

Article

Whether Behavioral Guidance Policies of Construction Waste Resource Utilization Are Effective for Construction Contractors: Evidence from China

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Abstract: This research endeavors to delve comprehensively into the ramifications of behavioral guidance policies pertaining to construction waste resource utilization (CWRU) on the behavioral awareness and attitudes of Chinese construction contractors. The implicit attitudes of 98 construction contractor workers toward construction waste collection, sorting, and reuse were quantitatively assessed by simulating different types of behavior-guided policies using the External Affective Simon Task (EAST) method with unconscious reaction time as an indicator. At the same time, the questionnaire survey was combined to collect and analyze the scores of these workers' exogenous attitudes toward CWRU, with a view to revealing the contractors' intrinsic behavioral awareness and exogenous attitudinal tendencies. The study reveals that economic incentive behavioral guidance policies are pivotal in fostering the collection, sorting, and reuse of construction waste. Furthermore, it novelly uncovers the distinct advantages of laws and regulations frameworks in safeguarding the fundamental aspects of construction waste collection. Notably, publicity and education behavioral policies emerge as a cornerstone in elevating the significance of construction waste collection and sorting, highlighting the cruciality of enhancing public awareness and knowledge to propel CWRU. The results of the study not only provide empirical evidence to understand the inherent attitudes of construction contractor workers toward CWRU behavior but also provide practical support for future policymakers. By advocating for economic incentives, strengthening regulations, and leading education, the multi-pronged approach promotes China's CWRU accelerates the green transformation of the construction industry.

Keywords: construction waste resource utilization; behavioral guidance policies; construction contractors; implicit experiments



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1. Introduction

Amidst the growing emphasis on sustainable development, concerns pertaining to the environmental footprints of various industries, including construction, have intensified [1]. The construction sector, inherently, is not environmentally benign [2]. Construction waste, stemming from the demolition, renovation, repair, and construction of buildings, represents a significant byproduct of this industry [3]. China's swift urbanization fuels an annual spike in construction waste, posing a significant environmental challenge that demands attention [4]. It is estimated that China produces over 2 billion tons of construction waste annually [5]. The traditional approaches of landfilling and incineration consume substantial land and emit greenhouse gases, at odds with China's pursuit of carbon peaking and

neutrality goals [6,7]. Hence, construction waste resource utilization (CWRU) becomes crucial in China's pursuit of a low-carbon, green, and circular economy [8]. It is an urgent strategy that addresses environmental concerns. It represents a pivotal avenue for mitigating carbon emissions and advancing toward a more sustainable future.

CWRU encompasses the comprehensive process of collecting, sorting, treating, and repurposing construction waste for reuse [9]. Presently, a growing number of nations are recognizing its importance and initiating measures to foster its development. Several developed countries and regions have already achieved remarkable accomplishments both theoretically and practically. For instance, Germany and Japan have surpassed 90% recycling rates for construction waste through legislation, policy incentives, and innovative mechanisms [10]. Specifically, Germany has enacted rigorous regulations on construction waste management, outlining clear standards for sorting, collection, transportation, treatment, and reuse [11]. These are bolstered by economic incentives like tax breaks and subsidies to motivate enterprises and individuals to engage in waste recycling. Japan prioritizes technological R&D and innovation, regularly introducing cutting-edge waste treatment tech and equipment [12]. This boosts recycling efficiency and improves product quality. In contrast, China's journey in CWRU started relatively late, resulting in a lower recycling level. The "Construction Waste Disposal Industry 2023 Annual Report" highlights that China's overall resource utilization rate is less than 10%, vastly different from the over 90% achieved by developed nations [13]. Construction waste contains abundant recyclables like concrete, metal, wood, and bricks [14]. With advanced treatments, they transform into valuable building materials like recycled aggregates, bricks, and concrete. This circular economy approach alleviates pressure on natural resources, reduces mining, and cuts construction costs, boosting economic efficiency.

CWRU is a multifaceted process that engages diverse stakeholders, notably construction contractors, construction material manufacturers, and governmental bodies [15]. Construction contractors, as the direct executors of construction projects, occupy a dual role. They are both the primary producers of construction waste and potential users of recycled products [16,17]. Contractors can significantly reduce environmental pollution and resource consumption by improving waste collection, sorting, and reuse practices. Huang et al. [18] conducted an insightful analysis of construction waste management practices and existing policies, applying the 3R principle (Reduce, Reuse, Recycle). Their findings underscore the pivotal role of government in fostering resourceful corporate behaviors. Recently, the Chinese government has devoted considerable efforts to advancing CWRU. It has issued numerous policies to encourage active participation from construction contractors [5]. A prime example is the Regulations on Municipal Construction Waste Management. It highlights resourcefulness and the 'polluter pays' principle, emphasizing waste generators' responsibility and promoting comprehensive waste utilization [19]. As direct participants in generating and disposing of construction waste, contractors' behavioral awareness and attitudes are crucial to the success of policy implementation [20]. However, the question lingers. Have these policies effectively resonated with construction contractors, and to what extent have they been implemented effectively? This remains a crucial area deserving of further exploration and analysis.

The researcher employed questionnaires [21] and interviews [22] to investigate the current status and challenges in implementing construction waste management policies. While these methods yield invaluable firsthand insights, their constraints are acknowledged. Subjective perceptions and expressions by interviewees may limit the study, overlooking genuine attitudes and motivations of construction contractors [23]. While prior studies focused on policy formulation and execution from a governmental perspective [24], they mainly analyzed how subsidies influence contractors and recycling enterprises [25], overlooking a comprehensive view across various policy contexts [26]. To effectively bridge this research gap in CWRU and transcend existing limitations, this study outlines the following key objectives:

- Utilize implicit experimental methodologies to delve into the unconscious attitudes and preferences of construction contractors;
- Conduct a rigorous evaluation of the impacts of varying guidance policies;
- Provide a robust scientific foundation for policy formulation and implementation;
- Foster the advancement of CWRU in China.

Ultimately, the ambition is to achieve a harmonious coexistence between the construction industry and the natural environment. It requires mitigating the environmental impacts of construction waste with scientific policy guidance. This steers the industry toward green, low-carbon, and sustainable development.

The structure of this paper is as follows. Section 2 reviews the literature related to CWRU, behavioral guidance policies, and the Implicit Association Test (IAT) experimentation. Section 3 introduces the research methodology, encompassing participants, experimental materials, the Extrinsic Affective Simon Task (EAST) procedure, and explicit attitude surveys. Section 4 reports the findings from the analysis of the baseline and control groups. Section 5 discusses the research results, their theoretical and managerial implications, limitations, and suggested directions for future research. Finally, Section 6 concludes the paper.

