



Exploring consumer's intention to recycle waste from household kitchen and bathroom appliances in a formal way: extending behavioral reasoning theory

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Abstract

The increasing number of kitchen and bathroom appliances has resulted in the production of a large quantity of electronic waste (e-waste). To identify the various factors that influence consumers' decision to participate in formal recycling, the PLS-SEM method was used to test hypotheses based on behavioral reasoning theory and personal values theory. The results show that (1) attitudes and reasons are the main factors influencing consumers' intention to participate in formal e-waste recycling, with the exception of "Reason against"; (2) consumer values and consumer reasoning have a significant impact on consumer attitudes toward e-waste recycling; and (3) publicity and education positively moderate the effect of consumer value on their attitude toward e-waste recycling and negatively moderate the effect of consumer reasoning on intention. This study provides new theoretical support for governments and organizations in understanding the underlying mechanisms that influence consumers' willingness to participate in the formal recycling of e-waste.

Keywords Waste household kitchen and bathroom appliances · PLS-SEM · Behavioral reasoning theory · Personal values

Introduction

Rapid technological development has resulted in the increasing popularity of electronic equipment and household appliances. Due to the increasing amount of e-waste, it is considered the fastest growing waste source in the world. In 2020, it was estimated that the production of e-waste reached 53.6 million tons and is expected to continue growing by 2030 [1]. These electronic devices contain large amounts of heavy metals (such as copper, aluminum, cadmium, chromium, etc.), which, when released into the environment, cause significant heavy metal pollution [2]. China and other developing nations with rapid economic development are seriously threatened by the potential risks posed by e-waste

to human health and the environment, as well as the loss of crucial resources [3]. E-waste will inevitably become an enormous problem for countries around the world as electronic products are rapidly replaced. To solve a series of problems caused by e-waste, governments in a number of countries have implemented a variety of measures [4, 5]. The Restriction of Hazardous Substances (RoHS) Directive (2002/95/EC) and the Waste from Electrical and Electronic Equipment (WEEE) Directive (2002/96/EC) have been updated in Europe. Japan enacted the Act on the Promotion of Effective Utilization of Resources and the Home Appliances Recycling Act (HARA) in 2001, and in 2013, the recycling law for small-sized home appliances was released, thus establishing Japan's WEEE recycling system [6–8].

In response to growing concerns about the pollution caused by WEEE, China has taken various steps to encourage the recycling of electronic devices. The country has also published a series of regulations and legislation that aim to regulate the collection, transportation and disposal of WEEE. On January 1, 2011, China launched a catalog for the collection, transportation and disposal of WEEE. A new catalog (Batch 2) was launched on January 1, 2015. The original five goods (televisions, refrigerators, washing machines, air conditioners and personal computers) were

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expanded to the current fourteen [9, 10], and the kitchen and bathroom appliance products were listed in the Catalogue of Electronic Waste Recycling (Batch 2). The use of kitchen and bathroom appliances is becoming increasingly prevalent in this period of families looking for a better quality of life. According to the China National Statistical Yearbook, the ownership of kitchen and bathroom appliances per 100 households in China has increased significantly since 2014. For example, microwave ovens have increased by 14 percent, water heaters have increased by 33.5 percent, and range hoods have increased by 37.5 percent since 2014 (CSY, 2015, 2021). The Chinese government pays attention to the formal recycling of electronic waste, pointing out in its “14th Five-Year Plan for Circular Economy Development” that guide WEEE to flow into standardized dismantling enterprises. In this study, formal recycling of WEEE refers to the recycling of WEEE by electronic waste recycling enterprises with environmental protection qualifications. To promote the healthy development of the WEEE recycling industry, China adopts the extended producer responsibility system. In 2012, the Ministry of Finance and other relevant departments announced the list of the first batch of fund-funded enterprises. Since 2015, the number of funded enterprises has been maintained at 109. In contrast, informal recycling of WEEE refers to the recycling of discarded electronic equipment by electronic waste recycling enterprises, which are not qualified. As a big consumer country of kitchen and bathroom appliances, the formal recycling of waste kitchen and bathroom appliances has great economic and environmental benefits in China. According to our previous estimates, during the period from 2012 to 2038, the scrap materials (scrap copper, scrap aluminum, scrap iron, and scrap plastics) in wasted domestic electrical storage water heater have a potential recovery value of up to 18.48 billion yuan [11]. The Chinese government has now certified some recycling companies to take formal steps to recycle waste household kitchen and bathroom appliances because the potential to recycle waste household kitchen and bathroom appliances is enormous.

However, many consumers now choose not to recycle their unwanted kitchen appliances in a formal way. Informal collection is the preferred method of collection in China due to the benefits of collection scope, service efficiency, flexibility, and availability [12]. Chinese consumers are unable to tell the difference between formal and informal recycling organizations [3]. Furthermore, China’s informal recycling enterprises are primarily made up of street sellers and rubbish recycling facilities. Consumers believe that informal recycling organizations have the advantages of flexibility, accessibility, and convenience of service over formal recycling companies. Despite the fact that most formal WEEE recycling firms in China have implemented several efforts to attract customers in response to customers’ preferences

to dispose of WEEE, most formal recycling companies have not met customer expectations [13]. As a result, despite the efforts of the Chinese government to encourage formal companies to participate in the recycling of WEEE, a large number of informal recycling vendors compete for market share with formal companies, making it difficult to establish a national system of recycling of WEEE in China that is fiscally and environmentally sound [14]. The Chinese government has established many early pilot initiatives to address this issue. Some of the world’s leading organizations have successfully implemented resource integration and model innovation in their WEEE recycling operations. However, many formal organizations still face significant obstacles due to the low level of public involvement [13]. According to the result of questionnaire survey we published from March 10 to May 31, 2022, there are only 24.54% of respondents tend to dispose of waste kitchen and bathroom appliances in a formal way. Therefore, determining the influencing factors of consumers’ intention to participate in the formal recycling of electronic waste is of great significance to the decision-making and strategic planning of formal recycling enterprises.

Consumer behavior is a key factor that affects the effectiveness of the recycling of kitchen and bathroom appliances. Due to the rapid growth of technology, many users update electronic devices not because they are faulty but because their functions have not progressed. As a result, many of them tend to store unwanted electronic devices rather than submitting them to a recycling center. Bovea investigated how Spanish customers processed small electronic debris from garbage and found that most consumers keep wasted small electronic equipment at home, which is related to small communication equipment maintenance and second-hand purchases [15]. In this way, for effective management of waste kitchen and bathroom appliances, people should be inspired to participate in the recycling of waste kitchen and bathroom appliances. The majority of the present research focuses on ways to encourage customer participation in WEEE recycling. Through the structural equation modeling process, Thi Thu Nguyen identified various factors that influence residents’ behavior when recycling WEEE [16]. Wang then conducted a study to analyze the effects of nonfinancial and financial incentives on the intentions of users to recycle online and discovered that both of these factors had a positive effect on the intention of users to recycle [17]. It is important to point out that previous research has mostly concentrated on the motivations or facilitators for recycling WEEE, but equally significant inhibitors or barriers that fuel consumer opposition to recycling WEEE are rarely studied.

