


From Virtual Trees to Real Forests: Public Participation in Virtual Forest Realization Projects in China

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Abstract: With the rapid development of Internet technology, the channels for the public to participate in forest protection and ecological construction have been expanded. In China, virtual forest realization projects have successfully heightened environmental awareness among the public. However, these projects have also faced a “green gap”, characterized by a substantial disconnect between environmental intentions and actual participation behaviors. Based on 69 articles about virtual forest realization projects in China, this paper aims to reveal the roots of the intention–behavior gap, influencing factors, and potential mitigation strategies. Our findings indicate the following: (1) While virtual forest realization initiatives have made progress, they still face multiple challenges such as governmental inefficiencies and platform traffic bottlenecks. (2) The factors influencing public participation in virtual forest realization projects can generally be categorized into three types: external situational factors, internal psychological factors, and demographic variables. Initially, external influences like online word-of-mouth and gamified platforms played a crucial role in attracting the public. Over time, internal factors such as public trust in the platform and perceived enjoyment have become more prominent. Inconsistent findings regarding demographic variables suggest a need for further research. (3) Current solutions primarily focus on macro policies and have not fully addressed existing challenges. This study reveals the reasons and influencing factors of the intention–behavior gap, with the goal of offering valuable insights for future public engagement and project optimization.

Keywords: pro-environmental behavior; virtual forest; green gap; public participation



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1. Introduction

Given the serious threat posed by global warming, numerous countries are actively exploring strategies to mitigate carbon emissions and enhance carbon sinks, aiming to combat climate change effectively. In September 2020, China announced its commitment to peak carbon dioxide (CO₂) emissions before 2030 and to achieve carbon neutrality by 2060 [1]. As one of the most populous countries globally, the climate governance strategies in China depend significantly on extensive public participation and support. Scholars also argue that while technological advancements provide significant support in addressing environmental issues, the fundamental challenges are rooted in human activities [2]. Therefore, it is essential to mobilize the public to actively engage in carbon emission reduction work. Despite numerous policies from the Chinese government to encourage public participation, the results have been suboptimal [3]. Consequently, there is an urgent need to enhance efforts to effectively promote active public involvement in reducing carbon emissions [4].

Forests serve as crucial carbon sinks and hold substantial carbon storage potential, which makes them essential for mitigating climate change [5]. In response, China has

creatively utilized Internet technology to forge a closer connection between forests and public participation (Figure 1). Notably, the enterprise-led “Ant Forest” project stands out as a prime example of this innovation. In this project, participants accumulate green energies by engaging in eco-friendly activities online. Once they have gathered sufficient energies and selected their preferred tree species, participants can click the “plant tree” button. Virtual trees are then successfully planted, and corresponding real forests will be planted in desert areas by partnering organizations of Ant Forest [6–8]. The other mode is the government-led “Internet plus national voluntary tree-planting” program. Participation in the national voluntary tree-planting project can be divided into online and offline forms. Online participation involves users scanning Quick Response (QR) codes provided on official websites to make donations for forests. Offline participation encompasses various activities. Citizens can register online to take part in offline initiatives such as tree-planting at “national voluntary tree-planting bases” in their cities, as well as nurturing, weeding, and caring for seedlings already planted at these forestry bases [9,10].

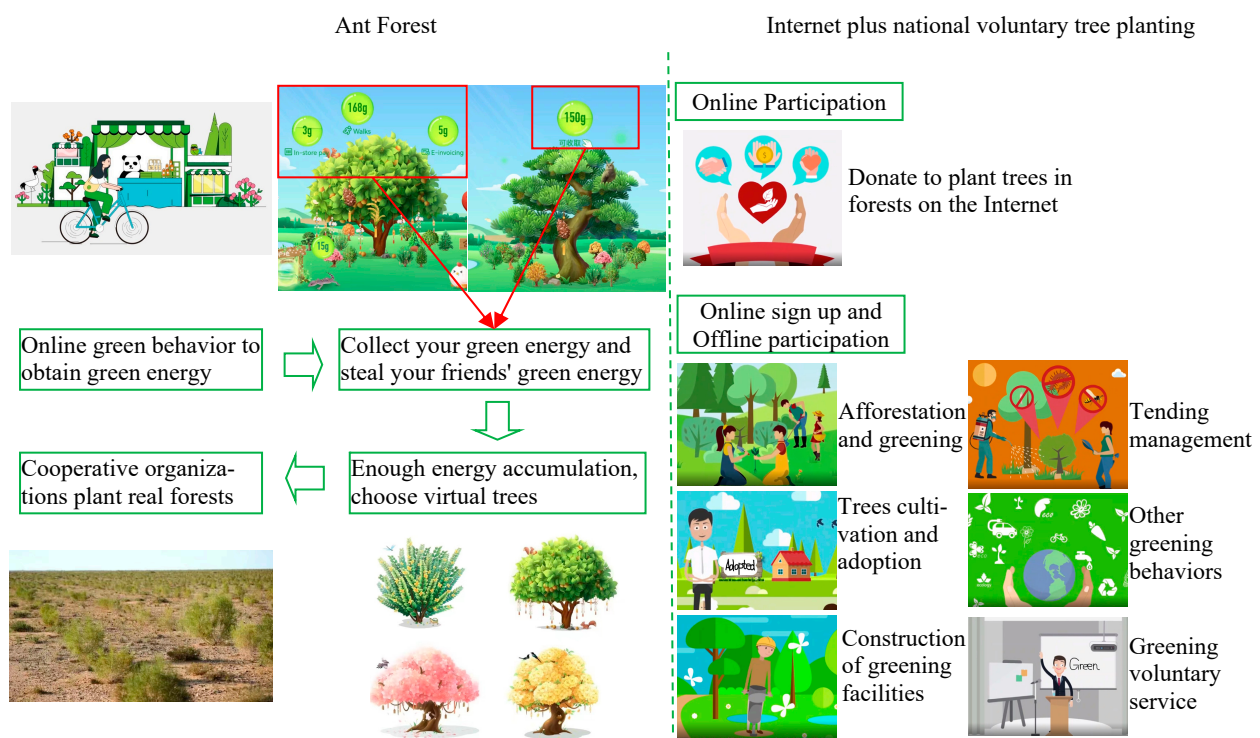


Figure 1. Public participation processes in virtual forest realization projects in China.

These initiatives which enable the transition from virtual tree-planting to actual forest creation through online platforms are referred to as virtual forest realization projects [11]. In contrast to traditional forest projects that rely on physical planting and are constrained by geographic limitations, this virtual approach facilitates continuous public engagement from any location and at any time. As a result, virtual forest realization projects have achieved significant success in China. Since its launch eight years ago, Ant Forest has successfully planted 548 million trees in regions like Gansu and Inner Mongolia, China. Furthermore, by the end of 2023, the pilot project of national voluntary tree-planting has expanded from the original 15 provinces and cities to the whole country, involving over 70 million participants in online donations and forest conservation activities [9]. However, opinion polls and surveys consistently reveal a gap between public intentions and actual participation in virtual forest realization projects [7,9]. This discrepancy within the realm of pro-environmental behaviors is commonly referred to as the green gap [12].

Over the past few years, many reviews have focused on explaining, understanding, and addressing the green gap. Of the available reviews, two types of articles appear to be

closely related to the current work. One type tends to sort out the influencing factors of this phenomenon. For example, Joshi and Rahman [13] identified factors influencing green consumption behavior. In their review, Joshi and Rahman proposed the direction of each variable and its impact on green consumption intentions and behaviors. Another type of review is dedicated to examining the methods and theories of the intention–behavior gap. Ghina ElHaffar’s review on the green gap examined methodologies and paradigms [12]. The review highlights that researchers frequently employ modeling techniques to investigate reasons behind consumer hesitancy towards purchasing green products. By incorporating psychological and contextual variables into these models, researchers aim to gain a deeper understanding of the factors contributing to the gap. Although numerous studies have provided thorough reviews of relevant variables and methods, they have neither explored the fundamental causes of the green gap nor delved into strategies to address it. For virtual forest realization projects, identifying the root causes of the green gap and examining existing solutions are essential steps for future development.

