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Abstract

The spatial distance of residents from potentially harmful facilities plays a vital role in shaping their perceptions of the facilities. Based on environmental psychology theories, such as the ripple effect, psychological typhoon eye effect, and marginal zone effect, two waste-to-energy (WTE) incineration plants in China's Zhejiang province are used as case studies to understand peoples' perceptions. Following a questionnaire survey of local residents, the results of a one-way ANOVA indicate a low acceptance of incinerators and a high level of perceived risk; the impact of spatial distance on the local residents' level of perceived risk correspond to the marginal zone effect; and the perception of economic benefits, trust, fairness, and acceptance of WTE incinerators have a ripple effect. Furthermore, the impact of spatial distance is effectively eliminated or alleviated by a range of community engagement approvals and various forms of economic compensation. These findings enrich the knowledge system related to environmental psychology research on NIMBY

infrastructure projects and contribute toward better understanding of public psychology in order to provide a future reference for more efficient decision-making models.

Keywords: Waste-to-energy incineration project; Public perception; Marginal Zone Effect; Ripple Effect; Psychological Typhoon Eye Effect

List of abbreviations including units and nomenclature:

ANOVA	Analysis of Variance	CAS	the Chinese Academy of Sciences
CNY	Chinese Yuan	COVID-19	Corona Virus Disease 2019
EFA	Exploratory factor analysis	EIA	environmental impact assessment
KMO	Kaiser-Meyer-Olkin	M	mean
MSW	Municipal solid waste	MZE	marginal zone effect
NIMBY	Not-in-my-backyard	PTE	psychological typhoon eye
RE	ripple effect	SARS	Severe Acute Respiratory Syndrome
SD	standard deviation	Sig.	significance
SPSS	Statistical Product and Service Solutions	Std. dev	Standard deviation
USD	United States dollar	WTE	Waste-to-energy

1 Introduction

There has been a dramatic rise in the output of municipal solid waste (MSW) owing to rapid economic development and extensive urbanization in China (Cui et al., 2020). Thus, there is an urgent need to solve the problem of MSW disposal and management. At present, landfill, composting, and incineration are the most important treatment methods that cause the least harm (Dong et al., 2010; Achillas et al., 2011). Of these, waste-to-energy (WTE) incinerators play a vital role in MSW treatment (Abd Kadir, 2013; Ali et al., 2021). As shown in **Figure 1**, the actual daily incinerated capacity of MSW increased from 40,000 tons in 2006 to 456,500 tons in 2019. Moreover, the number of incineration facilities increased from 69 to 389 during the same period. The rapid growth of MSW treatment capacity was mainly due to the large-scale implementation of WTE incinerators.

< Figure 1 >

Nevertheless, there has been a constant increase in environmental awareness (Fatima et al., 2021; Yasmeen et al., 2021), which has created obstacles for site selection and construction of WTE incineration facilities (Johnson, 2013; Baxter et al., 2016). There have been frequent anti-incineration campaigns around the world (Rootes and Leonard, 2009). Site selection of WTE incineration projects has met with considerable opposition from the local communities that are most affected, especially in densely populated cities (Sun et al., 2019; Jabeen et al., 2021a). Public perception of the local communities in the proposed area is considered to be one of the most critical factors for enabling the smooth progress of MSW treatment projects (Hou et al., 2019; Jabeen et al., 2021b). Public perception is defined as the public's subjective evaluation of a target event based on subjective feelings (Cong et al., 2021), and is the result of factors, such as perceived risk, perceived economic benefit, perceived trust, perceived fairness, and public acceptance (Woo et al., 2021). Currently, public acceptance and perceived risk of "not in my backyard" (NIMBY) projects