2. Literature Review

2.1. CWRU

CWRU entails transforming construction waste into reusable resources, thereby reducing natural resource consumption and minimizing environmental impact. Its objective is twofold, alleviating the strain on natural resource extraction while mitigating negative environmental consequences [27]. Despite immense potential, this endeavor confronts multiple hurdles. Inadequate technology hinders efficient resource utilization. Automatic sorting systems, though identifying most waste types, struggle with mixed materials. Insufficient and imperfect policies hinder the industry's standardized development. Additionally, a lack of robust environmental protection awareness dampens corporate enthusiasm for industry participation. Current research focuses on advancements in classification and sorting technology [28], waste material design optimization [29], and sustainable building materials [30], with a vision to establish an efficient and effective CWRU ecosystem. Moreover, scholars have contributed innovative solutions to advance CWRU. Sukholthaman and Sharp [31] emphasize the importance of source separation in managing construction waste. They highlight that setting reasonable separation rates can boost the efficiency of waste collection and transportation. The CWRU process encompasses a comprehensive closed-loop system, spanning from waste collection and sorting, efficient transportation, professional crushing, and screening, to recycled aggregate processing, and ultimately, the reuse of final products [32]. This intricate chain intimately interconnects diverse stakeholders, including construction contractors, construction material producers, and government entities [33]. Li et al. [34] created a dynamic evolutionary game model that includes construction contractors and recycling enterprises. This model offers a profound analysis of how behavioral patterns evolve among participants in the CWRU management system.

Ding et al. [6] conducted a thorough analysis of the pivotal role and contributions of construction material producers within the CWRU framework, utilizing a perceived value model. Their findings highlighted that producers, through continuous technological innovation, significantly improved the performance indices of recycled building materials. This, in turn, enhanced their market competitiveness and recognition. In parallel, Zhao et al. [35] refined the multifaceted factors influencing construction waste utilization management, reasserting the centrality of construction material producers in driving environmental transformation. Despite widespread recognition of the importance of construction material producers, research on the role and contribution of construction contractors in the CWRU process is still limited. Zhang et al. [36] emphasize that the dual-pronged approach, a stable supply of raw materials coupled with market demand for resource-based products, is crucial to the success of the resource utilization process. Construction contractors, as

the main source of construction waste and major consumers of resource-based products, have a crucial influence on the smooth operation and overall efficacy of this process. Their willingness and actions are decisive [37]. As the direct executors of construction projects, construction contractors serve as the frontline managers of construction waste generation. They are tasked with controlling waste at its source, minimizing output by optimizing construction plans, enhancing efficiency, and reducing material waste. Nevertheless, even under optimal circumstances, some waste generation is inevitable. Hence, contractors' priority lies in effectively collecting this waste to prevent haphazard or illegal dumping that could pollute the environment [38]. The sorting of construction waste is pivotal to the efficiency and success of subsequent resource recovery and reuse efforts. Given the diverse nature and applications of various waste types, precise categorization is essential to unlock their latent value. Construction contractors play a pivotal role, not only directly executing the sorting process but also driving innovation in sorting technology and process optimization [39]. Furthermore, contractors can significantly promote construction waste reuse by advocating for recycled building materials and directing market demand toward environmentally friendly options [21]. Due to the lack of research on how construction contractors specifically impact CWRU, the aim is to explore their attitudes and willingness regarding the collection, sorting, and reuse of such waste. This endeavor seeks to furnish a theoretical foundation and practical insights for developing a more comprehensive and effective construction waste management system.

2.2. Behavioral Guidance Policy

Behavioral guidance policy, an innovative tool, integrates psychology and behavioral economics to guide individual behavior and decision-making for social and personal well-being [40]. This policy is grounded in extensive research by scholars across fields. From a behavioral economics perspective, individual decisions are not always rational; they are influenced by cognitive limits, emotions, and social norms. Hu et al. [41] confirm the behavioral economics view that corporate environmental decisions are influenced not only by rationality but also by factors like environmental taxes, carbon emissions trading, and regulations. This aligns with the idea that individual decisions are shaped by cognitive, economic, and social factors. Meanwhile, psychology's social identity theory and habit formation mechanism suggest promoting environmental behavior among construction contractors by fostering a positive social atmosphere and cultivating environmental habits. Hogg and Terry's research further supports this, showing that environmental activities, recognition, and education boost social identity and encourage habits like saving and sorting, confirming the positive effect of social identity and habits on environmental behavior [42]. Lai et al. [43] stressed that effective CWRU requires proactive efforts from enterprises and behavioral guidance from the government, creating a synergistic mechanism for promotion. Cheng et al. [44] further validated the effectiveness of policy guidance on construction contractors' participation in CWRU through a system dynamics model simulation.

Behavioral guidance policies can be categorized into three main types based on policy instruments and objectives: market-based, command-based, and information-based [45]. Market-based instruments leverage market forces, offering greater flexibility than regulatory tools [46]. Conversely, command-and-control instruments impose stringent restrictions and involve substantial government intervention [47]. Information-driven policies strive to shape collective action by disseminating knowledge to citizens and stakeholders [48]. However, in the emerging field of CWRU, the exploration of behavioral guidance policies is still in its early stages, and the classification system needs further refinement. Considering the current understanding of environmental policy instruments among Chinese citizens, this study focuses on conducting an in-depth analysis of representative guidance measures across various types.

Economic incentives employed in behavioral policy guidance involve the utilization of prices, taxes, subsidies, loans, and other governmental tools to impose positive or negative

repercussions on specific behaviors, thereby guiding actors toward policy objectives [49]. Japan's government, for instance, offers tax exemptions and preferential loans to firms engaged in CWRU, along with low-interest loans to encourage consumers to purchase recycled products [50]. Li et al. [51] conducted a regression analysis to delve into the developmental priorities of China's construction and demolition waste recycling industry, revealing economic incentives as the most prevalent policy instrument in this sector. Previous research has concentrated on the direct impact of economic incentives on contractors, particularly with regard to government subsidies. Tan et al. [52] analyzed stakeholder decision-making under scenarios with no subsidies, subsidies for contractors, or subsidies for manufacturers. The results indicate that economic incentives for construction contractors are crucial, as they alleviate cost burdens and enhance their enthusiasm and willingness to engage in resource utilization.

As a form of command instrument, laws and regulations employ mandatory and binding measures to regulate the conduct of enterprises and citizens [53]. Extensive research underscores their pivotal role in incentivizing CWRU [54,55]. Ma et al. [56] underscore this significance further through comprehensive fieldwork conducted in 10 Chinese cities, encompassing 10 local recycling facilities, highlighting the centrality of laws and regulations in advancing China's CWRU process. These legal frameworks articulate clear standards and requirements for resource utilization, governing the disposal and utilization of construction waste, thereby ensuring proper execution of resource utilization efforts [57]. Being mandatory and ubiquitous, laws and regulations exert direct constraints and influences on stakeholders, serving as a vital means to ensure the seamless implementation of resourcing endeavors.

Publicity and education serve as primary tools to elevate the awareness and engagement of enterprises and citizens in resourcing endeavors, achieved through widespread campaigns, instructional programs, and training sessions. Misconceptions surrounding recycled materials often dampen the construction industry's willingness to embrace them [21]. However, publicity, education, and demonstrations can significantly boost public perceptions of recycled products. Japan, for instance, employs the Reduce–Reuse–Recycle strategy to enhance public understanding of construction waste management by actively disseminating knowledge to the masses [58]. Similarly, in Belgium, the successful demonstration of recycled aggregates in three road projects has markedly bolstered consumer trust in recycled building materials [59]. By altering attitudes and behavioral patterns, publicity and education foster long-term sustainable resourcefulness awareness and practices. However, most of the existing literature focuses on exploring the effects of singular behavioral guidance policies, overlooking longitudinal analysis. Additionally, research on the role of smaller contractors in CWRU is inadequate. Therefore, this study adopts a classification framework of economic incentives, laws and regulations, and publicity and education to deeply investigate how these policy tools can effectively motivate construction contractors to actively participate in the process, aiming to address the gaps in current research.