On the global stage of environmental protection, virtual forest realization projects in China have emerged as an exemplary model, showcasing innovative approaches and extensive public participation aimed at further safeguarding forests and the environment [14]. For instance, countries like the Philippines have adopted the “Ant Forest” mode to stimulate innovation and enhance their own forest protection initiatives. In this context, this paper focuses on the virtual forest realization project in China, screens relevant articles through three the step methodology of systematic literature reviews [12], constructs a research project framework, identifies the key obstacles and core influencing factors in public participation, and sorts out the existing solutions. The purpose of this paper is to promote the narrowing of the green gap in public participation, and constantly optimize and innovate the virtual–real participation mechanism.

Specifically, this paper aims to make several novel contributions: (1) establish a classification framework for research on Chinese virtual forest realization projects, encompassing dimensions such as project types, operational systems, and research logic. The framework provides a structured perspective on the similarities and differences between various projects, contributing to a more comprehensive understanding of the current trends and directions of research; (2) delve into the problems and challenges faced during implementation, particularly the causes of the green gap, and analyze factors affecting project effectiveness while summarizing response strategies like technological innovation and improved public participation mechanisms; (3) recognize the contributions and shortcomings of existing research, and propose future research directions with a view to bridging the intention–behavior gap of public participation in these projects. Overall, this paper provides insights into the green gap and solutions and offers guidance for the development of virtual forest realization projects both in China and globally.

2. Methodology

To identify relevant articles, we conducted a comprehensive search of the Web of Science (WoS) and Chinese National Knowledge Infrastructure (CNKI) databases, and the three step methodology of systematic literature reviews was followed [12]. First, the search keywords were defined, then the data were filtered and cleansed, and finally, the results were analyzed and presented. The WoS serves as a robust and widely utilized database for reliable academic information, primarily focused on English-language articles [15]. Given that this paper centers on virtual forest realization projects in China, it was essential to include peer-reviewed studies published in Chinese. Consequently, we utilized the leading multidisciplinary Chinese database, CNKI, to search for academic journal articles in Chinese [15]. Data collection and analysis were supported using Endnote X9.

The criteria for article screening were established as follows: (i) the virtual forest realization projects encompass activities related to green behavior on online platforms, culminating in real-world forest construction. This includes initiatives such as Ant Forest and voluntary tree-planting under the Internet plus framework; (ii) studies must be conducted

in real or virtual environments within China that (1) address the methods, challenges, influencing factors, and solutions for public participation in virtual forest projects, and (2) have undergone peer review. Any discrepancies were resolved through discussions among all authors, led by the corresponding author.

Initially, we gathered data by searching for English-language articles on virtual forest projects within the core collection of the WoS, using the following keywords: “ant forest” OR “tree planting” OR “virtual*”. The search spanned from 1 January 2015 to 21 April 2024, resulting in a total of 1192 articles. We refined the search by filtering for the document type “article” and language “English”. After reviewing titles and abstracts to exclude the irrelevant literature, 96 articles remained. A full-text assessment of these resulted in the identification of 43 articles, leading to the inclusion of 42 articles in the review (Figure 2). One article was excluded due to a lack of content related to public participation.

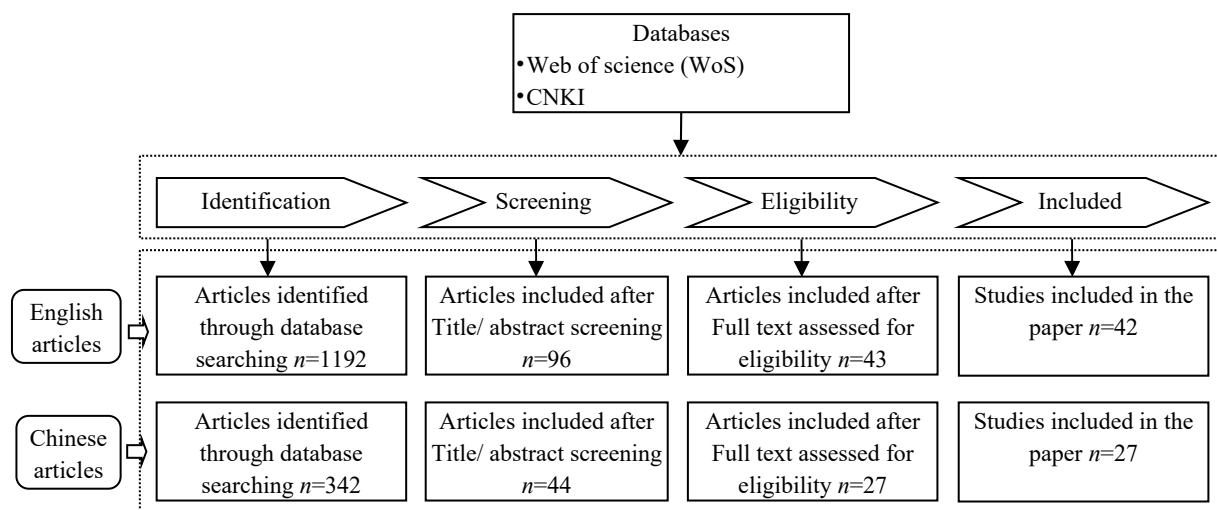


Figure 2. The flow diagram of the article selection process.

Subsequently, we employed a search string that included “ant forest” OR “Internet Plus national voluntary tree planting” OR “virtual*” in CNKI. This search, covering the same date range, yielded a total of 342 articles. Further refinement by selecting the document type “article” from the Chinese core journal criterion of Peking University narrowed the results to 44 articles. Following a review of titles, abstracts, and author keywords, 27 articles were retained (Figure 2).

3. Results

3.1. Study Characteristics

3.1.1. The Evolution of Publications

In the selected 69 articles (detailed in Appendix A—Table A1), comprehensive information is provided, including the publication dates, research focuses, sample sizes, methodologies, and theoretical frameworks employed in each study. This review encompasses articles published between 2017 and 2024 (Figure 3), with a notable 86% ($n = 59$) published in the last five years. This trend indicates a rapid expansion in research on virtual forest realization projects. Moreover, the annual number of publications has consistently increased each year in both English and Chinese. This growth highlights the rising significance of virtual forest realization projects within the research community. Importantly, since 2020, the volume of English-language articles has exceeded that of Chinese-language articles, reflecting a growing recognition and interest in this field among the global scientific community.

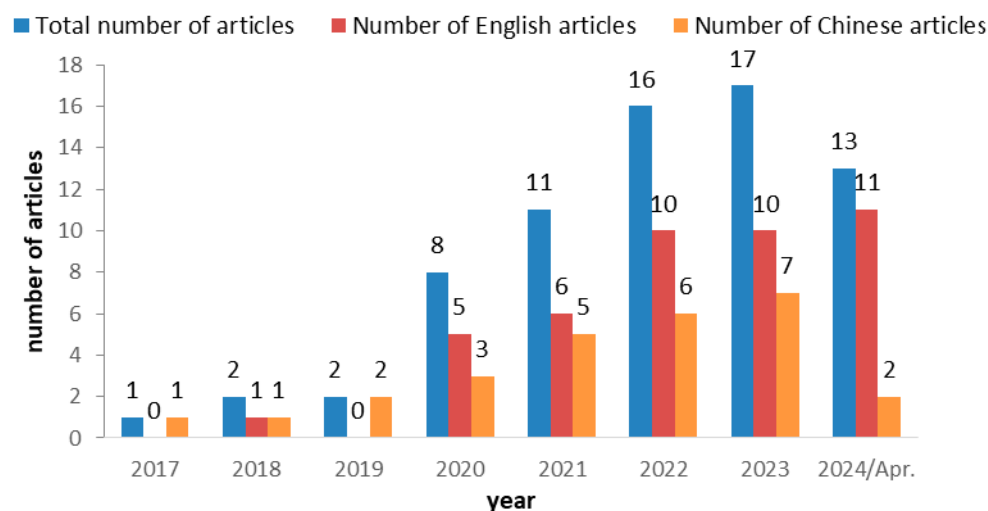


Figure 3. The annual number of publications from 2017 to April 2024.