have attracted the attention of many studies. These studies have shown that public acceptance and perceived risk of NIMBY projects are affected by many factors (Chung and Kim, 2009; Liu et al., 2021), of these, spatial distance from WTE incinerators has been identified as the most important (Liu et al., 2018; Cong et al., 2020). Moreover, it has been discovered that distance affects public perception of risk events or NIMBY facilities (Xie et al., 2011a). Three theoretical models, namely the ripple effect (RE), psychological typhoon eye effect (PTE), and marginal zone effect (MZE) have been proposed in previous studies. Of these, the RE describes the decay of public level of perceived risk with distance in risk analysis (Burns and Slovic, 2012). The PTE was discovered and named by the research team of the Chinese Academy of Sciences (CAS) in relevant studies on risk perception of the Wenchuan earthquake. It is used to describe the phenomenon of people closer to high-risk locations/periods having a lower level of perceived risk and higher public acceptance (Li et al., 2009). However, the MZE, a special phenomenon discovered by Xie et al. (2011a) in the process of verifying PTE, occurs when people's level of perceived risk in the middle zone is lower than that of the two ends. An analytical framework provided by these theories helps understand the internal connection between distance and public perception.

However, there are limited studies on this issue. With respect to the impact of spatial distance on public perceived risk and acceptance, the literature provides three different distance laws (RE, PTE, and MZE). However, in terms of NIMBY facilities, no consensus has been reached over which distance law can be applied to WTE incinerators. Furthermore, the public's perceived risk and acceptance conform to the RE (Van der Horst, 2007; Cong et al., 2020), the PTE (Lima, 2004), or the MZE (Wen et al., 2020), and has been confirmed by many studies. However, it has not been established if perceived economic benefits, perceived fairness, and perceived trust follow the above distance law. Additionally, although distance has been found to be closely related to public perception in the field of NIMBY (Giordano, 2010), studies on the impact of distance differences on public perception of NIMBY projects mainly focus on nuclear power (Frantal et al., 2016) and

wind power (Rand and Hoen, 2017) generation projects, with little research on waste treatment. Given that most studies are conducted in developed countries (Gravelle and Lachapelle, 2015), similar work is needed in developing countries to explore the specific relationship between distance and the public perception of WTE incineration facilities.

To fill this research gap, the present study tests the influence of spatial distance on the public perception of WTE incinerators using a questionnaire survey of residents who live adjacent to two selected WTE incineration plants located in a representative province in the eastern coastal region of China. Based on descriptive statistics, one-way ANOVA, and comparative analysis, the findings help understand the relationship between public perception and distance in WTE facilities. This is also of great significance for local governments and related companies to promote green and sustainable development.

2 Research hypotheses

This section introduces three psychological effects (RE, PTE, and MZE) in detail and proposes related hypotheses.

2.1 Ripple effect

Previous studies have shown that risks perceived by the public are directly related to the objective risk situation (Kasperson et al., 1988; Xu et al., 2020). This can be analogous to ripples caused by a stone falling in a pond; that is, the greater the proximity to the high-risk area or period, the higher the public level of perceived risk and negative emotions involved (Slovic, 1987). Researchers term this ripple effect as a vivid metaphor of the public's psychological state when faced with risk events (Xie et al., 2011a). The scope and duration of the ripples are affected by the quality and nature of the stones. Accordingly, the depth and breadth of the ripples are affected by the degree of harm of the risk event, type of event, the way of public access, etc. (Xie et al., 2003). The ripple effect has been verified in several fields. For instance, Wen et al. (2020) studied the risk

perceptions and anxiety characteristics of people in different COVID-19 severity regions from the perspectives of the actor and bystander, and found that the perceived risk and anxiety scores of Wuhan residents (the actor) were higher than residents in other parts of Hubei province (the bystander). Yang et al. (2020) investigated public risk perceptions during an epidemic using actual distance and psychological distance, and found that those who were further from the epidemic center were more worried than their counterparts who were closer to the center.