2.3. IAT Experiment

Since its inception by Greenwald et al. [60] in 1998, the IAT has emerged as a pivotal tool for assessing individuals' implicit social cognitions, encompassing implicit attitudes, self-esteem, and stereotypes, which often operate beneath conscious awareness. The experiment utilizes the IAT to gauge participants' attitudes toward various entities by assessing the differential response times in categorizing these as compatible or incompatible concepts [61]. Since participants are unaware of the experiment's true objective, this approach effectively precludes intentional manipulation of results, rendering the outcomes a more accurate reflection of their genuine attitudes [62]. Nevertheless, the classical IAT method has its constraints, notably its limitation to measuring relative attitudes between two objects, rather than the specific attitude toward a single object. For our research focusing on construction contractors' attitudes toward CWRU, identifying a clearly corresponding research object is challenging. Consequently, there is a necessity to adapt the IAT methodology to

accommodate single-variable implicit testing, leveraging a refined variant tailored to our research needs [63].

In recent years, scholars have devised numerous refined experimental paradigms to address the limitations of the traditional IAT, including the Single Category Implicit Association Test (SC-IAT), Single Attribute Implicit Association Test (SA-IAT), and EAST, among others. Table 1 outlines the specific differences between these paradigms. The SC-IAT, adept at measuring the strength of associations between individual attitude objects, overcomes the IAT's inability to directly assess implicit attitudes toward a single entity [64]. However, its focus on the strength of a single target-attribute association may prove insufficient for the intricate context of studying attitudes toward CWRU [65]. The SA-IAT, by employing a single attribute word dimension, mitigates biases from complementary attributes and simplifies experimental manipulation [66]. Nevertheless, its limitation to a single attribute word hinders its applicability to the multidimensional attitude system explored in this study.

Table 1. Comparison of research paradigms in the implicit association test (IAT).

Nomenclature	IAT	SC-IAT	SA-IAT	EAST
Principle	A computerized categorization task that tests the degree of association between target and attribute words, using reaction time as an indicator.	A computerized categorization task that tests the degree of association between target and attribute words, using reaction time as an index.	A computerized categorization task that tests the degree of association between target words and attribute words, using reaction time as an index.	Assigning positive or negative meanings to computer keystrokes and subsequently influencing when subsequent individuals respond to the noun color during their response.
Procedure	Five or seven experimental steps	Four experimental steps	Three experimental steps	Two experimental steps (subjects need to be grouped in the second step)
Target word count	Two	Single	Two	Multiple
Attribute word count	Two	Two	Single	None

Conversely, the EAST paradigm, by integrating categorization tasks with evaluative stimuli, offers a highly efficient and sensitive means of data collection [67]. Its ability to swiftly capture subjects' automated responses to subtle stimuli and accommodate multiple target words makes it well-suited for investigating complex social attitudes. Given the scarcity of implicit research on practitioners' attitudes toward CWRU, despite abundant studies on technical processes and economic benefits, EAST emerges as a valuable tool to uncover practitioners' subconscious acceptance and willingness to support this endeavor [68]. Hence, this study employs the EAST experimental paradigm to precisely measure and thoroughly analyze the implicit attitudes of construction contractors toward CWRU, both before and after policy guidance, thereby contributing to a deeper understanding of this critical issue.

3. Method

3.1. Purpose of the Experiment and Hypothesis

To delve into and precisely portray the subconscious sentiments of construction contractors toward CWRU, both prior to and subsequent to policy incentives, this study employed the EAST implicit experiment paradigm. The EAST implicit experimental paradigm is employed as the primary assessment tool. This paradigm employs "positive" and "negative" as evaluation dimensions, quantifying changes in construction contractors' implicit attitudes toward the collection, sorting, and reuse of construction waste before and after policy implementation by measuring response time differences. Additionally, a scientifically rigorous questionnaire is designed to collect explicit attitude data from

construction contractors regarding CWRU, facilitating a comparative analysis with the implicit attitude measurements.

Drawing upon a comprehensive literature review, this research posits the following hypotheses: economic incentives, laws, and regulations, as well as publicity and education policies, can effectively foster positive shifts in contractors' implicit cognitive attitudes toward the collection, sorting, and reuse.

3.2. Identification and Control of External Variables

To ensure the purity and validity of the experimental results, this study has thoroughly identified and planned the control of a series of external variables that may influence participants' responses during the design phase. These potential factors, such as economic conditions, regulatory changes, and market dynamics, are not the direct independent variables of this experiment but may indirectly affect construction contractors' attitudes toward CWRU.

To systematically address these challenges, the study first determined the optimal time window for the experiment through comprehensive literature reviews and market research, choosing a period of relative economic stability to minimize potential disturbances caused by economic fluctuations in participants' mindsets. Additionally, close attention was paid to regulatory policy dynamics by regularly reviewing official announcements and communicating with industry experts to ensure no significant policy adjustments would occur during the experiment, thereby maintaining the consistency and controllability of the experimental environment.

During the data collection phase, a detailed recording system was designed to not only record core experimental data but also meticulously document all external emergencies that might affect participants' responses. In the data analysis phase, statistical methods such as regression analysis and covariance analysis were employed to more accurately isolate the direct impact of independent variables on dependent variables, scientifically controlling and analyzing the influence of these external variables. This approach allows for more reliable and convincing research conclusions.

3.3. Participants

The field personnel within construction contractors, serving as both participants and implementers of CWRU, possess invaluable direct experience and insights that significantly contribute to understanding and executing this practice. To capture this diversity, a strategic sampling of 107 frontline individuals from various regions, sizes, and business sectors of China's construction contractors was meticulously selected for this study. To broaden the sample's representativeness, a multifaceted recruitment approach was employed, encompassing collaborations with industry associations, leveraging business directories, and disseminating recruitment notices across social media platforms and specialized forums. This comprehensive strategy aimed to engage contractors from diverse backgrounds and geographies.

During the recruitment process, the level of industry experience and expertise among potential participants was paramount. Through questionnaires and preliminary interviews, information was gathered on their years of construction experience, the types of projects they have undertaken, and their level of understanding regarding CWRU. This rigorous process ensured that the final sample encompassed a broad spectrum of expertise and experience. Moreover, to uphold the accuracy and reliability of our experimental results, we implemented rigorous screening measures. These measures ensured that our sample was representative across enterprise sizes (ranging from large to small), business types (residential, infrastructure, renovation, and more), and geographical locations. By adhering to these principles, we have assembled a comprehensive and diverse sample that will provide invaluable insights into CWRU.

Participants were mandated to complete a questionnaire assessing their handedness (to identify and exclude left-handed individuals) and the Positive and Negative Affect

Schedule (PANAS), a validated scale used to detect and exclude individuals experiencing extreme emotional states at the time of experimentation. This rigorous screening process aimed to minimize external confounders that could potentially skew the results. Consequently, a refined sample of 98 valid participants, as detailed in Table 2, was utilized for analysis.

Table 2. Descriptive table of the situation of the experimental sample.