3.1.2. Differences between Chinese and English Articles

Among the 69 articles, most of the research focuses are about the Ant Forest project, with only four addressing national voluntary tree-planting initiatives [9,10,16,17]. This disparity suggests that the Ant Forest project has garnered considerably more scholarly attention both domestically and internationally, while national voluntary tree-planting initiatives remain underexplored. This could be attributed to the relatively lower popularity and engagement rates of national voluntary tree-planting.

Through the research focuses, we can also observe the differences between articles written in English and those in Chinese. English-language articles typically emphasize microscopic perspectives, concentrating on user experiences and public viewpoints. These studies often rely on data from questionnaire surveys, which capture insights from individuals and the general public. In contrast, Chinese-language articles generally adopt a more macroscopic approach, addressing virtual forest realization projects from the perspectives of enterprises and government bodies. These studies are more likely to use public data, providing a broader view that encompasses institutional and governmental perspectives. This divergence highlights how research methodologies and focuses differ between the two languages, reflecting varying priorities and interests in the field.

3.1.3. The Evolution of Research Methods

The evolution of research methods can be summarized in Appendix A—Table A1. Initially, structural equation modeling (SEM) and qualitative analysis were the predominant methodologies. As the projects progressed, the range of research methodologies expanded to include various approaches such as game theory, web crawlers, ethnography, quasi-experimental research, text-coding analysis, simulations, and other mixed methods. Among the 69 articles reviewed, SEM was the most frequently used method, appearing in 31 articles. Partial least squares structural equation modeling (PLS-SEM) was the next most common technique, utilized in 14 articles. Other quantitative methodologies were used in fewer than five articles each. This indicates that most of the research on virtual forest realization projects has concentrated on analyzing influencing factors rather than developing solutions to address the green gap.

Within the 45 articles examining influencing factors, research can be categorized into two main disciplinary paradigms: social psychology and environmental education. The representative paradigm of social psychology is the theory of planned behavior (TPB), which emphasizes the relationship between attitude and behavior, focusing on factors like subjective norms and self-efficacy [18]. However, TPB tends to underplay the moderating role of cognitive factors, which have become increasingly important due to the complexity of information related to environmental protection activities in the digital age [9,19].

On the environmental education side, models such as the environmental literacy model by Hungerford and Tomer, and the responsible environmental behavior model by Hines [20], prioritize cognitive aspects like environmental knowledge and behavior strategies [21]. Some scholars have sought to integrate these two paradigms, merging TPB with cognitive theories from environmental education to create a comprehensive theoretical framework for understanding the influencing factors in virtual forest realization projects. This integration allows for a more nuanced approach to enhancing public participation by addressing both behavioral intentions and the cognitive processes involved [9,16].

3.2. Content of Virtual Forest Realization Projects

The true value of a review lies in the refinement and deeper understanding of research content. While many traditional reviews focus on analyzing visual data such as keyword frequencies, term variations, and associations among researchers and institutions, these analyses often only scratch the surface. To provide a more comprehensive understanding, we systematically categorized the content of the selected articles. This approach allows us to delve deeper into the nuances of the research, uncovering underlying themes and patterns that are not immediately apparent from surface-level data (Figure 4).

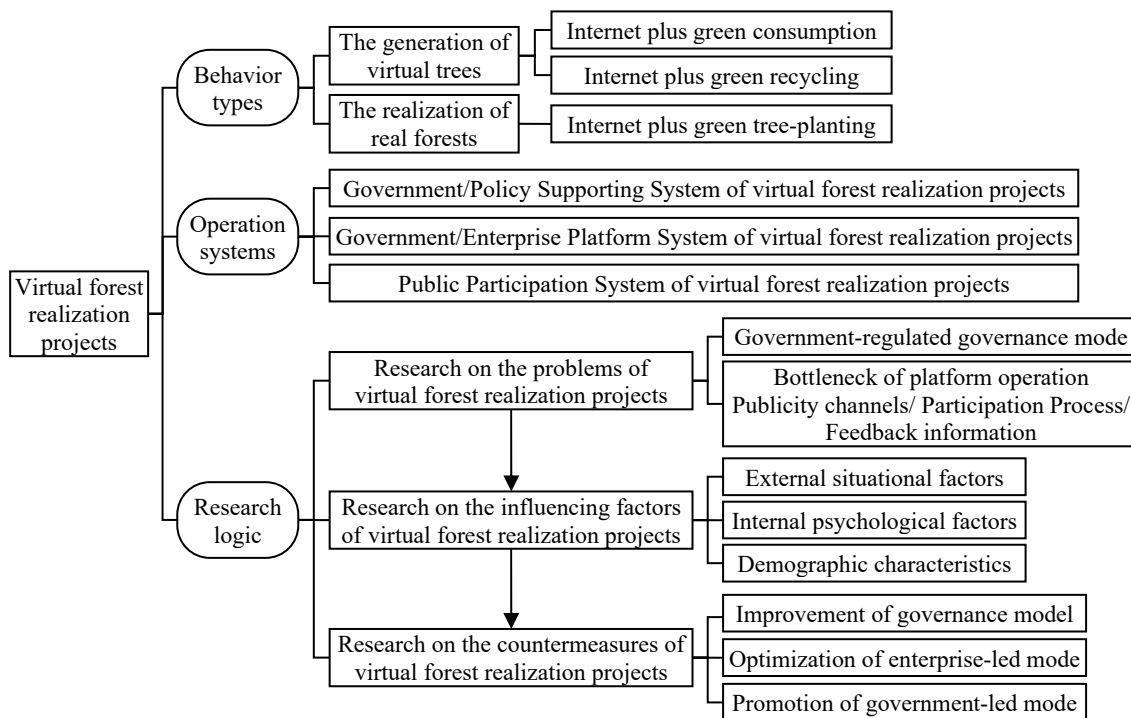


Figure 4. Theme classifications of selected articles.

From the perspective of behavior types, research on virtual forest realization projects can be divided into three main categories: Internet plus green consumption, Internet plus green recycling, and Internet plus green tree-planting. The first two categories focus on generating virtual trees through online consumption and recycling activities. The third category, Internet plus green tree-planting, is a core component of realizing these virtual trees into the real-world. Specifically, in Ant Forest, users accumulate green energy by completing consumption and recycling activities on the Alipay platform. When the energy reaches a certain level, the platform plants a real tree. Additionally, the Internet plus national voluntary tree-planting project further expands participation channels, allowing users to support afforestation activities through online donations or directly participate in offline tree-planting events, thus realizing the forest in reality.

From the perspective of operational systems, research on virtual forest realization projects can be categorized into three main aspects: policy supporting systems, government

and enterprise platform systems, and public participation systems. Policy supporting systems involve researching and designing policies and regulatory frameworks that support virtual forest realization projects. Government and enterprise platform systems focus on the online platforms or systems established by government entities and businesses to facilitate and promote virtual forest realization projects. These platforms provide information on tree-planting activities, manage environmental protection projects, and offer other related functions. Public participation systems concentrate on platforms encouraging and enhancing public engagement in green forests. These systems include social media platforms and organization platforms which aim at motivating the public to participate in green initiatives and fostering opportunities for communication and interaction.