Therefore, based on the RE, we propose

Hypothesis H1*: The distance law of the WTE incineration facility in public perception conforms to the ripple effect (RE).*

2.2 Psychological typhoon eye effect

Li et al. (2009) conducted a large-scale survey of residents in disaster-stricken and non-disaster-stricken areas during the "5.12" Wenchuan earthquake. They discovered a counter-intuitive phenomenon: people who are in close proximity to the area of crisis have a lower level of perceived risk and higher acceptance. Similar to the meteorological phenomenon of calm nature at the center of a typhoon, this effect is termed the PTE, which describes the public's psychological state after a crisis event (Liang et al., 2008; Li et al., 2009). The PTE effect has been supported by various research fields. For instance, Melber and Nealey (1977) observed that residents that lived closer to a nuclear power plant had lower public risk perception; a similar phenomenon was also seen in other studies (Giordano, 2010). Lima (2004) conducted a longitudinal study on the mental health of the public at different spatial distances from the WTE incineration facilities and concluded that the level of perceived risk of nearby residents decreased over time. Research on earthquakes, SARS, COVID-19, and other events have also verified the PTE effect (Shi et al., 2003; Li et al., 2009, 2020). Additionally, Zheng et al.'s (2015) survey of the participation level of lead-zinc mining among residents located in China's Fenghuang County found that the level of

perceived risk of residents living around the lead-zinc mining area in China's Fenghuang Country was to be negatively correlated with their mining participation. Li et al. (2020) used the China-Eurasian Expo in Xinjiang as an opportunity to conduct a nationwide survey of 2,034 residents in 31 provinces and municipalities across China. They found that the distance from Urumqi to the city where respondents lived was positively correlated with their level of attention to the safety and security of the Expo, thereby verifying the PTE effect. There are several possible explanations to understand the PTE, such as cognitive dissonance theory (Li et al., 2009), psychological immunization theory (Zheng et al., 2015), individual experience theory (Xu et al., 2020), perceived benefit accounts (Wang et al., 2000), and the RE of social amplification framework theory (Wen et al., 2020). Nevertheless, these reasons have not been unanimously confirmed. Thus, the inner mechanism of the psychological eye of typhoons needs further research.

Therefore, based on PTE effect, we propose

Hypothesis H2*: The distance law of the WTE incineration facility in public perception conforms to the psychological typhoon eye effect (PTE).*

2.3 Marginal zone effect (MZE)

MZE was discovered in the process of researching public risk perception and state of anxiety due to major natural disasters and major public health events in the past. That is, the level of perceived risk in a medium-risk area or medium spatial distance area to where the crisis occurred is less than in higher or lower areas (Xie et al., 2011a; Wen et al., 2020). Xie et al. (2011a) proposed the disaster MZE in their study of the Wenchuan earthquake and found that the public in the Panzhihua area, which was not strongly affected by the earthquake, were the least aware of the risk of aftershocks. Zou et al. (2021) studied the relationship between perceived social support and despair in the context of the COVID-19 epidemic and concluded that, compared with other provinces, residents in Wuhan or more distant areas in Hubei province had less social support than

151 those between the two regions. Endowment and contrast effects can be used to explain the MZE
152 (Xie et al., 2011a), where the former refers to the negative or positive factors the event that directly
153 affect the current emotional trend of a person, and the latter indicates that past events will affect
154 people's evaluation of current events (Tversky and Griffin, 1991; Wen et al., 2020).

155 Therefore, based on the MZE, we propose

156 ***Hypothesis H3****: The distance law of the WTE incineration facility in public perception*
157 *conforms to the marginal zone effect (MZE).*

158 # 3 Research design

159 This section introduces the research design containing the research framework, questionnaire
160 design, data collection, and analysis methods.

161 ## 3.1 Overall research framework

162 Traditional hypothesis testing is adopted to empirically verify the impact of spatial distance
163 on the public perception of WTE incineration projects using a combination of research methods,
164 including literature analysis, questionnaire surveys, and one-way ANOVA. **Figure 2** shows the
165 flow of the overall research framework, which comprises of four parts: a comprehensive literature
166 review to identify research progress in the relationship between distance and psychological
167 reaction in crisis; a questionnaire survey of residents associated with two typical large-scale WTE
168 incineration projects located in two representative Chinese cities to obtain public perception and
169 descriptive statistics data; the difference analysis using one-way ANOVA; and a comparative
170 analysis from case studies across two selected plants.