Variable Name	Total Sample (107 Persons)	Effective Sample (98 Persons)	Variable Name	Total Sample (107 Persons)	Effective Sample (98 Persons)
Age (years)			Enterprise Scale		
20–30	54	49	Large-Scale Enterprises	23	21
30–40	41	38	Medium-Sized Enterprises	54	50
>40	12	11	Small Businesses	30	27
Sex			Business Type		
Male	71	65	Residential Construction	32	31
Female	36	33	Infrastructure Construction	27	25
Academic qualifications			Interior Decoration	20	18
Below Bachelor’s Degree	9	7	Commercial Real Estate Development	15	13
Undergraduate	54	50	Industrial Real Estate Development	5	4
Graduate students and above	44	41	Diversified Business Operations	8	7

3.4. Materials

Drawing from the relevant literature, “construction waste collection”, “construction waste sorting”, and “construction waste reuse” were selected as target concept terms based on the stages of construction contractors’ involvement in CWRU. The attribute words encompass five positive (useful, feasible, supportive, acceptable, good) and five negative (useless, bad, opposed, rejected, poor) adjectives, which are all presented in white color. Additionally, to validate the experiment’s effectiveness, the conceptual words “flower” and “pest” were incorporated from the EAST paradigm. By recognizing potential biases in subjects’ perceptions of CWRU, a series of illustrations will precede the experiment, illustrating the entire CWRU process to provide a clearer understanding before the test begins.

The aim was to more accurately assess participants’ behavioral intentions toward CWRU and ensure these measurements align with the overall research objectives. Drawing upon prior research conducted by Wang et al. [69] and Spišáková et al. [70], the explicit attitudes of participants toward CWRU were quantitatively assessed using a custom-designed questionnaire. As shown in Table 3, the questionnaire employed a 7-point scale and consisted of 10 questions. Among them, five were positively framed items, assessing participants’ positive perceptions and actual actions toward CWRU. The other five were negatively framed items, aimed at detecting potential negative attitudes or concerns. This design helped to comprehensively understand the distribution of participants’ attitudes and reduce bias that might arise from single-direction questions.

Table 3. Construction waste resource utilization (CWRU) explicit attitude survey scale.

	Measuring Items	References
Positive	1. I believe that CWRU is an effective means of reducing environmental pollution and protecting the ecological environment.	[71–73]
	2. I think that through CWRU, projects can save costs and create additional economic value.	
	3. In my projects, I actively promote the collection, sorting, and recycling of construction waste to facilitate resource reuse.	
	4. If more laws and regulations supporting CWRU are introduced, I will respond positively and participate.	
	5. I look forward to new technologies further improving the efficiency and effectiveness of CWRU.	
Negative	6. I am concerned that CWRU will increase project operating costs, so I am not very willing to implement it.	
	7. When dealing with construction waste, I tend to opt for simple disposal rather than meticulous sorting.	
	8. My lack of understanding of the specific methods and processes of CWRU makes me hesitant.	
	9. I believe that current regulations impose restrictions on CWRU.	
	10. I am worried that reused building materials may not be popular in the market, affecting sales.	

The stimulus material tailored for the control group comprised three video clips, each meticulously crafted to span three minutes in duration. The economic incentives video is a multifaceted piece, encompassing triumphant case studies, expert policy elucidations, and a pronounced emphasis on the dual economic benefits. The laws and regulations video, on the other hand, is structured into segments that introduce pertinent legislation, dissect illegal cases, and showcase law enforcement scenarios. The publicity and education video serves as a conduit for environmental awareness, encompassing the revelation of pressing environmental issues, the dissemination of knowledge, the conveyance of environmental protection ideologies, and a call to action for environmental stewardship.

Preceding the experiment's commencement, a rigorous pre-test was administered to assess the efficacy of these stimulus materials. This endeavor entailed inviting 10 accomplished project managers and esteemed professors to participate; their insights were invaluable in gauging the perceived effectiveness. Subsequent to their feedback, iterative refinements were undertaken until the behavioral guidance policy's effectiveness was conclusively validated, thereby solidifying these materials as the definitive stimulus for the control group.

3.5. Experimental Procedure

The experiment is meticulously divided into two distinct phases: the baseline group, which aims to capture participants' inherent attitudes toward the CWRU, and the control group, designed to simulate the influence of various policies. This latter group stimulates participants accordingly and assesses the efficacy of different policies by comparing the impacts of various interventional measures. Recognizing the potential for bias in subjects' perceptions of CWRU, the experiment commences with a comprehensive introduction to the entire process, conveyed through a series of illustrative graphics. This ensures that participants possess a clearer understanding of CWRU prior to engaging in the experimental tasks.

During the experiment, experimental participants will be confronted with a computer pre-installed with the E-prime 2.0 program to complete the EAST response task on CWRU. Although the use of E-prime 2.0 software presented certain technical challenges, these were effectively overcome by providing detailed operational instructions to the experiment

personnel beforehand and ensuring thorough software testing prior to the experiment. Upon conclusion of the response task, they will fill out a questionnaire encompassing an explicit attitude test and behavioral tendency assessment. Strategically, the explicit attitude session follows the implicit test to mitigate any potential influence on the latter's outcomes. The control experiment is structured into three groups, based on the valid samples from the baseline group. Prior to the experiment, a 3-min video stimulus tailored to each group will be played. After the completion of the stimulus, the experiment participants will be asked to rest for 5 min. To ensure the fairness and accuracy of the experiment, and without altering the stimuli, the attribute words and target concept words in the Implicit Association Test program of the baseline group experiment will have their presentation order adjusted. This is to avoid any impact on the experiment results caused by the participants remembering the answer order from the previous stage in the control group experiment. Figure 1 outlines the experimental flowchart for clarity.

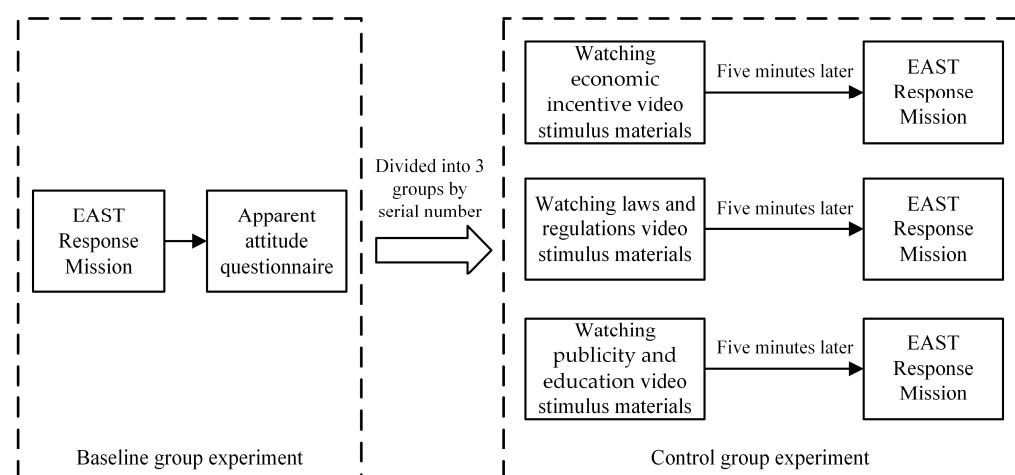


Figure 1. Flow chart of the experiment.