From the perspective of research logic, research on virtual forest realization projects can be divided into three main parts: identifying problems and challenges, examining influencing factors, and assessing feasible countermeasures. The problems faced by public participation in virtual forest realization projects can be categorized into two main areas: government governance issues and the bottleneck of platform operation. In terms of influencing factors, three main aspects are considered: external situational factors, internal psychological factors, and demographic characteristics. Feasible countermeasures include implementing strategies such as enhancing environmental governance and optimizing both enterprise-led and government-led modes.

The three research types mentioned are juxtaposed, with their contents intertwined. Within the broader research context, the developmental trajectory of these articles follows a logical framework of “problem identification, influencing factors, and countermeasure analysis”. Furthermore, we delve into virtual forest realization projects from three perspectives: reasons, influencing factors, existing solutions, and subsequently propose future research prospects.

3.3. Problems and Challenges of Virtual Forest Realization Projects

3.3.1. Government-Regulated Governance Model

In involving the public in virtual forest realization projects, a major challenge stems from the inherent limitations of the “government-led” environmental management model [22]. This model often results in poor communication channels between the public and the government, affecting the efficiency of information exchange and collaboration [23]. Although the government has implemented various measures with good intentions, such as mandatory pauses to address issues related to the excessive deployment and disorderly parking of shared bicycles in the Internet plus green consumption project, these “one-size-fits-all” solutions have not fundamentally resolved the underlying problems [24]. Instead, their lack of flexibility and public involvement has led to dissatisfaction and resistance among the public.

Moreover, in the unique political and ecological context of China, non-profit environmental organizations are still in their early stages of development and face challenges such as low visibility and limited public interaction [25,26]. These organizations largely depend on government funding and support, which weakens their independent operational capabilities and innovative abilities, making it difficult for them to fully play their role as social monitors and communication bridges [27]. Consequently, these organizations often struggle to facilitate effective public participation in environmental projects like virtual forests, hindering the development of efficient and smooth dialogue mechanisms between the public and the government [28,29].

3.3.2. Publicity Channels

Before participation, publicity channels are crucial for engaging the public in virtual forest realization projects. Ant Forest, leveraging the Alipay platform, has established ongoing collaborations with major media outlets across various provinces and cities [10]. These mainstream media channels have reported on or republished information about Ant Forest’s initiatives [30]. Additionally, Ant Forest maintains a presence on prominent

social media platforms like WeChat [31], which has significantly boosted public awareness and engagement.

Compared with the diversified publicity efforts of Ant Forest, the publicity channel of the Internet plus national voluntary tree-planting website is relatively simple [11]. Limited by the constraints of the relevant administrative units within the forestry department, the website's promotional strategy relies heavily on traditional online news and documents issued by official state organs. This narrow approach creates a disconnect between the project and its potential audience, resulting in significantly reduced visibility for national voluntary tree-planting initiatives. As a consequence, the implementation of related projects has been sluggish, with some undergoing frequent cancellations due to prolonged deficiencies in public engagement. Overall, the website's static design and limited interactive features make it less attractive and effective compared to dynamic platforms like Ant Forest [26], leading to a noticeable green gap.

3.3.3. Participation Process

During participation, while the platforms of virtual forest realization projects offer digital space for engagement, its simple online interface may lack sufficient physical feedback [32]. Specifically, users interact mainly via clicks on a single terminal device, which can lead to a suboptimal experience and potential disengagement in Ant Forest [33]. Additionally, the gamification elements introduced by Ant Forest might shift the initial motivation for public participation, causing an excessive focus on game achievements. This shift could divert participants from their original goals, potentially resulting in negative spillover effects on their future engagement [34].

In contrast, the website of the national voluntary tree-planting initiative presents a more traditional and less interactive experience. The official website is organized into nine sections: institutional profile, policies and regulations, entity participation, network participation, style display, experience exchange, achievement display, green stories, and ecological science popularization. The online donation section includes basic information such as mode introduction, execution plans, and estimated funds, accompanied by visual elements like landscape drawings and engineering sketches. At the bottom of the page, there are QR codes for Alipay and WeChat donations [17,35,36]. However, the website lacks interactive communication features. As a result, users may find the experience monotonous and uninspiring, which could lead to reduced participation and a lower likelihood of recommending the initiative to others [10].

3.3.4. Feedback Information

After participation, acquiring public feedback is also a crucial step in determining whether to continue engaging in the projects. Ant Forest issues users an electronic certificate with a unique number after successfully planting virtual trees. Additionally, it offers satellite tree viewing and real-time tree viewing functions for the public [37]. These features, supported by advanced augmented reality (AR) technology, enable users to view a tree they have "planted" even if it is thousands of miles away [27,38]. This type of desert comparison map, showing before and after planting trees through satellite cloud images, provides a visual impact and a sense of spiritual pride for many users. On the other hand, some users remain skeptical about the Ant Forest project's authenticity because they cannot see the real forests themselves. This skepticism stems from a lack of direct, tangible evidence of the trees they have helped plant [8,39,40].

An electronic certificate will also be automatically generated after the online donation of national voluntary tree-planting. Meanwhile, when applying for the offline planting of trees at the national voluntary tree-planting bases, the public can make on-the-spot observations after planting. This kind of feedback information with a sense of physical objects can enhance the public satisfaction and trust [9]. However, the lack of timely updates on the flow of funds and project progress contributes to opaque information feedback, which is a significant reason why the public may choose to abandon the project [10].

3.4. Influencing Factors of Virtual Forest Realization Projects

3.4.1. External Variables

In the initial stage of public participation in the virtual forest realization projects, several external factors influence the process, including online word-of-mouth, transaction costs, and gamification platforms. During this phase, the level of autonomous decision-making by the public is relatively low and is more susceptible to external environmental controls. As a result, this can lead to a discrepancy between their initial intentions and actual behavior.

Online word-of-mouth is particularly important for the public in virtual forest realization. This can be categorized into positive and negative types [41]. Research indicates that, to some extent, positive online word-of-mouth attracts more public attention than negative online word-of-mouth [42]. Data show that the frequency of public participation influenced by positive online word-of-mouth is twice that of those not influenced. The number of positive online reviews reflects the popularity of a project, and factors such as authenticity, credibility, and source of information also impact public attitudes, playing a crucial role in enhancing public participation enthusiasm [43].

At the same time, the gamification features of platforms play a crucial role in capturing public attention and fostering novelty by enhancing the enjoyment of the service [7,19,26,38–40,43–47]. For example, gamification setting in Ant Forest generates green energy through online green behaviors. This simplified participation process and entertaining reward delivery not only bring freshness to the public but also influence the frequency of online green activities among users. However, subsequent research indicates that this gamified design may reduce the public's perception of behavioral efficacy, decreasing their inclination to continue engaging in virtual forest realization projects. In other words, gamification settings may lead to negative spillover effects.

Then, the participation costs are considered a key factor influencing public involvement. Participation costs can be categorized into time costs and monetary costs. In general, higher participation costs tend to lower public participation intentions. However, the impact of time costs versus monetary costs differs between the two virtual forest realization projects. Some scholars argue that participating in Ant Forest primarily involves time costs, while others note that activities such as green consumption and recycling, which generate green energies, also incur monetary expenses [28,48]. This kind of hidden money expenditure is more acceptable to the public than the direct donation [46,49]. Moreover, many people believe that the cost of forest construction is already paid by taxes, so it is unnecessary to make additional contributions in the donation of national voluntary tree-planting. Therefore, the public is more inclined to participate in physical tree-planting projects at tree-planting bases rather than engaging in donation actions [9,16,38].