There is a gap in current research regarding the intentions of consumers in regard to recycling WEEE. Through the use of behavioral reasoning theory (BRT), the study was able to

bridge this gap. BRT offers rationality to behavior that acts as a bridge and link between individual beliefs and values, comprehensive motivation (including attitudes, subjective norms, and sense of control), behavioral intentions, and behaviors [18]. A thorough analysis of the various facets of behavior connected to consumer intent is provided by BRT, which considers both factors that can encourage and factors that can impede consumer activity [19].

Values are the internal characteristics of individuals, and they will gradually influence people's behavior in a subtle way. In the process of consumer participation in recycling, consumers are mainly concerned about the benefits that consumers themselves have obtained, whether personal economic benefits or emotional benefits that individuals can obtain or social benefits that individuals have obtained to improve their social status. Therefore, we explore whether consumers with the value of maximizing personal interests can accurately grasp the internal needs of consumers and encourage formal recycling companies to take measures to stimulate consumers to participate in the formal recycling of household waste kitchen and bathroom appliances according to consumers' internal needs.

Based on the current situation of consumer behavior research and the advantages of BRT in consumer behavior research, this study uses BRT to explore the influencing factors that affect consumers with the value of maximizing benefits to participate in the formal recycling of household waste kitchen and bathroom appliances and proposes suggestions for enterprises to carry out the layout and strategy of the formal recycling of household waste kitchen and bathroom appliances. The current research is organized as follows: In Sect. 2, the theoretical framework of BRT and consumer values are presented together with a survey of pertinent literature on the management and recycling of WEEE. The theoretical framework and the various hypotheses are established and explored in Sect. 3. The methodology is presented in Sect. 4, and the study results are presented in Sect. 5. Section 6 presents the discussion in light of the past literature. The various theoretical and practical consequences, as well as the limitations and future research directions, are highlighted in Sect. 7.

Background

WEEE management and recycling

In terms of investigation and research on the disposal behavior of users' WEEE, most existing research focuses on the disposal behavior of small WEEE such as smartphones and laptops, and the disposal behavior focuses mainly on three aspects: recycling, storage, and maintenance. In terms of recycling behavior, Bahers and Kim found that most of the

recycling of electrical appliances in France is performed by outsourcing companies for recycling [20]. Darby and Obara categorized wasted electrical items into large and small electrical items, examined how British users recycle their waste electrical appliances and found that income and gender influenced the recycling behavior of the respondents for small appliances [21]. Islam and Huda found that users are more likely to throw away their phones than recycle them, and older users are more likely to recycle them [22]. In terms of storage and repair behavior, Pérez-Belis et al., after studying the behavior of Spanish users for small electronics repairs and buying second-hand products, found that respondents rarely repair damaged small electronics and found that repair prices in appliance repair shops are too high, one of the factors that discourage users from servicing electronics [23]. Martinho et al. found that extended households are also more aware of precious and critical raw materials and are more likely to leave broken smartphones at home, and the majority of educated respondents keep their devices at home instead of recycling them [24]. Qu et al. investigated the factors that influence the recycling of discarded mobile phones among Chinese users and found that the fear of information leakage by users is the main reason that users do not participate in mobile phone recycling and prefer to store mobile phones at home [25].

In summary, the existing achievements have led to many useful explorations of behavior research theory, descriptive statistics of WEEE recycling behavior, and analysis of factors affecting WEEE recycling behavior. On the basis of the current findings, specific research must still be conducted depending on the actual demands. The literature mainly analyzes small communication devices, and most of them are smartphones and tablet products [22, 24, 25]. In terms of large household appliances, the main analysis is of refrigerators, TV sets, washing machines and other household appliances [26, 27], but in 2014, China announced that newly added household appliances in the new waste electrical and electronic product disposal catalog are rarely analyzed in the literature. Studying the relationship between users' disposal behavior of these household appliances and the social and economic factors of users is helpful for China's formal recycling enterprises to respond and provide policy recommendations for stimulating users to participate in formal recycling.

Behavioral reasoning theory

Previous studies have demonstrated that products or services fail frequently because their creators are unaware of the many causes of customer boycotts or other obstacles to adoption [28]. The field of WEEE recycling still faces such a situation, and to identify the factors that hinder consumer participation in the recycling of WEEE, there is an urgent

need to develop more novel models to analyze the various factors that influence the behavior of individuals in regard to WEEE recycling. Westaby first proposed BRT in 2005, but it took another 5 years to receive empirical research and is still in its infancy. However, because BRT can be compatible with a large number of behavioral research theories, such as planned behavior theory and technology acceptance theory, scholars increasingly rely on it to predict user behavior, and its popularity has soared [19].

Currently, BRT has been widely used in various aspects to study factors that hinder consumer behavior. Through the use of BRT, researchers can now distinguish between 'reason for' and 'reason against' in regard to analyzing the various factors that influence the behavior of consumers. This method could also be used to make informed decisions about the recycling of WEEE. Wang used BRT to explore the gap between attitudes and intentions of green consumption in China and discovered that while the reasons against green consumption affect intentions that bypass attitude, the reasons for green consumption only indirectly affect intentions through attitudes [17]. Using BRT, Park investigated the drivers of clothing donation behavior among young users and discovered that, as expected, power was positively connected with self-directed reasons to give, kindness was positively correlated with self-directed motivations to give, and motivations for other and self-directed reasons all influenced opinions about clothing donation behavior [29]. An et al. used BRT to explore the determinants and barriers to studying new product purchase intentions [30]. In terms of WEEE recycling, Dhir et al., based on BRT, explore the influence of users on the intention to dispose of WEEE by studying the reasons why users will participate in the disposal of WEEE and the reasons for opposing disposal. Positive attitudes toward the recycling of WEEE were found to be driven by personal and environmental interests, which, in turn, led to relevant actions [31].

Personal values

Personal values have been the subject of much academic debate, and a commonly accepted formulation has emerged. Values are the guiding ideas and motivations that shape people's lives and influence how they understand events, obtain information and behave [32]. Values are related to concepts such as preferences, beliefs, norms, attitudes, motivations, goals, and intentions, which are all psychological characteristics of people. Among them, values belong to the upper cognitive structure, while norms and intentions belong to the lower cognitive structure, e.g., intentions are "instructions that people give themselves to act in a particular way" [33]. Existing research has explored many values related to consumer environmental behavior. Among them, the dimensions of self-transcendence and self-improvement have been

empirically studied and proven to be highly relevant for environmental behaviors. Specifically, the study also revealed that people with a self-transcendence value orientation were more likely to practice pro-environment behaviors. In contrast, those with a self-improvement value orientation were less likely to do so [34]. In addition, scholars have also studied egoistic values, altruistic values, and environmental protection values [35, 36]. Values can have a significant influence on whether consumers adopt environmental protection behaviors and can reflect consumer internal preferences, which are the antecedents of their attitudes and intention to adopt environmental protection measures. In the domain of the recycling of WEEE, although consumer values have been the subject of extensive research, current research is based on consumer values of environmental protection and altruism, and very little research has been conducted on consumer values for the maximization of self-interest [20, 31]. In conclusion, it is important to examine how the value of maximizing personal gain affects consumers' attitudes and intentions to participate in the formal recycling of household waste from kitchen and bathroom appliances and how consumer reasoning plays a role in both routes.