The introductory screen of the EAST experimental program provides a comprehensive overview: “Welcome to a series of categorized tasks designed to assess your judgment and reaction speed. On the upcoming computer screen, white and colored words will sequentially appear against a black backdrop. Your task is to respond swiftly and accurately based on specific instructions. Upon keystroke submission, the next word will appear, continuing until the end. Should you make an error, a ‘×’ will momentarily appear to remind you, allowing you to correct and move on without disruption. The entire quiz duration is approximately 15 min. Initially, you’ll undergo 3 practice rounds to acclimate yourself to the experimental flow, followed by the official quiz. If you’ve grasped the requirements, kindly press the space bar to proceed”.

The second screen offers specific guidance: “This practice session involves white words. Your task is to categorize them based on their meaning: Press ‘F’ for positive words and ‘J’ for negative ones. In simpler terms, press ‘F’ for good words and ‘J’ for bad words”. (Note: Ten attribute words, randomly selected, will be presented twice each, totaling 20 trials).

The third screen introduces the next exercise: “This practice segment deals with colored words. Here, you’ll sort them based on their hue: Press ‘F’ for blue words and ‘J’ for green words. (Reminder: The three concept words will be randomly displayed twice in both blue and green shades, resulting in a total of 12 trials)”.

Screen 4 Directions: “This segment combines both white words meaning categorization and colored word hue sorting. For white words, continue using ‘F’ for positives and ‘J’ for negatives. However, for colored words, the key assignments reverse: Press ‘J’ for blue words and ‘F’ for green words. Prepare for a total of 32 trials, consisting of 20 iterations

of the 10 white attribute words and 12 trials featuring the 3 concept words randomly displayed in blue and green hues”.

Screen 5 Instructions: “The formal test task mirrors the combined exercise on screen 4. You’ll undertake three separate tests, with brief respites in between. Note that these sections are timed, emphasizing the importance of speed and accuracy in your responses. Each formal test comprises 32 trials, totaling 96 trials across all three tests. The order of stimuli presentation is outlined in Figure 2. Practice sessions have established performance benchmarks, requiring a minimum of 80% correct responses to proceed to the formal experiments. Based on your performance, you’ll either advance to the formal tests or return to practice rounds”.

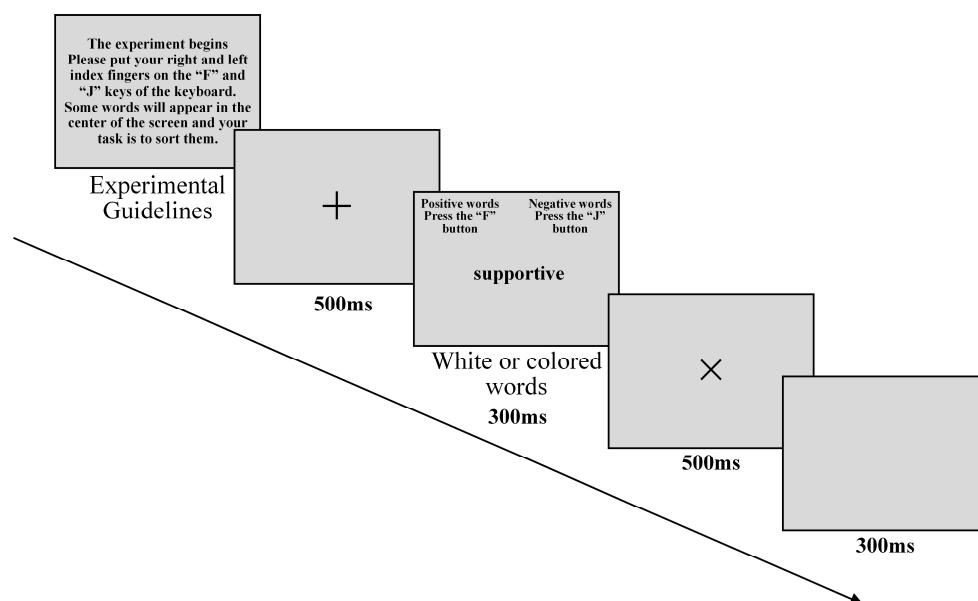


Figure 2. External Affective Simon Task (EAST) program stimulus presentation sequence diagram.

4. Results

4.1. Results of the Implicit Experiment in the Baseline Group

All data were meticulously analyzed using SPSS 25.0. Initially, the response times (RT) and error rates were scrutinized: (1) RTs below 300 ms were adjusted to 300 ms, while those exceeding 3000 ms were truncated to 3000 ms. Furthermore, test results with an error rate exceeding 20% were excluded from the analysis, adhering to [60] guidelines. (2) Subsequently, for each EAST score, separate analyses were conducted for the categories of flowers, pests, construction waste collection, construction waste sorting, and construction waste reuse. In the EAST task, the EAST effect values (EAST effect = $RT_{\text{negative}} - RT_{\text{positive}}$) are derived when participants exhibit significantly faster reaction times (RT_{positive}) to associations between an object (e.g., flower) and a positive attribute word (e.g., “beautiful”, “pleasant”) compared to their reaction times (RT_{negative}) to the same object paired with a negative attribute word (e.g., “ugly”, “unpleasant”). Conversely, if the RT_{negative} , i.e., the response time to the negative attribute pairing is significantly faster than the RT_{positive} (the response time to the positive attribute pairing), the resulting EAST effect value (EAST effect = $RT_{\text{negative}} - RT_{\text{positive}}$) becomes positive or close to zero but statistically significant ($p < 0.001$). In such cases, participants are deemed to hold positive implicit attitudes toward the object. However, when participants respond significantly faster (RT_{negative}) to associations between an object perceived negatively (e.g., pest) and a negative attribute vocabulary word (e.g., “disgusting”, “harmful”) compared to their reaction times to the same object paired with a positive attribute word (e.g., “beautiful”, erroneously stated as “harmful” earlier, it should be “harmless”), the computed EAST effect (EAST effect = $RT_{\text{negative}} - RT_{\text{positive}}$) yields a negative and statistically

significant value (e.g., $p < 0.001$). Here, participants are considered to hold negative implicit attitudes toward the object.

A paired-sample t -test was employed to analyze the mean response times (RTs) for the subjects across compatible and incompatible tasks. Compatible tasks encompassed positive judgments toward flowers, construction waste collection, sorting, and reuse, alongside negative judgments toward pests. Conversely, incompatible tasks involved negative judgments toward the aforementioned environmental aspects and positive judgments toward pests. The outcomes of this analysis, including the baseline groups, are presented in Table 4. In this study, flowers served as a proxy for positive attitudes, whereas pests were employed as a reference for negative attitudes. The experimental outcomes revealed that participants' reaction times to positive associations involving flowers (RT_positive) were significantly shorter than their reaction times to negative associations (RT_negative), yielding a positive EAST effect value of + 42.82 ms. Conversely, for pests, the negative reaction times (RT_negative) were significantly faster than the positive reaction times (RT_positive), resulting in a negative EAST effect value of −49.35 ms. Notably, all these differences achieved a high level of statistical significance through t -tests ($p < 0.001$). This finding not only underscores the robustness and sensitivity of the EAST task in uncovering individuals' implicit attitudes but also validates the scientific rigor of the study's methodology and the rationality of its experimental design, thereby firmly establishing the validity of the experiment.