3.4.2. Internal Variables

As participation time and intensity increase, the stimulating effect of the external environment triggers a change in the public's internal emotions. This change gradually diminishes the influence of external variables driving public behavior while a deeper internalization of demand emerges. When intrinsic needs such as perceived efficacy, subjective norms, and platform trust are fulfilled, the public intention to participate strengthens over time. At this stage, the trend of public participation being driven by external environmental stimuli decreases, and internal motivations take precedence. As a result, the green gap gradually narrows, and behavior becomes more autonomous, stable, and persistent.

For the public, individuals with a greater exposure to and understanding of environmental issues generally exhibit a stronger inclination to engage in afforestation efforts [26]. Environmental awareness can be categorized into three types: environmental crisis awareness, environmental protection awareness, and environmental risk awareness. All three types of awareness can effectively influence the public participation attitude in virtual forest realization projects, with environmental crisis awareness having the strongest impact [9].

This reflects that the Chinese public is more likely to engage in forest projects when they perceive environmental dangers.

Trust variables also positively inspire the public intention to engage in virtual forest realization projects. Research indicates that trust variables significantly influence the public to participate in virtual forest realization projects. While trust variables significantly promote public intention, there are differing views on whether they genuinely translate into actual actions [37,50]. One perspective suggests that the high levels of platform trust contribute to public behavior. Another viewpoint points out that trust variables positively impact the public intention to participate in virtual forest realization projects but do not significantly influence behaviors [41,47]. To transform trust into actual behaviors, it is necessary to consider the moderating effect of social environmental pressure, that is, the effective implementation of trust depends on external influences.

For the platforms, research indicates that perceived usefulness and perceived benefits are crucial for public participation in virtual forest realization projects. Both factors positively influence public attitudes; when individuals view these services as practical or beneficial, their inclination to participate is strengthened [49]. Notably, while perceived usefulness does not exert a significant direct effect on participation intention, it influences attitudes indirectly [47]. This suggests that the public's perception of a service's utility shapes their overall viewpoint, ultimately impacting their intention to engage. Perceived enjoyment is another vital factor in public engagement with virtual forest initiatives. Effective gamification design can enhance the perception of these activities as interesting; however, sustained engagement with gamified elements may lead to burnout over time. Consequently, some scholars argue that in the context of virtual environments, the public's perception of behavioral effectiveness is key to maintaining continuous participation [9,45,51,52]. For instance, in the Internet plus tree-planting model—whether through online activities in Ant Forest or hybrid online–offline initiatives—behavioral efficiency positively influences public intention [9].

Therefore, some scholars believe that in this virtual Internet context, the public perception of behavioral effectiveness is the key to maintaining participation. For example, in Internet plus tree-planting, whether online activities in Ant Forest or online–offline activities in Internet plus national voluntary tree-planting, behavior efficiency positively affects public intention. Meanwhile, subjective norms exert a more decisive influence than behavioral efficacy in both projects [17,22]. The possible reason is that in China, policy orientation and opinion leaders hold a dominant position. The publication of government documents and engagement of government officials can effectively motivate and guide the public to understand the general trend of the country and encourage their attention to environmental protection [16].

3.4.3. Demographic Variables

In addition to the external and internal influencing factors discussed previously, demographic characteristics are also a focal point of attention in the academic community. Research on gender differences suggests that, compared to females, males often demonstrate a stronger inclination toward environmental awareness and are more proactive in addressing environmental issues. However, some scholars propose that urban female citizens may exhibit a higher propensity for pro-environmental behaviors than males [53,54]. As for academic qualifications and income, research results align [55]. It is generally believed that the higher the education level and income, the more active individuals are in online behavior [56]. Individuals with higher levels of education are more likely to accept new information and technologies, while higher-income groups tend to prioritize environmental concerns [57].

Moreover, in studies concerning virtual forest realization projects, some scholars highlight contextual differences between the elderly and young individuals regarding environmental concerns [26]. Young people tend to be more receptive to the new trend of Internet technology development, so most of the participants in Ant Forest are college

students [33,58,59]; however, the elderly are more inclined to respond to the government's environmental policies and participate in environmental activities organized by official institutions. Therefore, most of the participants who are obliged to national voluntary tree-planting are middle-aged people [9].

3.4.4. Theoretical Framework

In summary, it can be seen that the influencing factors in public participation in virtual forest realization projects can be divided into three main aspects: external, internal, and demographic factors (Figure 5).

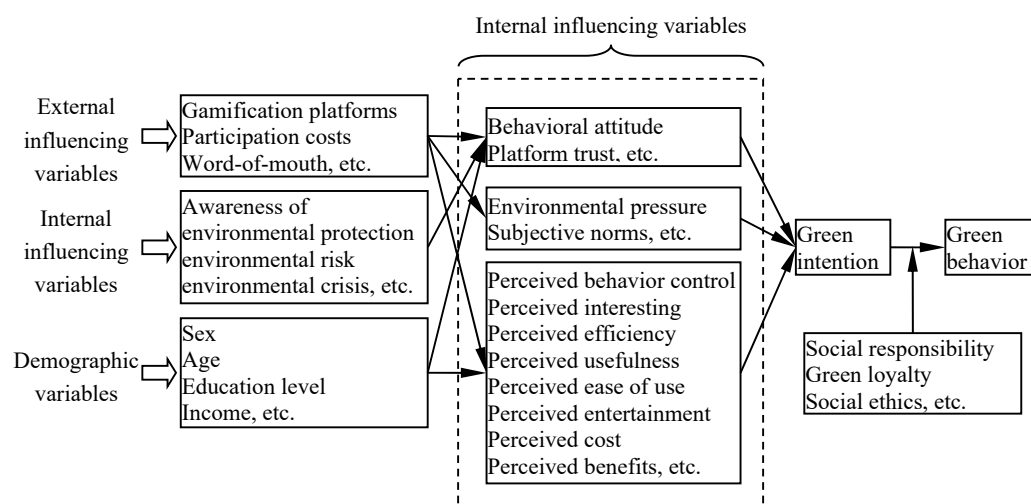


Figure 5. A framework of influencing factors for public participation in virtual forest realization projects.

External variables stimulated by Internet technologies include gamification platforms and participation costs. Internal variables are classified into four categories: environmental awareness, subjective norms, attitudes, and perceived control. Environmental information provokes public awareness of environmental protection, environmental risk, and environmental crisis. Within the category of attitudes, behavioral attitudes and trust in platforms are considered typical factors. The perceived control category encompasses various dimensions, such as perceived behavioral control, perceived interest, perceived efficacy, and other related factors. Demographic factors emphasize the influence of gender, age, education level, and income. The interweaving and integration of these influencing factors represent the trends and characteristics that affect public participation in virtual forest realization projects. Alongside the variables mentioned above, factors such as social responsibility [50], green loyalty [60], and social ethics [42] also serve as moderating variables which affect the intention–behavioral gap of public participation.

3.5. Coping Countermeasures of Virtual Forest Realization Projects

3.5.1. Improvement of Governance Model

Based on research into governance models, several conclusions can be drawn regarding environmental protection. Scholars largely agree that multi-stakeholder collaboration is essential for its evolution [30]. From both government and public perspectives, it is crucial for the government to recognize and empower public participation in environmental governance [61]. This approach not only stimulates public awareness but also fosters a partnership between the public and government [35].

Moreover, government agencies should encourage environmental organizations to develop independent and professional capabilities. These organizations must effectively communicate with the government, the public, and the media to broaden their impact [62]. For instance, in addressing issues like illegal road occupation by bike-sharing services, non-governmental organizations, and environmental agencies can utilize the Internet

to disseminate timely information, gauge public concerns, and serve as intermediaries between the public and government. Additionally, by considering feedback from these organizations, the government can formulate relevant laws and regulations to regulate the operations of online platforms [17], thereby creating a conducive environment for forest protection through a suitable legal framework.