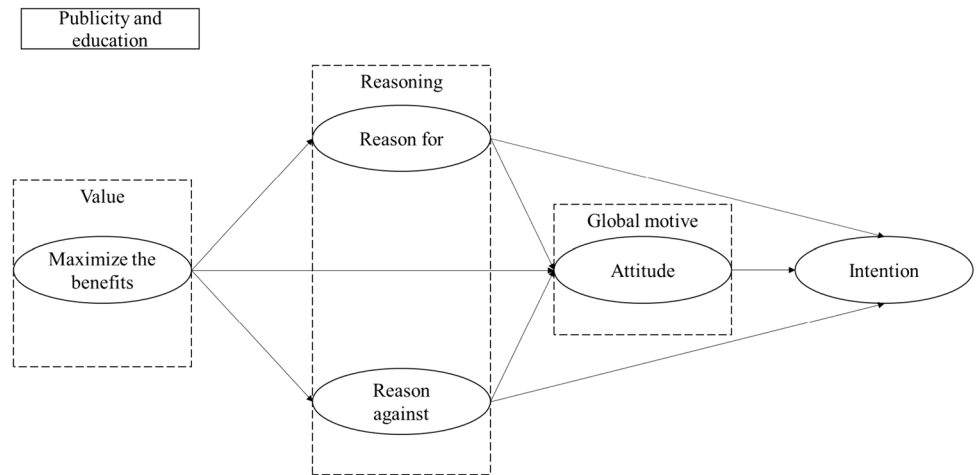
Methodology

Framework and hypotheses

In this study, a research model was developed to understand the factors that influence the intention of consumers to recycle household waste kitchen and bathroom appliances based on the framework of BRT. This study focused on waste from household kitchen and bathroom appliances in the Catalogue of Electronic Waste Recycling (Batch 2), including range hoods, electric water heaters and gas water heaters. In it, benefit maximization is selected as a consumer value and reasoning is used as a mediator between values and attitudes or intentions for the study (see Fig. 1). The consumer's purpose of participating in a specific action, task or behavior is called their intention [37]. A positive attitude refers to the belief that a behavior is beneficial, while a negative attitude is the opposite. For instance, if a person has a positive attitude toward a certain behavior, they may be more inclined to engage in it, but if their attitude is negative, they may not [19, 38].

BRT suggests that reasoning plays a key role in the relationship between consumers' personal values and intentions [31]. According to Westaby, the greatest predictor of attitudes toward behavioral intentions is reasons, which is in line with explanation-based decision theory and BRT. According to BRT, having strong 'reason for' or 'reason against' participating in a behavior helps people justify their actions. Other elements associated with behavioral goals are

Fig. 1 The research model based on behavioral reasoning theory



also activated as a result of this. BRT separates the 'reason' into two parts: 'reason for' and 'reasons against'. They were previously called 'facilitators' (adoption) and 'inhibitors' (resistance) or 'pros and cons' [18].

Values are antecedents of many specific beliefs and attitudes and can stimulate specific mental processes. Furthermore, values can have an important effect on consumer intentions [39, 40]. Existing research on benefit-maximizing values mainly divides personal benefits into two categories. One is hedonistic values, i.e., they are primarily concerned with the emotional satisfaction that the behavior brings to them. The other category is egoistic values, which are mainly concerned with personal monetary gains [36].

In this study, based on the existing situation in China, the government will give a portion of the cash reward to users who participate in the formal recycling of WEEE. For example, Shanghai launched a green smart home appliance consumption subsidy policy in October 2022 to increase people's awareness of home appliance replacement. With the development of society and awareness of environmental protection, participation in formal recycling will bring personal emotional satisfaction, improvement in social status [41], and security to users. Therefore, this study combines them and proposes the maximum benefit value. Figure 1 shows the various speculative associations in the current study model. Consumers have values centered around maximizing benefits. The "reason for" is measured by environmental benefits, while the "reason against" is measured using risks and barriers to use.

Attitude and intentions

An extensive body of research has investigated the early literature's suggestion that attitudes and intention have a close correlation [42–44]. Studies have shown that the relationship between an individual's attitude and his intentions in recycling WEEE is complex. Tonglet et al. found that recycling

attitudes can positively influence consumers' intention to recycle [45]. Similarly, a study conducted by Wang revealed that having a positive attitude can influence people's intentions in regard to recycling WEEE [44]. Then, this study hypothesizes the following:

H1. A positive correlation exists between consumer intentions to take part in the formal recycling of household kitchen and bathroom appliances and attitudes toward the recycling of WEEE.

'Reason for' and 'Reason against'

The key difference between BRT and traditional behavioral intention models is the use of rationality as a predictor of behavioral decisions. In the case of recycling household kitchen and bathroom appliances, contextualized rationality, which includes reasons to participate in recycling and reasons to refuse to participate in recycling, is an important predictor of attitudes and behavioral intentions. The reason for consumer participation in the recycling of household kitchen and bathroom appliance waste is mainly related to the environmental benefits of their actions. Environmental benefits refer primarily to formal recycling of WEEE to protect the environment from toxic substances, reduce greenhouse gas emissions, and avoid waste hazardous to human health [45]. Consumers are now concerned about environmental benefits and are willing to make decisions that assist the environment, according to research that has already been done [46, 47]. Therefore, this study chose environmental benefits as the reason for the participation of consumers in recycling household kitchen and bathroom appliances. At the same time, the literature on BRT has found that reasons are an important criterion influencing consumers in different contexts and that reasons can positively influence consumers' attitudes and intention to behave [18, 31, 42]. Therefore, we assume the following:

H2. A positive correlation exists between “Reason for” and attitude toward the recycling of WEEE.

H3. A positive correlation exists between “Reason for” and the intention to recycle WEEE.