171 < Figure 2 >

3.2 Questionnaire design

The questionnaire consisted of two parts: Part 1 elicited the respondents' socio-demographic characteristics (gender, age, education level) and Part 2 evaluated the respondents' attitudes toward the WTE plants (see **Appendix A**). Part 2 was divided into five sections with a total of 27 questions, based on a summary of the literature, to evaluate the differences in public perception at different spatial distances from the plants. These included 15 questions from Liu et al. (2018) and Ahmad et al. (2020) relating to the respondents' perceived risk, public trust, and public acceptance of the incinerator project; five questions from Chung et al. (2009) and Liu et al. (2020) involving the respondents' perceived economic benefits of the project, and seven questions from Colquitt et al. (2001) and Poon et al. (2012) concerning the respondents' perceived fairness of the project. These questions were rated on a five-point Likert scale ranging from 1 (extremely disagree) to 5 (extremely agree).

Taking the Hangzhou Jiufeng WTE incineration plant as the epicenter, 100 residents from varying distances were invited to participate in a preliminary pilot survey, and a total of 96 valid questionnaires were collected. Cronbach's alpha and exploratory factor analysis (EFA) were used to test the reliability and validity of the questionnaires. **Table 1** shows the results, which indicate that the questionnaire has sufficient reliability and structural validity.

< Table 1>

3.3 Samples and data collection

China's eastern coastal area is the main location of WTE applications in the country. According to the China Statistical Yearbook 2020 (National Bureau of Statistics of China, 2020), there are 389 WTE incineration plants nationwide, of which 220 are in the eastern coastal area. As a representative province in the eastern coastal area, Zhejiang Province has 39 WTE incineration plants in operation, accounting for 10% WTEs of all provincial administrative regions. As one of

196 the most economically and socially developed provinces in China, people in Zhejiang are
197 concerned about health and environmental protection. In recent years, there has been public
198 opposition to WTE in Zhejiang. For example, the Jiufeng WTE incineration plant (Jiufeng Plant)
199 had a fierce NIMBY conflict. Moreover, the arrival of the second Jinhua MSW incineration plant
200 (Jinhua Plant) was accompanied by complaints and dissatisfaction. Therefore, two typical large-
201 scale WTE incineration plants located in two representative provincial cities in Zhejiang were
202 chosen for the study. Furthermore, the two plants are benchmark projects that have been completed
203 and operated in recent years. Both have a great influence in the local area; the surrounding villages
204 around the two facilities are densely distributed. These factors make them suitable for a multi-
205 distance survey to explore the differences in public perception within different spatial distances.

206 The Jiufeng Plant by Everbright International is primarily responsible for garbage disposal
207 in the downtown area of Hangzhou. The total investment involved in the project is approximately
208 1.8 billion Chinese Yuan (CNY) (1 USD (United States dollar) =6.45 CNY in October 2021), with
209 a designed total incineration scale of 3,000 tons of domestic garbage per day. However, the
210 decision to construct the project was initially opposed by the local residents, and secret
211 construction rumors on social media prompted the outbreak of a sensational NIMBY conflict.
212 However, the project proceeded smoothly through measures, such as public participation and
213 economic compensation in 2017 (Liu et al., 2019).

214 Jinhua Plant by The Shanghai Environment Group Co. Ltd is located in the south of Jinhua.
215 The total investment involved in the project is approximately CNY 1.9 billion, with a designed
216 total incineration scale of 3,000 tons of domestic garbage per day. This project is being completed
217 in two phases. The first phase is complete and has been put into operation in 2020. The second
218 phase is expected to be completed in 12 years.