3.5.2. Optimization of Enterprise-Led Mode

Existing research on promoting participation in Ant Forest emphasizes two key aspects. First, it is recommended to incorporate physical tree-planting opportunities into the participation process. Ant Forest could announce events where the public can plant trees in desert areas or nearby cities [41,63], providing a hands-on experience that reinforces trust in virtual forest initiatives [47,64].

Second, enhancing the feedback mechanism is essential, allowing participants to receive environmental certificates and practical rewards, such as subway or bus coupons, upon successfully planting virtual trees. When these rewards are perceived as valuable, the public is more likely to invest their time and effort [65,66]. This gamification of rewards not only attracts users but also increases their intention to recommend the initiative, thereby enhancing public interest and encouraging sustained participation in forest conservation efforts.

3.5.3. Promotion of Government-Led Mode

The improvement of the participation process in national voluntary tree-planting initiatives focuses on three main aspects: network page design, publicity channels, and follow-up feedback methods. Government departments should enhance the web design of the official tree-planting website to make it visually appealing, utilizing enriched imagery and vibrant colors to create a distinctive and harmonious platform [9]. Efforts should prioritize balancing the color scheme with the user interface design, employing artistic color language to direct public attention to essential information while accurately conveying the publicity theme [16].

Furthermore, interactivity can be enhanced through features such as environmental quizzes and videos, thereby extending public engagement. Additionally, by leveraging the rise of We Media, content can be disseminated on major video and social networking platforms to educate and engage young audiences in tree-planting initiatives. These expanded channels also function as effective mechanisms for information disclosure, fostering widespread participation and ensuring timely updates on project developments [9]. Lastly, the regular and transparent reporting of fund-related information is crucial for enhancing government credibility and public trust, thereby encouraging continuous participation in tree-planting projects. This approach not only bolsters confidence in governmental efforts but also sustains public interest through informed engagement.

4. Discussion

4.1. Contributions and Limitations

By reviewing existing articles, this paper clarifies the research methods and content classification of virtual forest realization projects. It details the causes, influencing factors, and current solutions related to public participation in these projects. The relevant contributions and limitations of the current study are as follows.

The problems and challenges of Chinese public participation in virtual forest realization projects can be divided into two categories. From the perspective of government governance, it includes government governance and the failure of environmental organizations. On the other hand, in the bottleneck of the platform, Ant Forest faces problems such as a weak user physical experience, insufficient feedback information, and gamification spillover effects, while national voluntary tree-planting initiatives face limitations such as a low penetration rate, low user participation, interesting participation process, and insufficient fund supervision. The current research effectively identifies and highlights the

practical problems in the implementation of virtual forest realization projects, reflecting that these projects are still in their early stages. Therefore, addressing the green gap requires the joint support of all sectors of society. Effective cooperation between government agencies, businesses, and non-governmental organizations is crucial.

The influencing factors contributing to the green gap in virtual forest realization projects in China encompass external, internal, and demographic variables. While existing research provides a broad examination of these factors, many studies tend to deviate from actual needs in their variable selection. They often lack a deep analysis of the system structure and mechanisms underlying these gaps. Instead, there is a tendency to emphasize complexity and completeness in quantitative analyses, resulting in simplistic conclusions. This trend reflects a growing issue in academic research where articles may demonstrate advanced quantitative methods but lack substantive qualitative theoretical insights. This imbalance can lead to an incomplete understanding of the factors influencing the green gap and the underlying mechanisms that need to be addressed to improve the effectiveness of virtual forest initiatives.

The coping solutions for the green gap in virtual forest realization projects have traditionally focused on macro-level descriptions. To address this issue more effectively, future research should emphasize in-depth investigations of micro-level implementation solutions. Rather than merely analyzing influencing factors and discussing general solutions, it is essential to delve into specific strategies and practices that can be applied at a granular level. A thorough understanding of the strengths and weaknesses of both government-led and enterprise-led virtual forest realization projects is crucial. By doing so, we can facilitate a more effective integration of these approaches, leveraging the unique benefits of each to bridge the green gap. This deeper integration will enhance the overall impact and effectiveness of virtual forest initiatives, ensuring that both macro and micro-level solutions are aligned and actionable.

4.2. Future Research

The academic community has thoroughly examined Chinese public participation in virtual forest realization projects, significantly contributing to research on the role of Internet technology in society. Despite these advancements, the green gap in virtual forest initiatives remains a pressing issue that requires urgent attention. Therefore, the following outlook is proposed, based on current analyses and emerging trends.

Firstly, to address the gap in public participation in green initiatives, it is essential to enhance collaborative research among various stakeholders. The importance of carbon sinks is well-recognized, underscoring the need to develop and refine carbon markets with effective incentive mechanisms. Future research should concentrate on understanding the dynamics of interaction and cooperation among the public, businesses, governments, and diverse social organizations involved in virtual forest realization projects. Establishing mechanisms to harmonize interests among these stakeholders is crucial for the success of these initiatives.

Secondly, to better understand the underlying reasons for the green gap, a systematic analysis of the factors affecting virtual forest realization projects should be intensified. Research should explore how virtual platforms and real-life experiences together influence individuals' environmental commitment and values. Additionally, examining the emotional factors that drive behavior is vital. By analyzing the interplay between online and offline activities and understanding the role of emotions in motivating action, we can address the challenge of translating intention into tangible behavior. Future studies should focus on the combined impact of virtual and physical experiences on public participation and thoroughly analyze how emotional factors influence the promotion of real-world actions.

Thirdly, to bridge the participation gap in green initiatives, research should aim to enhance participation mechanisms within virtual forest realization projects. Integrating gamification elements, such as those used in platforms like Ant Forest, with tangible

aspects of national tree-planting initiatives can leverage rewards and social interaction to increase active involvement. By combining these approaches, we can enhance the high user engagement of “Ant Forest” and the robust physical project of “national voluntary tree-planting”, addressing their respective limitations and achieving a synergistic effect. This integration not only boosts participation but also strengthens public environmental awareness and trust through hands-on experiences.

5. Conclusions

Through an analysis of 69 selected articles, the research on virtual forest realization projects in China can be categorized into three types: behavior type, operating system, and research logic. The behavior type studies emphasize diverse participation methods to promote green consumption, recycling, and tree-planting activities through the Internet, illustrating user interactions with environmental protection initiatives on digital platforms. The operating system focuses on developing policy frameworks and government–enterprise platforms, which are crucial for advancing the implementation of virtual forest realization projects. Research logic identifies challenges and influencing factors in public participation, proposing targeted countermeasures and highlighting strategies for optimizing environmental governance and platform operations.

The current literature indicates that virtual forest realization projects in China are still in their early stages and face several challenges. While public participation has significantly advanced the attainment of dual carbon goals, individuals encounter practical obstacles such as insufficient government management and disrupted information channels. Influencing factors, especially external variables, heavily impact initial participation stages, resulting in unpredictable and unstable public behavior. Moreover, the introduction of gamification platforms and associated participation costs further exacerbate the green gap. As the duration and intensity of participation increase, external stimuli gradually give way to internal public perceptions, fostering more self-directed behavior that is both stable and enduring, thereby helping to narrow the green gap.

At present, solutions primarily emphasize macro-level government policy guidance but do not sufficiently address these specific challenges. Future efforts should aim to tackle these practical issues more effectively and develop targeted strategies to bridge the green gap. Additionally, while there is a wealth of literature discussing influencing factors, there is a notable scarcity of research focusing on practical problem-solving. Therefore, future research should broaden its scope to explore a diverse array of solutions, including the distribution of interests among multiple stakeholders and the refinement of participation mechanisms at the micro-level. By delving into these areas, researchers may more effectively bridge the intention–behavior gap in virtual forest realization projects in China, enhance public awareness of forest conservation, and lay a solid foundation for the continued advancement of forest protection initiatives.