Table 4. Baseline group response times (ms).

Targets	Response	Mean	Standard Deviation	t (97)	p	EAST Effect
Flowers	Positive	723.89	157.95	6.610	0.000	42.82 ± 64.09
	Negative	766.70	148.62			
Pests	Positive	744.11	150.39	−8.490	0.000	−49.35 ± 57.54
	Negative	694.77	139.05			
Construction Waste Collection	Positive	747.41	113.51	−3.655	0.000	−16.22 ± 43.95
	Negative	731.19	109.66			
Construction Waste sorting	Positive	751.70	147.59	−3.723	0.000	−15.85 ± 42.14
	Negative	735.85	140.28			
Construction Waste Reuse	Positive	751.04	127.05	−4.366	0.000	−18.39 ± 41.70
	Negative	732.65	123.98			

The baseline group results reveal intriguing insights into the subjects' implicit attitudes toward various aspects of construction waste management. Specifically, for construction waste collection, the negative response time was notably faster than the positive response time (EAST = −16.22 ms), with the t -test confirming the significance of this implicit effect (t (97) = −3.655, $p < 0.001$). Similarly, for construction waste sorting, the negative response time exceeded the positive response time (EAST = −15.85 ms), and the t -test indicated a significant implicit effect (t (97) = −3.723, $p < 0.001$). Lastly, regarding construction waste reuse, the negative response time was significantly faster than the positive response time (EAST = −18.39 ms), with the t -test confirming the statistical significance of this implicit effect (t (97) = −4.366, $p < 0.001$). These findings suggest that the subjects held negative implicit attitudes toward all three aspects of construction waste management.

4.2. Evidence of Implicit and Explicit Bias

Upon analyzing the exogenous data, a notable finding emerged: the mean score of 76.38 (SD = 10.54) surpassed the neutral threshold of 50, indicating a strong positive exogenous preference among experimental participants toward the CWRU. This contrasts sharply with the previously observed implicit attitudes, revealing a significant discrepancy. Specifically, participants' overt expressions of attitudes toward CWRU were markedly more positive than their underlying unconscious attitudes.

4.3. Determining the Effects of Policy Action Based on Implicit Experiments

The data from the control group in the EAST task underwent a similar analysis as previously described. According to Table 5, the control group participants demonstrated a shift in attitudes after receiving the economic incentives stimulus. Regarding construction waste collection, they exhibited positive attitudes, with the positive response time being faster than the negative response time (EAST = 18.16 ms), and the *t*-test confirmed the statistical significance of this implicit effect ($t(32) = 3.943, p < 0.001$). In contrast, for construction waste sorting, the difference in response times (EAST = −3.36 ms) failed to reach statistical significance ($t(32) = -0.535, p > 0.001$), indicating a neutral attitude. Lastly, for construction waste reuse, participants showed a positive attitude, with the positive response time exceeding the negative response time (EAST = 9.49 ms) and the *t*-test supporting the significance of this implicit effect ($t(32) = 4.173, p < 0.001$).

Table 5. Experimental data table for control group 1.

Targets	Response	Mean	Standard Deviation	<i>t</i> (32)	<i>p</i>	EAST Effect
Construction Waste Collection	Positive	721.56	104.83	3.943	0.000	18.16 ± 26.46
	Negative	739.72	95.48			
Construction Waste sorting	Positive	744.98	153.35	−0.535	0.596	−3.36 ± 36.09
	Negative	741.61	150.06			
Construction Waste Reuse	Positive	739.67	144.35	4.173	0.000	9.49 ± 13.06
	Negative	749.16	146.08			

As is evident from Table 6, the experimental participants exhibited positive attitudes toward construction waste collection after being exposed to laws and regulations stimuli. Specifically, the reaction time (RT) for positive responses was significantly faster than that for negative responses (EAST = 15.61 ms), with the *t*-test confirming the statistical significance of this implicit effect ($t(32) = 6.366, p < 0.001$). However, for construction waste sorting, the participants demonstrated a negative attitude, as evidenced by the faster RT for negative responses compared to positive ones (EAST = −8.51 ms), and the *t*-test validated the significance of this implicit effect ($t(32) = -6.443, p < 0.001$). Lastly, for construction waste reuse, the RT difference between positive and negative responses was negligible (EAST = 0.37 ms), and the *t*-test indicated an insignificant implicit effect ($t(32) = 0.023, p > 0.001$), suggesting a neutral attitude.

Table 6. Experimental data table for control group 2.

Targets	Response	Mean	Standard Deviation	<i>t</i> (32)	<i>p</i>	EAST Effect
Construction Waste Collection	Positive	726.20	117.47	6.366	0.000	15.61 ± 14.08
	Negative	741.81	118.30			
Construction Waste sorting	Positive	742.70	140.35	−6.443	0.000	−8.51 ± 7.59
	Negative	734.19	138.88			
Construction Waste Reuse	Positive	738.00	143.66	0.023	0.982	0.37 ± 23.70
	Negative	738.37	139.24			

As can be seen from Table 7, the experimental participants showed positive attitudes after the stimulation of publicity and education stimuli; with respect to construction waste collection, the RT of the negative response was faster than the RT of the positive response (EAST = 15.87 ms), and the *t*-test indicated that the implied effect was significant ($t(31) = 4.260, p < 0.001$). For construction waste sorting, the RT of negative responses was faster than the RT of positive responses (EAST = 10.95 ms) and the *t*-test indicated that the implied effect was significant ($t(31) = 5.554, p < 0.001$), presenting a positive attitude. For construction waste reuse, the RT of the negative response was faster than the RT of the positive response (EAST = 1.76 ms), but the *t*-test indicated that the implied effect was insignificant ($t(31) = 0.579, p > 0.001$), presenting a neutral attitude.

Table 7. Experimental data table for control group 3.

Targets	Response	Mean	Standard Deviation	<i>t</i> (31)	<i>p</i>	EAST Effect
Construction Waste Collection	Positive	718.52	126.48	5.908	0.000	19.79 ± 18.95
	Negative	738.31	125.63			
Construction Waste Sorting	Positive	726.04	157.89	7.721	0.000	11.99 ± 8.78
	Negative	738.03	155.50			
Construction Waste Reuse	Positive	735.99	149.82	0.494	0.625	1.52 ± 17.4
	Negative	737.51	146.50			

The paired-sample *t*-tests were applied independently to compare the changes in response time between distinct control groups and their respective baseline groups, both before and after the intervention, aiming to validate the influence of varying interference strategies. An analysis of participants' attitudes toward the resourceful collection, sorting, and reuse of construction waste, before and after the intervention, was also conducted to discern the directional effects of these strategies on internal attitudes. The outcomes of these comparisons are summarized in Table 8.

The intra-group comparison between Control Group 1 and Baseline Group 1 in Table 8 highlights a statistically significant difference in the mean response time shift among experimental participants toward construction waste collection before and after the introduction of economic incentives ($t(32) = 4.407, p < 0.001$). This significant influence effect indicates a transformation of implicit attitudes from negative to positive prior to the intervention, aligning with the hypotheses. Conversely, for sorting construction waste, the mean response time difference was not significant ($t(32) = 1.471, p > 0.001$), suggesting no notable effect and a shift from negative to neutral implicit attitudes, which contradicts the hypothesis. However, regarding the reuse of construction waste, the difference in mean response time was significant ($t(32) = 5.889, p < 0.001$), demonstrating a clear influence and a positive shift in implicit attitudes before the intervention, consistent with the hypothesis.