219 The study covered the entire area between the city center and the WTE incinerator. Previous
220 research revealed 5000 m to be the risk boundary of the assessment study (Khammaneechan et al.,

2011). Meanwhile, according to the first-level environmental impact assessment (EIA) standard of WTE in China, the measurement range was not less than 5000 m. Khammaneechan et al. (2011) and Liu et al. (2021) explored the impact of distance on public attitudes about WTE incinerators within 5000 m. Moreover, through field visits and investigation of the surrounding areas of the Jiufeng Plant and Jinhua Plant, it was observed that there was no clear boundary between the 5,000 and 6,000 m areas, and residents in areas over 6000 m were no longer clear about the selected projects. Therefore, this study selected the distance of 6000 m as the psychological influence boundary.

Specifically, Ren et al. (2016) found that the support rate of residents within 1000 m of a WTE incinerator did not exceed 50%, while Huang et al. (2015) and Liu et al. (2018) concluded that residents within 3000 m of a WTE incinerator have significantly different attitudes toward the facility, as compared to those who are 3000 m away. Furthermore, residents within 5000–6000 m of the Jiufeng Plant expressed clear negative attitudes in previous NIMBY incidents. Meanwhile, the distribution of residents within 1000 m of the two plants was less. The investigation scope was finally segregated into four groups: 0–1500 m, 1500–3000 m, 3000–6000 m, and over 6000 m.

The survey was conducted from May 15 to July 10, 2021. The distribution of residential communities or villages in different spatial distance sections around the WTE incinerators was determined. The sampling scheme was according to the population characteristics and village distribution. Stratified random sampling was adopted, with permanent residents of the selected survey area identified as potential target respondents. The pre-numbered and marked questionnaires were randomly distributed to the residents in the selected area. Investigators explained the project background to the residents. Moreover, to ensure the truthfulness and accuracy of the collected data, all respondent inquiries were promptly answered to ensure that respondents independently answered all questions. This ensured that the questionnaire captured their true thoughts, especially with respect to the elderly and less educated.

In total, 750 questionnaires were distributed based on the network distribution and population of the administrative villages in the surveyed area. Taking the selected incinerator as the center, 300 questionnaires were distributed around Jiufeng, of which 286 (95.3%) were recovered. Moreover, 350 were issued around Jinhua, of which 297 (84.9%) were recovered. Overall, there were a total of 573 valid questionnaires, with an effective recovery rate of 88.2%. Although this overall response rate was generally higher than traditional social investigations, the response rates in the studies by Huang et al. (2013) and Ren et al. (2016) had the same efficiency in similar face-to-face studies. Additionally, the reliability and validity of the final questionnaire were tested using Cronbach's alpha and the EFA. The result (Cronbach's α=0.896; KMO=0.940; Bartlett P=0.000) indicated that the questionnaire has sufficient reliability and structural validity.

< Table 2>

Table 2 summarizes the respondents' socio-demographic data, showing that the number of males and females are similar. Furthermore, a majority of the respondents are over 45 years, nearly half have high school/technical secondary school education or above, and 60% of the respondents have their residences (workplaces) located within 3000 m of the plant. Many belong to rural areas; the left-behind residents are mainly young and middle-aged people, women, and children with low education levels (Liu and Li, 2017; Wang et al., 2021). In this case, the sample distribution is representative of typical people who do not live too far from a WTE incineration plant.

3.4 Data analysis

The data analysis process was divided into three steps. First, a descriptive statistical analysis method was used to quantitatively evaluate the respondents' attitudes toward WTE incineration projects. Then, a one-way ANOVA was used to compare public perceptions, including level of perceived risk, perceived economic benefits, perceived trust, perceived fairness, and public acceptance within the four different spatial distances ranges of 0–1500 m, 1500–3000 m, 3000–

6000 m, and over 6000 m. Finally, the data were analyzed by one-way ANOVA to determine the similarity or otherwise of the residents' perceptions of the two plants.

4 Results

This section details the empirical results based on descriptive statistical analysis, one-way analysis of variance, and comparative analysis.

4.1 Descriptive statistics

Table 3 shows the descriptive statistical results for all the variables. The perceived risk items had the highest overall mean, followed by perceived trust, perceived economic benefits, and perceived fairness. Public acceptance of the plant was similar to perceived trust, both of which were relatively low. This result was expected in view of the frequent occurrence of anti-incineration incidents in China in recent years.