'Reason against' refers mainly to perceptions that prevent consumers from adopting the behavior [31]. In the WEEE recycling process, the barriers that prevent users from engaging in the formal recycling of WEEE mainly include barriers to use and barriers to trust. These two types of barriers make it impossible for formal recycling enterprises to compete with informal recycling enterprises in China's WEEE recycling system. The use barrier refers to the fact that it is difficult for formal recycling companies to have the mobility advantage that informal recycling companies have when their locations are fixed [12]. The convenience of formal recycling can affect people's intention to participate in recycling [48, 49]. In addition, the small number of formal recyclers makes it difficult for consumers to obtain information about formal recyclers, making it difficult for formal companies to compete with the large number of informal recyclers. In this study, barriers to use are mainly measured by how easy it is for consumers to collect information about formal recycling firms and how easy it is for consumers to use formal recycling methods. Trust barriers mainly refer to whether consumers trust formal recycling enterprises, mainly in two aspects. One is the existing formal recycling enterprises for door-to-door recycling, especially for large household appliances such as waste household kitchen and bathroom appliances. Whether the door-to-door recycling method will disclose consumers' home address and other private information has become part of consumers' concerns. Second, formal recycling enterprises can reasonably handle the recycling of WEEE, and whether it will cause environmental pollution will also affect the trust of consumers. In this study, the trust barrier is mainly measured by consumers' fear of formal recycling companies leaking their personal information and whether they trust formal recycling companies to properly recycle WEEE.

Existing studies show that 'reason against' is negatively related to consumer attitudes and the intention to participate in WEEE recycling; for example, Dhir et al. found that barriers to use and risk barriers negatively affect the intention to recycle WEEE [31]. Therefore, it is possible that such an effect may also exist in terms of attitudes and intention to recycle waste household kitchen and bathroom appliances.

H4. A negative correlation exists between “Reason against” and attitude toward the recycling of WEEE.

H5. A negative correlation exists between “Reason against” and the intention to recycle WEEE.

Value

Existing research on personal egoism, hedonistic values and pro-environmental behavior has found that consumers with hedonistic and personal egoistic values are reluctant to become involved in pro-environmental behavior [36]. However, the hierarchy of needs theory declares that human needs range from physiological (food and clothing) to self-actualization, respect, safety (job security), and social needs (friendship) [50]. Therefore, people will develop more positive attitudes toward certain behaviors when the rewards they receive exceed the costs they pay, that is, when they receive external benefits such as partial monetary rewards, personal satisfaction, promotions, or educational opportunities [51]. Such consumers are also likely to become involved in pro-environmental behavior when such behavior can give the benefits that hedonistic and individual egoists demand. Therefore, this study combines hedonism and personal egoism to measure consumers' values of maximizing personal gain from three perspectives: personal economic gain, personal spiritual satisfaction, and personal social status enhancement. It is believed in this study that when a consumer with the value of pursuing profit maximization achieves the maximum benefit, consumers are more likely to have a positive attitude toward participation in the formal recycling of waste household kitchen and bathroom appliances and are more likely to have the intention to recycle. Based on this research hypothesis,

H6. A positive correlation exists between attitude and Value (maximizing the benefits) regarding the recycling of WEEE.

H7. A positive correlation exists between “Reason for” and Value (maximizing the benefits) regarding the recycling of WEEE.

H8. A negative correlation exists between “Reason against” and Value (maximizing the benefits) regarding the recycling of WEEE.

Moderating effect

This study examines the moderating role of publicity and education in affecting the relationship between consumer values, “reason for”, “reasons against”, attitudes and intention to participate in the formal recycling of waste household kitchen and bathroom appliances. In existing research on the influencing factors of waste recycling, Xu et al. found that in the process of the government's promotion of WEEE recycling-related knowledge, publicity and education had a greater impact on the participation of highly educated people in recycling waste than those with low education [52]. In regard to WEEE recycling, Almulhim found that 70.1% of the participants claimed that they had not been educated on how WEEE poses a serious environmental problem [53].

Lan noted that the disclosure of policy publicity information can influence the actions of individuals [54]. In this way, we hypothesized the following:

H9a. Publicity and education moderate the association between value and attitude.

H9b. Publicity and education moderate associations between value and “Reason for”.

H9c. Publicity and education moderate associations between value and “Reason against”.

H9d. Publicity and education moderate the association between “Reason for” and attitude.

H9e. Publicity and education moderate the association between “Reason against” and attitude.

H9f. Publicity and education moderate the association between “Reason for” and intentions.

H9g. Publicity and education moderate the association between “Reason against” and intentions.

H9h. Publicity and education moderate the association between attitude and intentions.

Questionnaire design and collection

The previous section explored the various hypotheses presented in the behavioral reasoning literature. To test these hypotheses, a survey was conducted.

Questionnaire design

The main source of the questionnaire is the research scale of BRT by Westaby and other researchers. This study builds the scale based on economic interests, emotional interests and social interests [18, 42]. The survey was split into two parts. The first collected demographic data about the respondents. This section also analyzes the various hypotheses related to gender, age, qualification, income, number of family members and disposal method. The second section had questions about the structure of the BRT, each with diverse terms (see Table S1). A five-point Likert-type scale between 1 and 5 (1 for strongly disagree and 5 for strongly agree) was used to measure consumer responses to the BRT structures. Within these constructs, attitudes, intentions, reason for, and reason against had similar variables to those used in the authors’ previous studies [31, 42], retaining the question items with the highest factor loadings. The value of maximizing personal interest was added by extracting variables from the academic literature.

Data collection

Before the data collection process started, a team of experts thoroughly checked questionnaire 396 to ensure its validity. Experts also performed a preliminary test to assess the content and surface of the questionnaire. After the necessary

requirements were satisfied, the survey was sent to the target sample. The data collected by the survey were handled by two professional platforms, Credamo and WJX, which are two professional questionnaire data collection platforms with more than 9 million sample sizes. From March 10 to May 31, 2022, a total of 475 questionnaires were collected in China. Excluding questionnaires with response times that were too long or too short and incomplete responses, a total of 402 valid questionnaires were collected. The characteristics of the collected data are shown in Table 1. Specifically, the number of males in the sample (52.38%) is slightly higher than that of females (47.62%), the age is mainly between 19–35 years old (52.01%), and the number of respondents with a bachelor’s degree or higher in education (38.83%) is more in line with the 35% bachelor’s degree prevalence rate reported by the Chinese government. The respondents’ annual income is concentrated between RMB 60,000 and 120,000 (40.29%), and their family size is generally three (44.44%). In terms of disposal methods for waste kitchen and bathroom appliances, there is not much

Table 1 Descriptive statistics ($N=402$)

	Demographics	Frequency	Percent
Gender	Female	191	47.62%
	Male	211	52.38%
Age	0–18	12	2.93%
	19–35	209	52.01%
	36–59	144	35.90%
	More than 60	37	9.16%
	Qualification	Primary school	47
	Middle high school	94	23.44%
	High school	99	24.54%
	University or above	156	38.83%
Income	Below 24,000	7	1.83%
	24,000–60,000	130	32.24%
	60,000–120,000	162	40.29%
	More than 120,000	103	25.64%
The number of your family members	1	3	0.65%
	2	18	4.58%
	3	179	44.44%
	4	108	26.80%
	5	60	15.03%
	6	29	7.19%
	7	5	1.31%
Disposal method	Discard	52	12.82%
	Store	59	14.65%
	Give away	90	22.34%
	Recycle in an informal way	84	20.88%
	Recycle in a formal way	99	24.54%
	Else	19	4.76%

difference between the proportion of respondents who prefer recycling in a formal way and the proportion who prefer informal recycling methods.