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Appendix A

Table A1. The characteristics of the included articles ($n = 69$).

Researcher, Year	Research Focus	Sample Size	Methods	Theoretical Lens
English articles (42/69)				
Ashfaq et al. (2023) [67]	The public's intention for continuous participation in Ant Forest.	353 Ant Forest users (172 were males, and 181 were females)	SEM ¹	Expectation–confirmation model task–technology fit model
Ashfaq et al. (2022) [33]	The public's experience, personal traits, and motivational factors influencing the intention to continue using Ant Forest.	337 Ant Forest users (195 were males, and 142 were females)	PLS-SEM ²	User experience, personal attributes, and motivational factors
Ashfaq et al. (2021) [7]	The public's attitudes towards Ant Forest and continuous intentions, moderated by environmental knowledge.	293 Ant Forest users (129 were males, and 164 were females)	PLS-SEM	Behavioral reasoning theory
Cao and Cheng (2024) [48]	The impact of gamification on public eco-friendly behaviors in Ant Forest.	485 Ant Forest users (297 were males, and 188 were females)	PLS-SEM	Gamification affordances and cognitive evaluation theory
Cao and Liu (2023) [41]	The mechanisms driving customers' continuous consumption behaviors in Ant Forest.	280 Ant Forest users (114 were males, and 166 were females)	SEM	Stimulus–organism–response theory and theory of planned behavior
Cao et al. (2022) [40]	The impact of competition, cooperation, and shared gamified interactions on consumers' low-carbon actions in Ant Forest.	558 Ant Forest users (267 were males, and 129 were females)	SEM	Goal-framing theory
Chen et al. (2020) [68]	Reasons for public participation in Ant Forest and environmental impacts of Ant Forest.	600 Ant Forest users (219 were males, and 381 were females)	SEM	Environmental awareness and social motivation Online immersion and global cooperation intention
Chen et al. (2023) [37]	Gamification in Ant Forest influences green consumption behaviors by enhancing perceived value and environmental concerns.	18,069 comment postings and 486 respondents	Text-coding and SEM	Gamification affordances, psychological outcomes, and behavioral outcomes
Cheng and Cheng (2024) [69]	This study explores how Ant Forest influences tourists' intention to pay for visiting destinations that involve their participation.	320 Ant Forest users (137 were males, and 183 were females)	SEM	Theory of motivation
Cheng and Cao (2024) [46]	Gamification in Ant Forest positively affects users' intentions to engage in sustainable behaviors.	393 Ant Forest users (166 were males, and 227 were females)	PLS-SEM	Cognitive evaluation theory and gamification affordances
Huang and Zhou (2021) [19]	The roles of social gamification affordances in Ant Forest.	602 Ant Forest users (311 were males, and 291 were females)	PLS-SEM	Gamification affordances, psychological outcomes, and behavioral outcomes
Huang et al. (2024) [43]	Gamification in Ant Forest influences how consumers engage with brands through social media marketing.	305 Gen Z (born between 1996 and 2014) users of Ant Forest	PLS-SEM	Social media marketing (entertainment, interaction, trendiness, customization, and word-of-mouth).

Table A1. Cont.

Researcher, Year	Research Focus	Sample Size	Methods	Theoretical Lens
Huang et al. (2023) [47]	The relationship between gamification, perceived enjoyment, sustainable consumption, and green advertising in Ant Forest.	305 Ant Forest users (age between 18 and 25)	PLS-SEM	Theory of planned behavior
Lin and Lee (2024) [50]	Consumer social responsibility and long-term orientation affect the intention to continue using Ant Forest.	377 Ant Forest users (152 were males, and 225 were females)	PLS-SEM	Unified theory of acceptance and use of technology
Loizeaux (2023) [70]	The use of financial technology to address environmental issues, exemplified by Ant Forest.	—	Qualitative	—
Lu et al. (2024) [39]	The internal link between gamified interactions and green value co-creation behaviors in Ant Forest.	410 Ant Forest users (192 were males, and 218 were females)	SEM	Interaction ritual chains theory and green value co-creation
Ma and Liu (2022) [28]	Public participation in Ant Forest can influence green consumption behaviors.	517 Ant Forest users (204 were males, and 313 were females)	SEM	Theory of stimulus–organism–response
Mi et al. (2024) [39]	The decision-making process of group participation in Ant Forest.	—	Multi-agent simulation	Regret theory
Mi et al. (2021) [51]	The driving psychology of users' continuous behaviors in Ant Forest.	951 valid questionnaires	SEM	Gratifications theory
Obuobi, Tang et al. (2024) [52]	The impact of autonomous and controlled motivation on attitudes, intentions, and conservation behaviors in Ant Forest.	502 Ant Forest users (229 were males, and 273 were females)	PLS-SEM	Technology acceptance model and self-determination theory
Shao and Xu (2023) [66]	The impact of Ant Forest on environmental behaviors.	473 Ant Forest users (213 were males, and 260 were females)	SEM	Theory of reasoned action, knowledge–attitude–behavior theory, diffusion of innovation theory, reinforcement, and learning theory
Shen et al. (2021) [71]	The influence of Internet commonweal characteristics on participation intention of Ant Forest.	584 Ant Forest users (283 were males, and 301 were females)	SEM	Stimulus–organism–response model
Sun and Xing (2022) [45]	This study uses Ant Forest to examine how gamification participation motivation, ongoing usage, and eco-friendly consumption behaviors interact.	530 Ant Forest users (279 were males, and 251 were females)	SEM	Combining persuasion theory
Wang et al. (2022) [29]	The spatial distribution and quantitative effects on the carbon sink of Ant Forest.	NPP of vegetation in each Ant Forest area from 2016 to 2020	Web crawler	—
Wang et al. (2022) [65]	The factors that motivate users to participate in Ant Forest.	400 Ant Forest users (260 were males, and 140 were females)	Multiple regression model	—
Wang and Yao (2020) [44]	The factors that lead to users' continuous participation in Ant Forest.	Group interviews and 207 questionnaires	Qualitative	Two-dimensional Kano model

Table A1. Cont.

Researcher, Year	Research Focus	Sample Size	Methods	Theoretical Lens
Wei, Wang et al. (2024) [60]	Digital technology influences Ant Forest users' intentions to engage in eco-friendly travel.	214 Ant Forest users (102 were males, and 112 were females)	SEM	Stimulus–organism–response theory and goal-framing theory
Wu and Sun (2022) [72]	The effect of gossip within Ant Forest and strategies to manage it to boost public engagement.	—	Game theory	—
Xiong et al. (2022) [6]	The game elements to motivate users in Ant Forest.	500 Ant Forest users (230 were males, and 270 were females)	SEM	Stimulus–organism–response theory and self-determination theory
Xiong et al. (2024) [27]	The effect of participating in Ant Forest on consumers' low-carbon behavior.	298 Ant Forest users (137 were males, and 161 were females)	SEM	Theory of consumption value and stimulus–organism–response theory
Yang et al. (2018) [49]	Factors affecting the ongoing use of Ant Forest by the public.	295 Ant Forest users (150 were males, and 145 were females)	PLS-SEM	Persuasion and motivation theories
Zafar et al. (2024) [38]	The impact of gamification on sustainable purchasing behavior in Ant Forest.	320 users and 238 non-users	PLS-SEM	Gamified learning and behavioral reasoning theory
Zhang et al. (2022) [42]	Ant Forest and its influence on the public pro-environmental behaviors.	596 Ant Forest users (227 were males, and 369 were females)	SEM	Value theory
Zhang and Anwar (2023) [64]	Gamification in Ant Forest encourages users to engage in environmentally responsible behavior after adoption.	1869 Ant Forest users (1026 were males, 843 were females)	PLS-PM	Persuasion and motivation theories and affordances–psychological outcomes–behavioral outcomes framework
Zhang (2023) [63]	The impact of various factors on green self-awareness and individual behavior change, illustrated through a research model using the Ant Forest app.	220 respondents	PLS-SEM	Environmental concern, sense of achievement, social and entertainment, self-awareness change, and individual behavior change
Zhang and Zhang (2023) [9]	The factors influencing public participation in Ant Forest and Internet plus national voluntary tree-planting.	604 Internet plus national voluntary tree-planting and 802 Ant Forest users	SEM	Theory of planned behavior and knowledge–attitude–practice
Zhang et al. (2021) [73]	Ant Forest aids in land restoration and has notable socio-economic impacts.	Official reports from Alibaba's ant financial and remote sensing data	Qualitative	—
Zhang et al. (2020) [8]	The factors influencing the public's continuous intention to use Ant Forest.	278 Ant Forest users (100 were males, 178 were females)	PLS-SEM	Perceived cost, environmental concern, game interaction, perceived enjoyment, and satisfaction
Zhao et al. (2021) [74]	The effective incentive mechanisms in Ant Forest for reducing household carbon emissions.	—	Game theory	—
Zhong et al. (2020) [14]	Taking Ant Forest as an example to expound the combination of Internet technology innovation and digital financing.	Case study	Qualitative	—