< Table 3>

4.2 One-way ANOVA

Table 4 shows the results of the one-way ANOVA test, indicating that the differences in public perception among the five constructs at different spatial distances are significant. SPSS post-hoc multiple comparisons show that, except for the level of perceived risk, all other constructs were positively related to a distance up to 3000 m, after which an increase in distance no longer has any significant effects, placing the results close to the RE (*H1*). However, with perceived risk, there was no significant difference in the level of perceived risk among residents between 1500 and 3000 m (M = 3.48, SD = 0.66) and those above 6000 m (M = 3.35, SD = 0.80); that is, the perceived risk first decreased and then increased, which was in accordance with the MZE (*H3*).

< Table 4>

4.3 Comparative analysis between Jiufeng and Jinhua

Table 5 shows that the public perceptions of Jinhua and Jiufeng only subtle differ from the combined results in **Table 4** with respect to perceived economic benefits and perceived fairness, while the acceptance of WTE incineration facilities by residents of the two places is quite different. As shown in Table 5, when the distance reaches 3000 m, the public acceptance of Jinhua and Jiufeng reveals the same tendency of no significant difference between spatial distances. However, within 3000 m, there is no significant difference in the acceptance of residents near the Jiufeng Plant, while the acceptance of residents located around the Jinhua Plant increases with the distance, and this distance law conforms to the RE (*H1*).

< Table 5>

5 Discussion

As shown in **Table 3**, the acceptance of WTE incineration projects by residents around Jiufeng and Jinhua is generally low ($2<M<3$), while the level of perceived risk is generally high ($3 \leq M<4$). This indicates that the public has a negative attitude toward WTE incineration projects, which is consistent with the findings of Hou et al. (2019) and Liu et al. (2020). Hou et al. (2019) concluded that public acceptance can be transformed into a problem of fairness and trust. Lahl and Zeschmar-Lahl (2018) believed that public trust in government and operators could improve public acceptance. In the present study, although the public believed that the project will use equipment that met standard requirements during operation (Q20 score: $M=3.19$), the residents still showed a low level of trust in the government and operating enterprises (perceived trust construct score: $2<M \leq 3$). Moreover, the public's perceived fairness (perceived fairness construct score: $2<M<3$) level was low, which was consistent with public reluctance to accept WTE incineration projects.

This study revealed that an increase in the spatial distance from the plants had a significant impact on public perception. This result coincided with previous studies, which also found that

people's feelings and attitudes were closely related to distance (Cong et al., 2020). In the past, researchers observed that residents living in NIMBY facilities, especially those around nuclear power facilities, had a lower level of perceived risk and higher safety evaluation or acceptance than residents farther away, like the PTE (Frantal et al., 2016). Some studies also found that residents' acceptance of NIMBY facilities was positively correlated with distance (Van der Horst, 2007; Cong et al., 2020). However, the results of the present study differ in the process of verifying the distance law of the residents' mental state. Specifically, public perception is evaluated by the varying distances from the WTE incineration plant. Furthermore, perceived economic benefits, perceived fairness, perceived trust, and public acceptance are similar to those of RE (*H1*), while the level of perceived risk of the public is consistent with the MZE (*H3*).

On the one hand, the reasons for the law of distance between public acceptance and level of perceived risk may stem from the public's inherent impression of similar facilities, such as landfill. On the other hand, the operation of WTE incineration facilities may be accompanied by problems, such as noise and unpleasant smell of MSW (Sun et al., 2019; Shah et al., 2021). In fact, smell and noise are the best indicators for nearby residents to realize danger (Lima, 2004). Environmental pollution revealed by sensory impact also places psychological pressure on nearby residents (Rahardyan et al., 2004; Jabeen et al., 2019). Therefore, residents closer to WTE incineration facilities have a higher level of perceived risk and lower acceptance.