Results

According to the research objectives of this study and the proposed research model, PLS-SEM was used for analysis. The data were first evaluated according to the guidelines provided by Hair et al., and later, the hypotheses were tested [55].

Outer model measurement

The outer model measurement was used to evaluate the validity and reliability of the collected data. Reliability refers to a measure of the consistency of the data, while validity is focused on discriminant and convergent validity.

Reliability testing

Composite reliability is used to calculate reliability (CR). Compared to Cronbach's alpha, it offers a more reliable indicator of internal consistency. The CR threshold should be 0.7 or higher. The degree of association between the construct validity indicators is referred to as convergent validity. Convergent validity is evaluated by using average variance extracted (AVE) [55]. The AVE should be 0.5 or greater, and the factor loadings for convergent validity should be above 0.7 [55]. The CR values and AVE values for all potential variables are shown in Table S2. It was found that the combined reliability of some of the indicators in Table 2 could not reach the CR threshold value of 0.7 and the AVE threshold value of 0.5. The inquiry revealed that the factor loadings of some of the questions were small, so we chose to remove some of the questions, and after removing them, the reliability test and convergent validity test were conducted again. The test results were obtained as shown in Table 2, and all indicators passed the reliability test and convergent validity test. Based on the smart-PLS software, the model structure shown in Fig. 2 can be obtained.

Discriminant validity

The degree to which a construct varies from other constructs is measured by discriminant validity. To guarantee that the results are unambiguous and devoid of statistical discrepancies, discriminant validity must be established. A single variable must deviate from its own items more than it does from other variables, according to the Fornell and Larcker criterion. To assess discriminant validity, heterogeneous single-trait ratios and cross-loadings between items are used

Table 2 Reliability testing and convergent validity (after modification)

Construct	Items	Loading	CR	AVE
Attitude (ATT)	ATT1	0.95	0.94	0.88
	ATT3	0.93		
Intention (IT)	IT1	0.82	0.84	0.63
	IT2	0.79		
	IT3	0.77		
Value (VU)	VU2	0.83	0.76	0.52
	VU3	0.74		
	VU4	0.66		
Reason against (RA)	RA2	0.74	0.90	0.69
	RA3	0.87		
	RA4	0.84		
	RA5	0.74		
	RA6	0.74		
Reason for (RF)	RF1	0.91	0.88	0.70
	RF2	0.88		
	RF3	0.72		
Policy and education (PE)	PE1	0.85	0.88	0.70
	PE2	0.83		
	PE3	0.83		

[55]. Therefore, Table 3's value in the diagonal, which is the square root of AVE, must be higher than the interstructural correlation. The correlation matrix is displayed in Table 3, which supports discriminant validity.

Fornell and Larcker are not always reliable indicators of discriminant validity, according to a number of studies. The heterotrait–monotrait ratio of correlations (HTMT), a novel technique to guarantee the discriminant validity of the data, was proposed by Henseler et al. [56] as a solution to this issue. If the HTMT value is less than 0.85, discriminant validity will be proven [56]. Table 4 shows the results of the HTMT to confirm discriminant validity.

Examining the cross-loadings of each indicator item is another technique to verify the discriminant validity of the indicators. The cross-loadings of the items on each of the corresponding indicators should be more than 0.1 times greater than the loadings of the other items. The cross-loadings of each item are displayed in Table 5.

Inner model measurement

The data were examined for internal model measurements after considering exterior model measurements. By bootstrapping, the hypotheses were tested using partial least squares (PLS). Using this resampling procedure, a sizable subsample is taken from the original data (usually 5000 or more) [55, 56].

The quality of the inner model depends on how well it can forecast the endogenous construct. Examining the coefficient

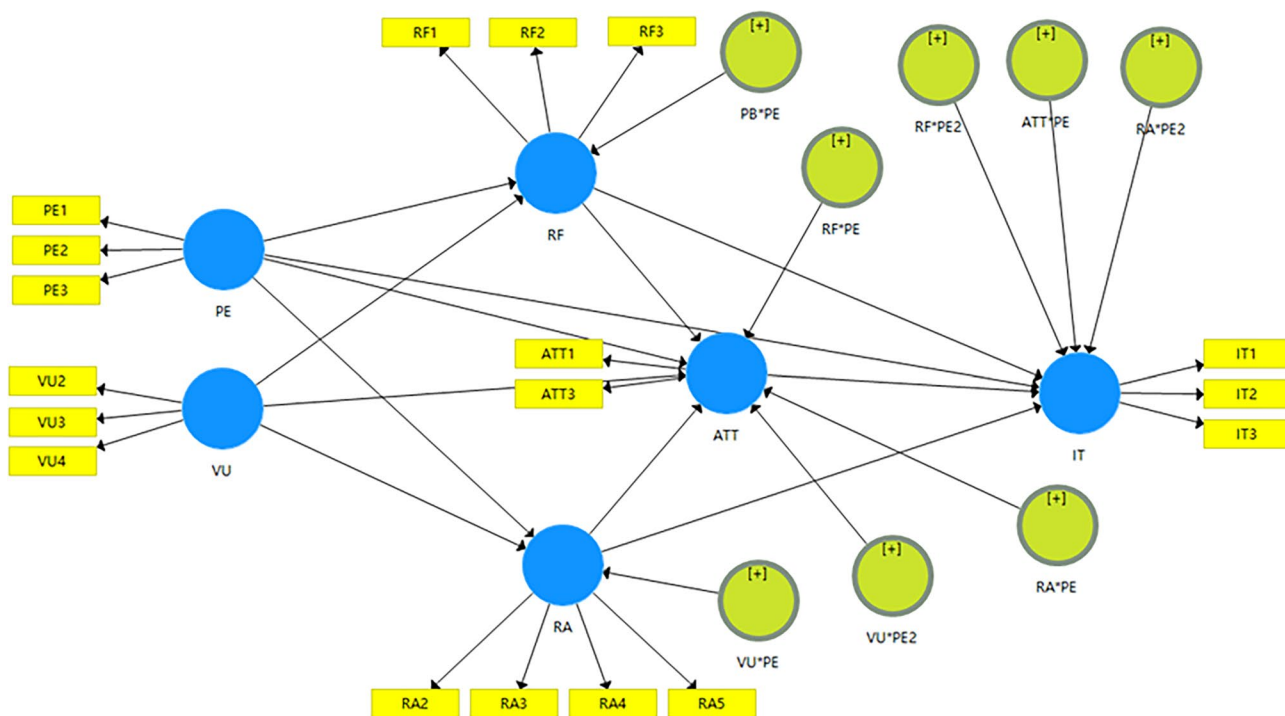


Fig. 2 Structure of the specific research model

Table 3 Correlations of discriminant validity

	ATT	IT	PE	VU	RA	RF
ATT	0.942					
IT	0.358	0.792				
PE	-0.048	0.216	0.837			
VU	0.204	0.487	0.445	0.722		
RA	-0.076	-0.412	-0.579	-0.348	0.829	
RF	0.484	0.501	0.003	0.207	-0.054	0.839