Similarly, the comparison between Control Group 2 and Baseline Group 2 reveals a marked difference in the mean response time change toward construction waste collection before and after exposure to laws and regulations stimuli ($t(32) = 4.686, p < 0.001$). This significant influence effect mirrors a transition from negative to positive implicit attitudes pre-intervention, in accordance with the hypotheses. For sorting construction waste, the mean response time difference failed to reach significance ($t(32) = 1.945, p > 0.001$), indicating no significant effect and a neutral shift in implicit attitudes, which is inconsistent with the hypothesis. Furthermore, the mean response time difference for the reuse of construction waste was also non-significant ($t(32) = 1.102, p > 0.001$), suggesting no notable influence and a neutral shift in implicit attitudes, again contradicting the initial hypotheses.

Lastly, the intra-group comparison between Control Group 3 and Baseline Group 3 underscores a statistically significant difference in the mean response time variation among participants toward construction waste collection before and after the stimulus of publicity and education ($t(31) = 5.218, p < 0.001$). This significant influence effect signifies a positive shift in implicit attitudes from negative to positive before the intervention, aligning with the initial hypotheses. Notably, for sorting construction waste, the mean response time difference was significant ($t(31) = 4.914, p < 0.001$), indicating a notable influence and a positive shift in implicit attitudes. This aligns with the initial hypothesis. However, for the reuse of construction waste, the mean response time difference was not significant ($t(31) = 2.190, p > 0.001$), revealing no significant influence and a neutral shift in implicit attitudes. This outcome contradicts the initial hypothesis.

Table 8. Data table for within-group comparison.

Data Categories		Control Group 1			Control Group 2			Control Group 3			Mean	Standard Deviation
		CWC	CWS	CWR	CWC	CWS	CWR	CWC	CWS	CWR		
Baseline group 1	CWC	$t(32) = 4.407$ $p < 0.001$	$t(32) = 1.471$ $p > 0.001$	$t(32) = 5.889$ $p < 0.001$							−7.60	29.98
	CWS										−17.25	51.21
	CWR										−17.05	18.88
Baseline group 2	CWC				$t(32) = 4.686$ $p < 0.001$	$t(32) = 1.945$ $p > 0.001$	$t(32) = 1.102$ $p > 0.001$				−23.23	46.70
	CWS										−23.30	45.04
	CWR										−16.90	36.30
Baseline group 3	CWC							$t(31) = 5.218$ $p < 0.001$	$t(31) = 4.914$ $p < 0.001$	$t(31) = 2.190$ $p > 0.001$	−17.90	52.27
	CWS										−6.73	24.66
	CWR										−21.31	60.83
Mean		18.16	−3.36	9.49	15.61	−8.51	0.37	19.79	11.99	1.52		
Standard deviation		26.46	36.09	13.06	14.08	7.59	23.70	18.95	8.78	17.4		

Note: CWC = construction waste collection; CWS = construction waste sorting; CWR = construction waste reuse.

By comparing the influence of different stimuli on the implicit attitudes toward CWRU, we can intuitively observe that although all three types of stimuli significantly improved the participants' overall implicit attitudes toward CWRU, their effects differed. An examination of the baseline data from the three groups reveals that initially, the participants' implicit attitudes toward CWRU were relatively negative and similar across the groups.

However, after the economic incentive stimulus, the participants in Control Group 1 exhibited a positive shift in their implicit attitudes toward the collection and reuse of construction waste. This reflects the ability of economic incentive measures to rapidly stimulate the enthusiasm and participation of market entities within the context of China's socialist market economy with Chinese characteristics. Nevertheless, the initial investment required for construction waste sorting may be high, necessitating additional time and effort. The strength of the economic incentives may not be sufficient to cover these costs, resulting in limited enthusiasm among participants.

Following the laws and regulations stimulus, the participants in Control Group 2 only showed a significant attitude shift toward the collection of construction waste. This aligns with the high respect and compliance with laws and regulations in Chinese society. However, the effect on construction waste sorting and reuse was not as pronounced as that of economic incentives, possibly due to the need for stronger enforcement or more detailed operational guidelines for relevant laws and regulations. Upon exposure to publicity and educational initiatives, the implicit attitude of control group 3 participants toward the collection and sorting of construction waste shifted positively. By promoting CWRU as an environmentally conscious practice, participants gained a heightened awareness of their individual roles and responsibilities, fostering a cognitive enhancement that underpinned their attitudinal change. Nonetheless, regarding the reuse of construction waste, participants held a neutral stance, potentially due to a perceived lack of tangible benefits or direct personal relevance.

5. Discussion

5.1. Findings

In this study, experiments and questionnaires were conducted with Chinese construction contractors to investigate their implicit and explicit attitudes toward CWRU. Based on the baseline group experiment, it was found that participants showed negative implicit attitudes toward the collection, sorting, and reuse of construction waste as a resource utilization process. The study aligns with the findings of Ding et al. [74], confirming that construction contractors exhibit negative implicit attitudes toward CWRU. Conversely, explicit attitudes are more influenced by social expectations, moral norms, and cultural contexts. In public settings or when responding to surveys, individuals tend to express positive explicit attitudes, conforming to societal expectations and showcasing their environmental consciousness. The difference between implicit and explicit attitudes revealed in this study is not only observed among Chinese building contractors but is also reflected in studies in other fields and cultural contexts.

The discovery that economic incentives significantly contributed to a positive shift in construction contractors' attitudes toward construction waste collection aligns with the outcomes of numerous global studies on environmental policy [10]. This suggests that economic incentives possess universal applicability in fostering engagement in environmental protection initiatives. Although the specific forms and effects may vary according to regional and cultural differences, the universal applicability of economic incentives as an effective policy tool cannot be ignored. However, the change in attitudes toward construction waste sorting only reached a neutral level, and the positive effect on attitudes toward construction waste reusing was significant but not as pronounced as that of collection. This finding contradicts the Jin et al. [21] study, which argued that economic incentives should be more effective in promoting sorting and reuse behavior. The possible explanation is that the organizational culture of Chinese construction contractors emphasizes efficiency, cost

control, and profit maximization. Solely relying on economic incentives is insufficient to fully overcome these obstacles.

Laws and regulations policies have significantly improved attitudes toward construction waste collection, but have had limited effect in promoting sorting and reuse. Specifically, contractors may still have a fluky and negative attitude toward construction waste sorting. At the same time, due to some uncertainty about the quality, performance, and market acceptance of reuse products, contractors are concerned that the use of these products may bring about uncertain quality issues or poor market response, thus still maintaining a neutral attitude. This is in line with the fundamental role of legal instruments in environmental management as pointed out by the Shah et al. study [75]. Although the specific content and enforcement of laws and regulations may vary from country to country, they are universally instructive as important institutional safeguards for environmental protection. Unlike previous studies, which mostly focused on the mandatory features of the law, this study highlights the issues of contractors' adaptation and acceptance of the legal requirements, as well as the possible perception and implementation gaps in the process of law enforcement.

