0.108	0.815	0.792
Two-factor model: IN+COO+COM+EE, GVCC	1288.610	208	6.195	0.068	0.113	0.798	0.776
One-factor Model: IN+COO+COM+EE+GVCC	4797.352	227	21.134	0.399	0.222	0.147	0.132

Note: IN stands for interactivity. COO stands for cooperation. COM stands for competition. EE stands for emotional energy. GVCC stands for users' green value co-creation behaviors; the same below.

5.5. Descriptive Statistics and Correlation Coefficient Test

In this study, the independent variables include interactivity, cooperation, and competition, while emotional energy is the mediator variable, and users' green value co-creation behaviors are the dependent variable. Additionally, relational distance is examined as the moderating variable. Descriptive statistics and correlation analysis were conducted, and the results are provided in Table 6.

Table 6. Descriptive statistical results and correlation coefficients of main variables.

	Mean Value	Standard Deviation	1	2	3	4	5
1 Interactivity	5.273	0.879					
2 Cooperation	5.491	0.950	0.627 ***				
3 Competition	5.153	1.038	0.459 ***	0.424 ***			
4 Emotional energy	5.27	0.847	0.619 ***	0.559 ***	0.581 ***		
5 Users' green value co-creation behaviors	4.759	0.701	0.694 ***	0.635 ***	0.467 ***	0.688 ***	
6 Relational distance	1.507	0.626					

Note: *** indicates a significance level of 0.1%; the same below.

The results in Table 6 indicate significant positive correlations between users' green value co-creation behaviors and interactivity (r = 0.694, $p < 0.001$), cooperation (r = 0.635, $p < 0.001$), and competition (r = 0.467, $p < 0.001$), thereby providing preliminary support for H1a, H1b, and H1c. Furthermore, a significant positive correlation exists between emotional energy and users' green value co-creation behaviors (r = 0.688, $p < 0.001$). Additional testing is needed to validate the hypotheses regarding the mediating role of emotional energy in gamified interaction and users' green value co-creation behaviors, as well as the moderating role of relational distance.

5.6. Mediation Effect Test

The nonparametric bootstrap method was utilized for testing purposes, and the results are presented in Table 7. As shown in Table 7, interactivity, cooperation, and competition all exhibit significant positive effects on users' emotional energy (r = 0.405, $p < 0.001$; r = 0.188, $p < 0.01$; r = 0.388, $p < 0.001$), suggesting that these variables positively affect emotional energy. Additionally, emotional energy displays a positive correlation with users' green value co-creation behaviors (r = 0.536, $p < 0.001$).

Table 7. Mediating effect of emotional energy.

Variable	EE	GVCC
Use frequency	−0.005 (0.020)	0.130 *** (0.040)
Gender	−0.102 (0.057)	0.032 (0.037)
Age (years)	−0.026 (−0.042)	0.035 (0.036)
Occupation	0.000 (0.012)	−0.034 (0.039)
Working years	0.063* (0.031)	−0.029 (0.045)
Average monthly income (RMB)	−0.004 (0.024)	−0.017 (0.039)
IN	0.405 *** (0.020)	
COO	0.188 ** (−2.589)	
COM	0.388 *** (−5.551)	
EE		0.536 *** (0.115)
Mediating effect a (IN → EE)		0.217 *** (0.058)
Mediating effect b (COO → EE)		0.101 * (0.050)
Mediating effect c (COM → EE)		0.208 ** (0.067)

Note: *, **, *** respectively indicate a significance level of 5%, 1%, and 0.1%.

The bootstrap method report results demonstrate that interactivity, cooperation, and competition significantly affect users' green value co-creation behaviors through emotional energy, respectively. Specifically, the coefficient of interactivity on users' green value co-creation behaviors through emotional energy is 0.217 ($p < 0.001$), with a 95% confidence interval of [0.126, 0.347]. The coefficient of cooperation on users' green value co-creation behaviors through emotional energy is 0.101 ($p < 0.05$), with a 95% confidence interval of [0.020, 0.213]. The coefficient of competition on users' green value co-creation behaviors through emotional energy is 0.208 ($p < 0.01$), with a 95% confidence interval of [0.104, 0.365]. All three cases' confidence intervals do not contain zero, supporting H2a, H2b, and H2c. Therefore, the results suggest that interactivity, cooperation, and competition in gamified interaction positively impact users' green value co-creation behaviors through emotional energy, supporting H1a, H1b, and H1c.