The value of bold is the square root of AVE

Table 4 Heterotrait–monotrait ratio (HTMT) results

	ATT	IT	PE	VU	RA	RF
ATT						
IT	0.446					
PE	0.120	0.298				
VU	0.295	0.789	0.677			
RA	0.086	0.518	0.714	0.507		
RF	0.582	0.670	0.121	0.328	0.111	

of determination (R^2) and cross-validated redundancy (Q^2) is the main criterion for judging the inner model. R-square is a metric for model prediction accuracy (R^2). The external (independent) variable's overall effect on the endogenous (dependent) variable is represented by R^2 . R^2 was categorized by Sanchez into three levels: high, moderate, and low. When the value is greater than 0.6, R^2 is high; when it is

approximately 0.3 and 0.6, it is moderate; and if it is lower than 0.3, it is low [57]. The R^2 values in Table 6 demonstrate how well the model fits. Cross-validated redundancy is an additional technique for assessing the model's correctness (Q^2). Q^2 assesses the inner model's prediction usefulness. Q^2 is measured by using the blindfolding method. The value of Q^2 must be larger than zero. Table 6 displays the values of

Table 5 Factor analysis

	ATT	IT	PE	VU	RA	RF
ATT1	0.953	0.378	− 0.053	0.202	− 0.103	0.465
ATT3	0.930	0.292	− 0.036	0.181	− 0.035	0.445
IT1	0.242	0.817	0.222	0.366	− 0.283	0.324
IT2	0.331	0.794	0.149	0.423	− 0.383	0.422
IT3	0.270	0.768	0.156	0.364	− 0.302	0.434
PE1	0.067	0.244	0.847	0.392	− 0.452	0.108
PE2	− 0.050	0.153	0.833	0.316	− 0.521	− 0.067
PE3	− 0.135	0.15	0.831	0.413	− 0.48	− 0.027
VU2	0.212	0.404	0.31	0.834	− 0.217	0.252
VU3	0.192	0.423	0.219	0.735	− 0.126	0.189
VU4	0.036	0.237	0.425	0.658	− 0.400	0.001
RA2	− 0.011	− 0.256	− 0.489	− 0.296	0.871	− 0.097
RA3	− 0.143	− 0.525	− 0.385	− 0.309	0.858	− 0.136
RA4	− 0.051	− 0.285	− 0.543	− 0.266	0.840	0.016
RA5	− 0.035	− 0.276	− 0.511	− 0.283	0.736	0.042
RF1	0.442	0.400	0.020	0.181	− 0.031	0.906
RF2	0.442	0.441	− 0.023	0.202	− 0.054	0.880
RF3	0.325	0.423	0.014	0.133	− 0.052	0.719

The value of bold is the load, the other numbers are the cross load

Table 6 Predictive power of the construct

	R^2	Q^2
ATT	0.305	0.225
IT	0.467	0.242
RA	0.330	0.234
RF	0.071	0.032

Q^2 , all of which are larger than zero, supporting the model’s fitness.

Hypothesis testing

Direct effects test

The PLS-SEM results showed that in the hypothesis test for direct effects, all hypotheses were accepted except Hypothesis 4 ($p > 0.05$). The specific outcomes are demonstrated in Table 7 and Fig. 3.

Specifically, attitude ($b = 0.124, p = 0.012$) and reason for ($b = 0.414, p = 0.000$) had a significant positive effect on consumers’ intention to engage in formal recycling of household waste in kitchen and bathroom appliances, and Hypotheses H1 and H3 were accepted. Reason against ($b = - 0.398, p = 0.000$) had a significant negative effect on consumers’ intention to become involved in formal recycling of household waste in kitchen and bathroom appliances; thus, Hypothesis H5 was accepted. Value ($b = 0.106, p = 0.020$) and reason for ($b = 0.459, p = 0.000$) had a significant positive influence on consumers’ attitudes toward

Table 7 Hypothesis testing

	Estimates	S.E	T value	p	Support or not
ATT→IT	0.124	0.049	2.523	0.012	Support
VU→ATT	0.106	0.045	2.34	0.020	Support
VU→RA	− 0.326	0.05	6.582	0.000	Support
VU→RF	0.222	0.049	4.567	0.000	Support
RA→ATT	− 0.023	0.049	0.462	0.644	Not
RA→IT	− 0.398	0.034	11.75	0.000	Support
RF→ATT	0.459	0.043	10.692	0.000	Support
RF→IT	0.414	0.054	7.654	0.000	Support

becoming involved in the formal recycling of household waste kitchen and bathroom appliances; thus, Hypotheses H2 and H6 were accepted. Value ($b = 0.222, p = 0.000$) had a significant positive effect on “Reason for”; thus, Hypothesis H7 was accepted. Value ($b = - 0.326, p = 0.000$) had a significant negative effect on “Reason against”; thus, Hypothesis H8 was accepted. However, “Reason against” did not have a significant effect on consumer attitudes toward formal recycling to participate in formal recycling of household waste household kitchen and bathroom appliances; thus, Hypothesis H4 was rejected.

Moderating effects test

After adding policy and education as a moderating variable, the test results of the direct effect are shown in Table S3 and Fig. 4, and a significant path is selected to test the