Table A1. Cont.

Researcher, Year	Research Focus	Sample Size	Methods	Theoretical Lens
Zhou et al. (2023) [26]	The impact of gamification features on users' pro-environmental behavior in Ant Forest.	400 Ant Forest users (70 were males, 162 were females)	SEM	Affordance–psychological outcomes–behavior outcomes framework
Zhou et al. (2022) [75]	The way gamification affects users' perceived benefits and their intention to continue using Ant Forest.	The first questionnaire had 600 participants, and the second follow-up had 448 participants, resulting in 367 valid questionnaires	PLS-SEM	Affordances–psychological outcomes–behavioral outcomes framework
Chinese articles (27/69)				
Du et al. (2022) [76]	Gamification drives green consumption behavior of Ant Forest users.	5737 posts and 32,817 comments	Ethnography	Needs–affordances–features and goal-framing theory
Fan et al. (2017) [77]	Psychological mechanism of public participation in Ant Forest.	323 valid questionnaires (160 were males, 163 were females)	SEM	Theory of social presence and Maslow's hierarchy of needs
Guo et al. (2023) [24]	The internal mechanism of Ant Forest users' shift to offline green consumption.	504 valid questionnaires	SEM	Behavior reasoning theory
Hu and Zhang (2018) [61]	The enlightenment of Ant Forest on environmental communication.	Publicly available data	Qualitative	—
Li et al. (2023) [36]	The core driving force of gamified design in Ant Forest for young people's online low-carbon practices.	One is the collection of online textual materials; the second is in-depth interviews	Ethnography	Emotional entertainment mechanism, moral code mechanism, and cost–benefit mechanism
Lin and Xiu (2022) [58]	The influencing factors and mechanisms of college students' participation in Ant Forest.	607 college students (160 were males, 163 were females)	SEM	Stimulus organism response theory
Liu (2019) [30]	The generation logic of gamification of public welfare communication in Ant Forest.	Publicly available data	Qualitative	Self-determination theory and flow
Liu et al. (2024) [35]	The impact mechanism of virtual real transformation on users' low-carbon behavior willingness on the Ant Forest platform.	753 valid questionnaires (292 were males, 372 were females)	PLS-SEM	Affordance–psychological outcomes–behavioral outcomes
Mao et al. (2021) [78]	The relationship among digital experience environment, customer–enterprise social value co-creation, customer engagement, and social responsibility relevance in Ant Forest.	319 valid questionnaires (162 were males, 157 were females)	SEM	Self-determination theory, meaning construction theory, and attribution theory of cognitive psychology
Mou et al. (2023) [79]	Exploration of the driving mechanisms of openness and sociality characteristics on virtual identity in Ant Forest.	343 valid questionnaires (115 were males, 228 were females)	SEM	Social identity theory

Table A1. Cont.

Researcher, Year	Research Focus	Sample Size	Methods	Theoretical Lens
Qin and Tian (2021) [23]	Eco-friendly games in Ant Forest have an impact on public environmental behavior.	1246 valid questionnaires Beijing ($n = 315$) Shanghai ($n = 312$) Tianjin ($n = 312$) Chongqing ($n = 307$)	SEM	Goal-framing theory
She et al. (2023) [80]	The positive spillover effects and influencing mechanisms of digital green behavior in Ant Forest.	228 valid questionnaires (107 were males, 121 were females)	SEM	Psychological ownership and self-perception theory
She et al. (2023) [81]	Taking Ant Forest as an example to examine the spillover effect of digital green behavior.	304 valid questionnaires (92 were males, 212 were females)	SEM	Behavioral spillover theory, psychological ownership, environmental self-awareness
Tong and Sun (2022) [17]	Taking Ant Forest and national voluntary tree-planting as examples to examine social discourse in the process of platformization.	Semi-structured interview Publicly available data	Qualitative	The analytical framework of “state market society”
Tong et al. (2023) [34]	The negative spillover effects of gamified design in Ant Forest.	Publicly available data	Quasi-experimental Research	Gamified marketing theory and target adjustment theory
Wang and Yang (2024) [22]	The leisure labor process and continuous labor mechanism of Ant Forest user groups.	In-depth interview Publicly available data	Qualitative	Grounded theory
Wang and Shen (2021) [82]	Merging Ant Forest with gardening to advance urban garden landscape development.	Publicly available data	Qualitative	4I principle (interesting, interests, interaction, and individuality)
Xi and Yang (2020) [31]	An analysis was conducted on the public welfare communication practices of Ant Forest.	Publicly available data	Qualitative	—
Yang (2021) [59]	The behavior, motivation, and psychology of youth participation in Ant Forest from a cognitive perspective.	15 cases	Case study	Motivation theory, technology acceptance model, and embedding theory
Zhang and Tang (2022) [83]	The boundary conditions and mechanisms by which gamification affects consumer participation willingness in Ant Forest.	Divided into two groups for investigation (384 valid questionnaires; 332 valid questionnaires)	SEM	Social cognitive theory, mechanics dynamics aesthetics design framework
Zhang and Wang (2022) [32]	The mechanism of the impact of corporate social responsibility perception on participation willingness in Ant Forest.	512 valid questionnaires (272 were males, 240 were females)	SEM	Customer psychological empowerment
Zhang et al. (2022) [62]	The significant difference in the impact of public participation in Ant Forest on their environmental behavior in different regions.	Publicly available data (Select the experimental and control group based on the public welfare watering amount in the “Ant Forest” list)	Quasi-experimental Research	—

Table A1. Cont.

Researcher, Year	Research Focus	Sample Size	Methods	Theoretical Lens
Zhang and Wang (2023) [84]	Taking Ant Forest as an example to analyze the demand for realizing its ecological product value.	Publicly available data	Qualitative	—
Zhang and Zhang (2021) [10]	Comparison of Ant Forest and national voluntary tree-planting.	Publicly available data	Qualitative	—
Zhang and Zhang (2022) [16]	Comparative analysis of influencing factors between Ant Forest and national voluntary tree-planting.	802 valid questionnaires (404 were males, 398 were females)	SEM	Theory of planned behavior and knowledge–attitude–practice
Zhou et al. (2020) [11]	Analysis of Ant Forest generating virtual forest carbon sequestration.	Publicly available data	Qualitative	—
Zhou et al. (2019) [85]	The impact of interactivity in Ant Forest on the sustained usage intention of mobile app users.	511 valid questionnaires (227 were males, 284 were females)	SEM	Persuasion knowledge

¹ Structural equation modeling (SEM), ² partial least squares structural equation modeling (PLS-SEM).

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