5.7. Moderating Effect Test

The relational distance in this study is a categorical variable, suitable for testing the moderating effect using the multi-model method in the structural equation model. Therefore, this study sets the same model test parameters in the two types of relational distances to test whether they have cross-group invariance. In addition, this study used the bootstrapmethod to test the confidence interval to make the results more accurate. After sorting, the specific results are shown in Table 8.

Table 8. Moderating effect of relational distance.

Path	Group	Coefficient	*p*	95% Confidence Interval
IN → EE	intimate relationships	0.223 *	0.013	[0.084, 0.513]
	non-intimate relationships	0.406 ***	0.000	[0.251, 0.684]
	difference	0.183	0.168	[−0.070, 0.465]
COO → EE	intimate relationships	0.150 *	0.044	[0.002, 0.422]
	non-intimate relationships	0.052	0485	[−0.131, 0.251]
	difference	−0.098	0.318	[−0.312, 0.085]
COM → EE	intimate relationships	0.345 ***	0.000	[0.333, 0.678]
	non-intimate relationships	0.265 **	0.003	[0.146, 0.592]
	difference	−0.080	0.457	[−0.273, 0.134]

Note: *, **, *** respectively indicate a significance level of 5%, 1%, and 0.1%.

The analysis of Table 8 reveals that interactivity, cooperation, and competition are positively correlated with emotional energy in intimate relationships, and 95% confidence intervals do not include zero. Non-intimate relationships exhibit a significant positive correlation between interactivity, competition, and emotional energy, respectively (with 95% confidence intervals not containing zero). In comparison, there is no significant correlation between cooperation and emotional energy (with 95% confidence intervals containing zero). No significant difference was found between the two groups. The findings indicate that H3a, H3b, and H3c are not supported.

6. Conclusions and Implications

6.1. Result Discussion

This study focused on Ant Forest users as the research subjects and utilized a questionnaire survey method to collect data. It aimed to investigate the influence of gamified interaction on users' green value co-creation behaviors, along with its impact mechanism and boundary conditions. The findings were obtained through empirical research and are presented as follows:

Gamified interaction positively influences users' green value co-creation behaviors, validating H1a, H1b, and H1c. The three types of gamified interactions, namely, interactivity, cooperation, and competition, positively impact users' green value co-creation behaviors, indicating that gamified interactions can facilitate users' green value co-creation. Gamified interaction refers to the interaction between users and various gamified elements within the gamified system, including social elements as one category [29]. These findings align with previous studies, highlighting the positive influence of gamified interaction on user behavior [39,76,77]. The positive impact of gamified interaction on users' green value co-creation behaviors is supported, validating H1a, H1b, and H1c. Specifically, H1a corroborates the notion that interactivity can motivate participants' value co-creation [42]. H1b aligns with existing findings that cooperation enhances users' conservation behavior [46] and low-carbon actions [14]. H1c reinforces the positive role of competition in fostering users' environmental behaviors [41]. Consequently, this study enhances the understanding of the antecedents of users' green value co-creation behaviors by identifying gamified interaction as an effective motivator.

This study highlights the mediating role of emotional energy between gamified interaction and users' green value co-creation behaviors. The results demonstrate that gamified interaction can enhance users' emotional energy, promoting users' green value co-creation behaviors, which validates H2a, H2b, and H2c. Furthermore, the findings suggest that gamified interaction can trigger users' enthusiasm and curiosity, and cooperating with others through gamified functions can stimulate users' positive anticipatory emotions, leading to cooperative intentions [43]. Emotional energy also positively promotes individual users' behaviors [57,58], as seen in how residents' perceptions and behaviors change in response to tourism and tourists [78]. In Internet enterprises, this study found that gamified interaction can stimulate users' emotional energy, thereby promoting users' green value co-creation behaviors and revealing the mechanism between gamified interaction and users' green value co-creation behaviors.