Fig. 3 Structural model testing results

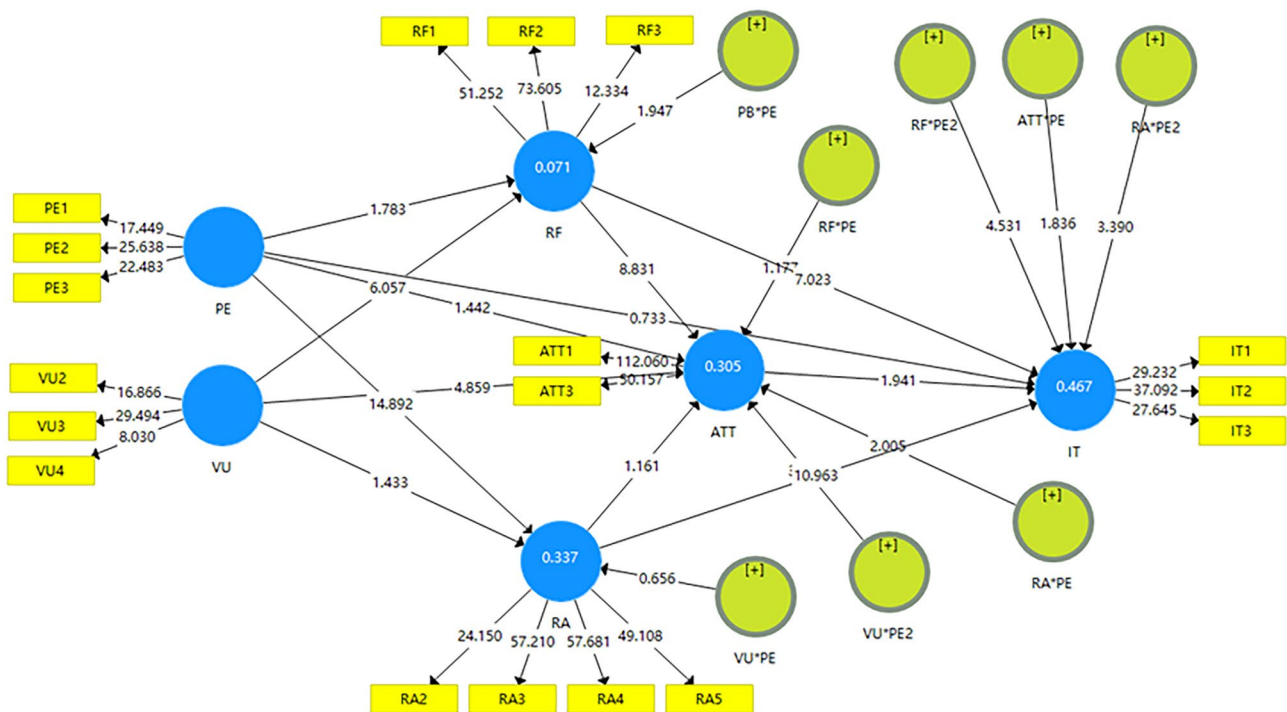
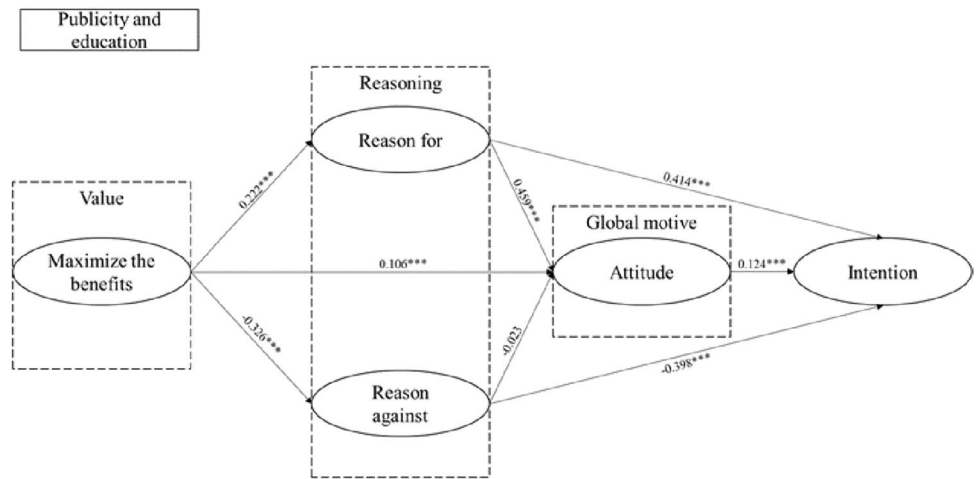


Fig. 4 Structural model testing results after adding policy and education

moderating effect. Further analysis of the influence of the interaction terms shows that some interaction terms have a considerable impact on the direct effect. The specific results are shown in Table S4. Then, the specific moderating effect was explored by constructing a simple slope diagram (see Fig. 5A–C). Specifically, policy and education positively modulate consumers' personal values and attitudes toward participating in the formal recycling of waste household kitchen and bathroom appliances. Policy propaganda reversely regulates “Reason for” and “Reason against” consumers' intentions to become involved in the formal recycling of household kitchen and bathroom appliances. Policy

and education did not show a significant moderating effect on other paths.

Discussion

The research model exploited in this study explores the factors influencing the intention of consumers with the value of maximizing personal benefit to become involved in the formal recycling of waste household kitchen and bathroom appliances. Specifically, the relationship between values, reasons, and attitudes and the intention to become involved