Publicity and education have positive and significant results in promoting attitudinal change in the collection and sorting of construction waste, with particular improvements in sorting attitudes. This finding coincides with that of Zeng et al. [76], which emphasized the positive effect of publicity and education on increasing the willingness to dispose of waste. However, the effectiveness of promotional education in enhancing attitudes toward reuse appears relatively neutral. This can be attributed to the cautious stance of construction contractors toward new technologies and reused products, as they harbor doubts about their effectiveness and market acceptance. Additionally, the traditional Chinese mindset of "prioritizing construction over environmental protection" still persists. This finding underscores the important role of public education and information dissemination in changing environmental behaviors but also points to the need for more targeted education and guidance strategies to increase the acceptance of reuse behaviors.

5.2. Theoretical Implications

This study significantly contributes to the theoretical understanding of CWRU by precisely evaluating the efficacy of behavioral guidance policies. By simulating behavioral comparisons before and after policy implementation and integrating qualitative and quantitative analytical methods, it provides a scientific foundation for policy formulation. This not only bolsters policy relevance and execution outcomes but also offers an optimization roadmap, guiding future policy revisions and enhancements. This approach ensures that policies are tailored to effectively foster CWRU, advancing the field of policy evaluation and design.

Another major theoretical contribution of this study lies in its innovative use of implicit experimental methodologies. By uncovering the unconscious behavioral patterns of construction contractors and their complex interactions with the policy environment, it enriches the theoretical corpus of organizational behavior. This work broadens the theoretical framework of policy science, specifically in the area of policy design and evaluation, by introducing a new perspective that delves into the intrinsic motivations driving CWRU behaviors. This deepens our understanding of how individuals respond to policy interventions at a subconscious level.

Ultimately, this research has profound implications for the green transformation and sustainable development of the construction industry. By elucidating the positive influence and untapped potential of policies in enhancing CWRU, it provides invaluable policy guidance and practical avenues for greening the sector. This guidance can effectively steer contractors toward refining their resource allocation and management strategies, thereby elevating resource utilization efficiency and environmental stewardship. The research thus contributes to achieving a harmonious balance between economic, social, and environmen-

tal benefits in the construction industry, advancing our theoretical knowledge of how to navigate toward more sustainable practices.

5.3. Managerial Implications

Firstly, to harness the effect of economic incentives in guiding the prominence of policy roles, the government can establish a dedicated financial subsidy fund for construction projects adopting resource utilization technologies. The subsidy criteria should be contingent upon factors such as resource utilization rates and technology levels, thereby stimulating enterprise enthusiasm. Additionally, the government can offer tax exemptions or concessions, including value-added tax and income tax, specifically for CWRU projects. This approach diminishes corporate costs and enhances project economic efficiency. Furthermore, the government can direct financial institutions to provide financing support, such as low-interest loans and green bonds, tailored to CWRU endeavors, thereby reducing financing barriers and costs for enterprises.

Secondly, the government must formulate and refine regulations governing the CWRU. This involves clarifying contractors' responsibilities and obligations and regulating the disposal and utilization of construction waste. Additionally, establishing technical standards and operational guidelines for resourceful utilization, along with quality and safety requirements for resource-based products, will standardize corporate production practices and elevate the quality and market competitiveness of these products. Enhanced supervision and enforcement mechanisms, coupled with investigations and punishments for violations, and a reporting reward system to encourage public participation in oversight are also vital.

Furthermore, the government should popularize the knowledge and technology of CWRU among the contractors by organizing exhibitions, lectures, training, and other activities. At a technical level, contractors can be encouraged to apply advanced optimization algorithms to all aspects of CWRU. These algorithms can analyze the waste classification, transportation, and disposal processes to maximize the recovery and reuse of resources [77]. In addition, the government can use advanced optimization algorithms to analyze the public's information-receiving habits, interest preferences, and other factors to provide data support for the development of publicity and education strategies. Typical cases of resource utilization of construction waste can be collected and organized for publicity and promotion to the public and enterprises. By showcasing the experience and practices of successful cases, enterprises can be inspired to participate in resource utilization with enthusiasm and confidence.

Lastly, governments should develop a comprehensive multifaceted policy framework that not only addresses the technical and economic aspects of CWRU but also recognizes the interconnections between these various factors and addresses the social and cultural barriers that may hinder CWRU [78]. By comprehensively assessing the effects and costs of various policy instruments, policymakers can obtain the optimal policy mix to balance the needs of different stakeholders and maximize the overall impact of CWRU programs. Similarly, fostering a sense of shared responsibility and ownership among all stakeholders, including governments, enterprises, and the public, is essential to ensure the long-term success and sustainability of these efforts.

5.4. Limitations and Future Direction

This study, while insightful, acknowledges several limitations in its exploration of CWRU. Notably, the constrained sample size, limitations inherent in the data collection methodology, and the intricacies of variable control may hinder the generalizability and depth of its findings. Furthermore, disparities in policy environments, regulatory frameworks, and market mechanisms across countries and regions significantly restrict the direct applicability of these findings to a broader spectrum of contexts. Critically, the current focus on short-term policy impacts, coupled with inadequate assessment of long-term effects post-implementation, somewhat diminishes the comprehensive understanding of policy sustainability and efficacy.

To transcend these limitations and foster the profound development of CWRU research, future endeavors should prioritize the following directions. Firstly, they should enhance the universality of research by broadening the sample scope and conducting cross-regional or international comparisons. This broader perspective will enrich the issue's examination and bolster the general applicability of research outcomes. Secondly, deepening the mechanism analysis necessitates embracing more sophisticated theoretical frameworks and empirical methodologies to delve into the inherent characteristics and driving forces of resource utilization behaviors, thereby offering more precise theoretical underpinnings for policy formulation. Thirdly, establishing a comprehensive long-term evaluation system is imperative for continuously monitoring and dynamically assessing policy implementation effects. This encompasses, but is not limited to, investigating policy lag, rebound effects, and cumulative impacts. A longitudinal research design, integrating time series and panel data analysis, will facilitate a nuanced understanding of policy evolution patterns and influencing factors across various timescales.

Moreover, future research should delve into the synergies between diverse policies, building upon a thorough analysis of their individual effects. This involves conducting cost-benefit analyses of economic incentives and examining the complementarity and potential conflicts within laws and regulatory frameworks. Additionally, recognizing stakeholder interactions and strategic behaviors during policy implementation is crucial to providing policymakers with nuanced recommendations for policy design and execution. By addressing these aspects, research in this field can contribute more meaningfully to optimizing policy mixes and implementation strategies, ultimately advancing the sustainable CWRU.

6. Conclusions

This study delves into the practical impact of behavioral guidance policies on the CWRU by Chinese contractors through the EAST experiment, elucidating the effectiveness of these policies. The findings reveal that economic incentive policies exhibit the strongest effect in promoting the CWRU, highlighting their pivotal role in environmental policy formulation. Although laws and regulations measures have achieved some success in waste collection, their overall impact remains relatively limited. Meanwhile, educational activities, while positively influencing collection and sorting behaviors, show less significant results in fostering the reuse of construction waste. The research outcomes provide a theoretical basis for policy formulation and emphasize the importance of integrating a comprehensive policy framework with modern technologies. This contributes positively to the sustainable development of the construction industry, promoting efficient resource utilization and sustainable environmental protection.

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