We will explore how the three types of gamified interactions affect users' emotional energy, and how emotional energy stimulates users' green value co-creation behaviors. Taking Ant Forest as an example, interactivity can strengthen the sense of closeness among users, which can positively affect the emotions of consumer engagement [51]. For instance, the act of watering a friend's tree can lead to compensatory low-carbon behaviors offline or online to make up for the green energy spent. Furthermore, cooperation, if co-operators aim to achieve their collaborative goals, especially within a shorter timeframe, can inspire greater motivation and enthusiasm. Since emotions affect user behavior [49], the need for collaborative partners to engage in more low-carbon green behaviors can translate into more green energy. Regarding competition, whether it is daily or overall rankings, if users aspire to improve their positions, competition positively influences users' emotions [49,55,56]. This

internal drive for victory and combativeness, if aimed at enhancing daily rankings, requires users to focus more on low-carbon green behaviors within a day. For overall rankings, it necessitates sustained low-carbon green actions over many days or even months to accumulate more green energy and achieve the goal of ranking higher. This reveals the mechanism by which gamified interaction affects users' green value co-creation behaviors. It is evident that H2a, H2b, and H2c in this paper support recent research indicating that emotions mediate the relationship between gamification and pro-environmental behavior [49].

Interestingly, this study did not observe a moderating effect of relational distance on the relationship between gamified interaction and emotional energy. Two reasons explain why hypotheses H3a, H3b, and H3c are unsupported. Firstly, the Ant Forest platform has a social media function [39], which allows users to establish or strengthen relationships with people of different relational distances, regardless of whether they are colleagues or family members. This feature could diminish the moderating effect of relational distance. Secondly, Ant Forest users aim to collect green energy to achieve their environmental goals. Consequently, having more Ant Forest friends can help them attain more energy, regardless of intimate relationships.

6.2. Theoretical Contribution

This study contributes to cutting-edge research on gamified interaction and users' green value co-creation behaviors. The main theoretical contributions are as follows:

Firstly, from the perspective of individual users, this study proposes the concept of users' green value co-creation behaviors, which expands the definition of green value co-creation. The research on green value co-creation is in its initial stage both domestically and internationally, and most of the previous studies took manufacturing enterprises as the research object to explore the influencing factors of green value co-creation [8–10]. However, few studies have examined the role of individual users in green value co-creation, despite their importance as essential participants according to the definition of green value co-creation [7]. Moreover, based on the service-dominant logic, enterprises allocate resources to provide products and services for users and services to support users in value creation [13]. The process of users using products or obtaining services is the process of value generation. Their positive contribution is irreplaceable. Therefore, this study highlights the user's role in green value co-creation and presents the concept of the user's green value co-creation behaviors.

Secondly, this study expands the scope of green value co-creation research by taking users as a new research perspective and exploring its influencing factors. Previous research has mainly focused on enterprises, with little attention given to users. This study diversifies the participants in green value co-creation by taking users as a new research object. Additionally, most studies on green value co-creation have explored its antecedents and results in the context of traditional manufacturing industries, with only a few applying it to Internet enterprises. To fill this gap, this study selects Ant Forest, the most representative online gamification platform, as the research background to explore the factors that affect users' green value co-creation behaviors, enriching the situational research on green value co-creation. Through empirical research, this study finds that interactivity, cooperation, and competition, three gamified interactions, positively affect users' green value co-creation behaviors. Overall, this study innovatively provides theoretical references for scholars who seek to understand the application scenarios and influencing factors of users' green value co-creation behaviors.

Thirdly, this study uncovers the intermediary mechanism's theoretical "black box" that links gamified interactions and users' green value co-creation behaviors. While studies have examined China's green behavior by investigating users' continuous use or green behaviors through the lens of user satisfaction [5,65], others have employed the Stimulus–Organism–Response theory and utilized Ant Forest consumers as research subjects to investigate the influence of Internet public welfare characteristics on consumers' willingness to participate. However, few studies have investigated the correlation between gamified interaction and

users' green value co-creation behaviors from the perspective of users' emotional energy. This study posits that emotional energy, as an emotional response to gamified interactions, is a critical antecedent to users' green value co-creation behaviors, providing a theoretical link for investigating the complex correlation between gamified interactions and users' green value co-creation behaviors. Moreover, Ant Forest was selected as the research situation, which is locally relevant and internationally recognized. The empirical results confirm that emotional energy serves as a mediating factor between the two. In summary, this study provides novel insights into the underlying mechanism linking gamified interactions and users' green value co-creation behaviors.