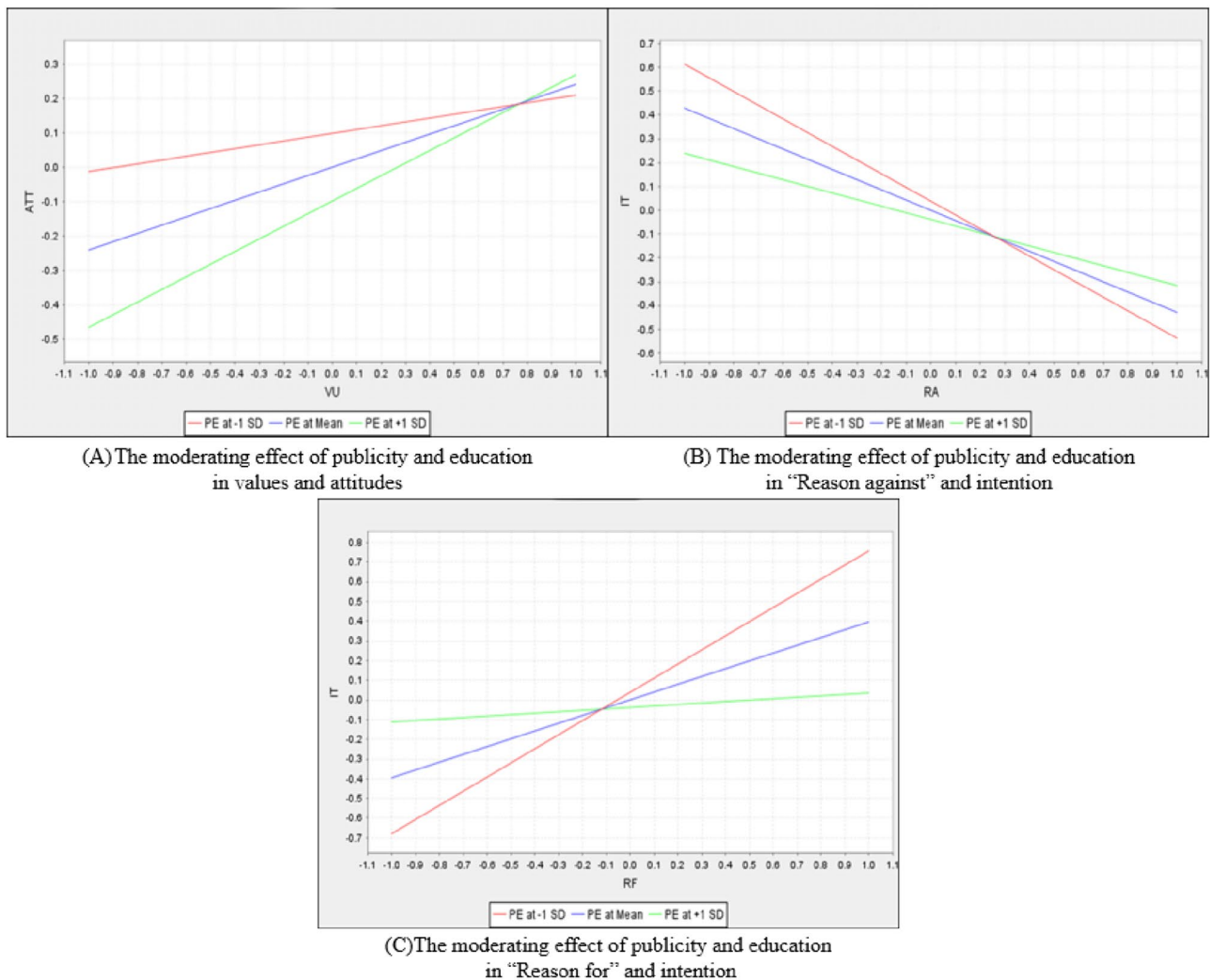


Fig. 5 The moderating effect

in the formal recycling of waste household kitchen and bathroom appliances was investigated. In this study, 402 consumers in China were studied using the PLS-SEM method. The results showed that seven of the eight hypotheses proposed for the direct effect were supported (H1, H2, H3, H5, H6, and H8), and three of the eight hypotheses proposed for the moderating effect were supported (H9a, H9f, and H9g).

Hypothesis H1 examines the association between attitude and intention, which is basically consistent with existing research [13, 21, 42]. The results show that consumers who have a positive attitude toward participation in the formal recycling of waste household kitchen and bathroom appliances will have positive recycling intentions. H2 and H3 examine the relationship between reasons and consumers' attitudes and intention to participate in the formal recycling of waste household kitchen and bathroom appliances. This finding is consistent with previous research on BRT [13, 21, 42]. The indicators used to measure the cause in this study

mainly include consumers' environmental awareness. The results of the study show that when a consumer has environmental awareness, the environmental awareness they have will prompt them to have a positive attitude and intention to participate in the formal recycling of waste household kitchen and bathroom appliances. Although such attitudes and intentions may harm their interests, they still do so.

H4 and H5 examine the relationship of reasons for objection to consumers' attitudes and intention to become involved in the formal recycling of waste household kitchen and bathroom appliances. Only Hypothesis H5 passed the test, indicating that objection reasons have a negative relationship with consumer intention but do not significantly affect consumer attitudes. This is consistent with previous articles on WEEE research using BRT [31]. Specifically, the research indicators of the reasons for objection mainly include consumers' doubts about the qualifications of formal recycling enterprises, the difficulty for consumers to obtain

relevant information about formal recycling enterprises, and the cost loss for consumers. When consumers face these difficulties, they may choose not to participate in recycling despite having a positive attitude toward participating in formal recycling.

H6, H7, and H8 examine the relationship between values and reasoning for consumers who have value maximization as a value. H6 shows a significant positive correlation between values and attitudes, which indicates that the stronger a consumer's values (benefit maximization), the more benefits they obtain. Hypotheses H7 and H8 were tested, indicating that values (benefit maximization) have a significant effect on consumers' reasoning for participating in formal recycling of waste household kitchen and bathroom appliances, specifically, a significant positive effect on "Reason for" and a significant negative effect on "Reason against". This conforms with the hypothesis of BRT [18]. This suggests that when consumers with the value of profit maximization perceive that they can gain from participating in the formal recycling of household appliances, this value positively promotes positive reasoning and inhibits negative reasoning. However, the results of Hypotheses H7 and H8 are inconsistent with Dhir et al.'s results in studying consumers' intention to recycle WEEE using behavioral inference theory [31]. The specific reasons may be (1) different research values, as this study focuses on consumers' decision-making based on maximizing their own interests, while Dhir et al.'s study is mainly concerned with the issue of environmental protection. (2) Different reasoning scenarios. This study focuses on the elements affecting consumers' intention to become involved in the formal recycling of waste household kitchen and bathroom appliances, which are regulated and endorsed by the government. (3) Differences in research objects. The main WEEE studied thus far is still focused on technology-intensive electronic products such as cell phones, TVs, and computers. Household kitchen appliances are large and difficult to move, and the recycling method in China is mainly door-to-door recycling, so product differences may also cause differences from previous WEEE recycling-related studies.

In a study addressing the moderating effect of policy and education on the model, this study found that policy and education played a significant moderating effect between consumer values and attitudes, reasoning, and intention to recycle. In previous studies, it has been found that in residents' green behavior, policy and education help to promote residents' behavioral intentions [58–60]. In this study, publicity and education play a positive role in moderating the relationship between consumer values and consumer attitudes (H9a). In addition, information and education negatively moderated the effect of reasoning and intention to participate in formal recycling of waste household kitchen and bathroom appliances, specifically, both "reason for" and

"reasons against", which weakened the effect of information and education on consumer intentions.

Conclusion

Exploring the factors influencing consumers' intention to recycle is important to improve any WEEE recycling management initiatives. Current research has focused on WEEE targeting cell phones, computers, televisions, and washing machines, neglecting discarded household kitchen appliances that have fewer sophisticated components and are more difficult to recycle. In addition, China faces fierce competition between formal and informal recycling companies, and a large number of consumers choose informal recycling channels to recycle WEEE. The contribution of this study is the selection of abandoned kitchen and bathroom appliances in the family. These appliances are currently very important but rarely studied and are studied by combining BRT and the value of maximizing consumer benefits. This study collected data through two professional questionnaire data collection platforms. After excluding those questionnaires with response times that were too long or too short and incomplete responses, we used PLS-SEM to analyze the valid questionnaire data. Finally, three main results were obtained. First, attitudes and reasons have a positive effect on the intention of consumers to participate in the formal recycling of household kitchen and bathroom appliances. Second, 'Reason for', 'Reason against', and values all have an impact on consumers' attitudes toward participating in the formal recycling of household appliances and kitchen appliances. Third, policy and education can promote the effect of consumer values on consumer attitudes and inhibit the influence of reasoning on consumer intention.

There are still some limitations in this study. First, this study chose the value of profit maximization possessed by consumers to replace the commonly used value of environmental protection as one of the indicators of BRT. However, some consumers are not concerned with simply maximizing their personal benefits. When consumers are risk averse, their focus changes from benefit maximization to risk minimization, and future research can enrich the behavioral reasoning model by studying risk averse consumers. Second, the size of the products was not discussed and mentioned, and we will consider the effect of product size on response trends and model construction based on the existing model in the next step. Third, it is interesting to consider the relationship between people's attributes and their recycling treatment methods, and more attributes can be added in future studies to explore the factors that promote the formal recycling of each attribute type. In addition, this study focuses on Chinese consumers as a sample, and future research can investigate the factors that affect consumers'

intention to participate in recycling in different countries and then investigate whether cross-cultural aspects have an impact on consumers' intention to become involved in recycling WEEE. In the next step, we will consider the effect of product size on response trends and model construction based on the existing model.

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Declarations

Conflict of interest The authors declare no competing interests.

Ethical approval and consent to participate Not applicable.

Consent for publication Not applicable.

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