It is important to note that empirical data from this study do not support the moderating effect of relational distance on the relationship between interactivity, cooperation and competition, and emotional energy. Please refer to the preceding discussion for potential explanations. Hence, in comprehending the role of relational distance, the academic community should consider its moderating effect on emotional energy in the context of gamified interactions. However, it is also worthwhile to explore the moderating effect of other variables on the relationship between gamified interactions and emotional energy.

6.3. Practical Implications

Firstly, it should be noted that green value co-creation extends beyond enterprises; user groups also play a significant role in this process. To enhance the motivation for users to engage in green value co-creation, the incentive factor of gamified interactions can be effectively leveraged. For instance, utilizing self-construction or collaborating with gamified platforms can leverage gamified interaction functions to enhance interactions between users and gamified elements, including interactivity, cooperation, and competition. More specifically, interaction elements such as likes, mutual assistance, comments, and bullet screens are incorporated to facilitate user–platform and user–user interactivity. As for cooperation, introducing cooperation projects, fostering user collaboration, and offering diverse rewards such as certificates can reinforce desirable user behaviors. In terms of competition, various competitive features that display users' records, such as daily, weekly, and overall leaderboards, can boost users' competitive spirit. Furthermore, offering special recognition to standout performers, such as medals and the ability to accessorize their avatars, can encourage users to strive for higher rankings and engage in more green value co-creation behaviors.

Secondly, it is crucial to focus on enhancing the emotional energy of users. Internet enterprises that advocate for green concepts should prioritize and emphasize the emotional energy of users while cultivating and guiding their behaviors. In addition to the self-construction or platform cooperation mentioned earlier, three types of gamified interactions (interactivity, cooperation, and competition) can be extended further. Emotional energy can be achieved by actively incorporating simple, convenient, and user-friendly channels, such as question-and-answer sections, feedback mechanisms, comments, and other interactive formats. These additions facilitate users in expressing their emotional energy more effectively, thereby bolstering their emotional energy by encouraging users' green behaviors and fostering collaborative green value creation with Internet companies.

Finally, it is worth noting that the impact of relational distance on gamified interaction and emotional energy has yet to be empirically tested. Therefore, when utilizing gamified interaction to enhance users' emotional energy, it is essential to consider not only the interaction between users with intimate relationships but also the interaction between users with non-intimate relationships. In other words, there is no need to distinguish between intimate relationships and non-intimate relationships intentionally. Building upon this, further expansion is possible. To expand the user base, Internet enterprises should not only focus on leveraging close relationships in marketing efforts, such as when users invite potential users or the system recommends friends, but also utilize common friends (displaying familiar friends) to simulate interactions with potential users who are not non-intimate potential users.

6.4. Limitations and Prospects

This research advances the understanding of how gamified interactions promote users' green value co-creation behaviors, validates this relationship empirically, and offers theoretical and practical insights. However, due to limitations in the research conditions, some areas require improvement. Firstly, this study only focuses on Ant Forest and its users as the research subjects, thus limiting the generalizability of the findings. Future studies could expand their scope to include gamification platforms with a more extensive user base, including small- and medium-sized users, to enhance the universality of the research conclusions. Moreover, this paper utilizes cross-sectional data, and it is recommended that future studies incorporate longitudinal data to capture the dynamic changes in user behavior over time. Furthermore, users from different cultural backgrounds may have varying responses to gamified interactions. Future studies could explore how cultural factors influence the relationship between gamified interactions and the co-creation of green values. Lastly, with the development of new technologies, such as virtual reality and augmented reality, future research can examine how these technologies are utilized in gamified interactions and their potential impact on behaviors related to the co-creation of green values.

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