Residents that lived 6000 m away from WTE incineration facilities had a higher level of perceived risk than those who lived between 3000 m and 6000 m because those who lived further away had a higher level of education and were more concerned about the environment and health risks associated with the project. Ge et al. (2020) showed that the higher the level of education, the more concern about the possible risks of NIMBY facilities. In order to verify this, we conducted a comparative analysis of the education status of residents within 3000 – 6000 m and beyond 6000 m, and found that 64.15% of the respondents beyond 6000 m received higher education

341 (≥ junior college), while only 17.82% of the residents between 3000 and 6000 m received higher
342 education. Online media may also be "risk fermenter" (Xie et al., 2011b) and frequently provide
343 possibly asymmetric information to people who are located further away from (and have no
344 obvious contact with) the facility but are indirectly affected by the incident, thus leading to a higher
345 level of perceived risk. Finally, endowment and contrast effects may also explain the situation,
346 because the facility itself has the attribute of a NIMBY, leading the public to have a preconceived
347 stereotypical impression of the facility (Xie et al., 2011a; Wen et al., 2020).

348 Previous studies have found that community engagement can effectively alleviate resident
349 opposition (Achillas et al., 2011; Wu et al., 2018). In China, only residents living within 3000 m
350 of WTE incinerators are involved in the decision process (Liu et al., 2021), and the Jiufeng Plant
351 is no exception. The local government carried out numerous community engagement approaches,
352 such as strengthening transparency and information disclosure, decision-making defense meetings
353 and hearings, a site visit program, and a variety of compensation arrangements (Liu et al., 2019).
354 These alleviated the residents' panic and dissatisfaction, effectively responded to and solved the
355 residents' concerns, and subsequently enabled the project to be implemented smoothly. However,
356 such strong public resistance was not observed in the case of the Jinhua Plant. This indicated that
357 sufficient community engagement may be an important reason for the apparent absence of RE at
358 the Jiufeng Plant. Finally, the level of economic and social development, especially direct
359 economic gains/losses, is an important factor affecting residents' acceptance/opposition (Vyn and
360 Mccullough, 2014; Petrova, 2016). Tourism and Longjing tea are the main sources of livelihood
361 of the residents around the Jiufeng Plant. Therefore, nearby villagers would have considered that
362 the emergence of the incineration plant would directly affect their economic benefits (Liu et al.,
363 2019), which makes the acceptance of residents within 3000 m likely to be the same at the Jiufeng
364 Plant. However, the residents in the Jinhua Plant area did not have such possible economic
365 implications, so the acceptance of WTE incinerator within 3000 m varies with distance.

6 Conclusions

The relationship between spatial distance from a facility and peoples' perception of the facility has attracted much attention in NIMBY infrastructure research. It is an important aspect of this study, given the vital role it plays in alleviating the problem of "garbage siege" in medium- and large-sized cities and in realizing regional sustainable development in China. The primary purpose of this study was to use spatial distance as an explanatory variable and public perception dimensions as dependent variables to verify the relationship between spatial distance and public perception of WTE incineration facilities. This was done by surveying the local residents of the two typical large-scale facilities of Jiufeng and Jinhua, which are representative cities of Zhejiang province in the eastern coastal area. The findings revealed that the perceived risks corresponded with the MZE, while the remaining public perceptions was represented by the RE. Meanwhile, a series of measures taken by the Hangzhou local government could eliminate or alleviate the impact of spatial distance on the public acceptance of NIMBY facilities. Moreover, it is worth noting that the public perception of WTE incinerators in Zhejiang province is still less than ideal.

This study contributes to the body of knowledge on the relationship between public perception and distance in the research on the harmless disposal of MSW, and enriches the application of psychological effects (RE and MZE) in the field of NIMBY (WTE incineration facilities) in the following ways: 1) It is conducive for the government to better understand the psychology of residents near WTE incineration facilities to implement relevant policies and measures, which are of important strategic significance for constructing the social governance pattern of co-construction, co-governance, and sharing; 2) It is beneficial for enterprises to adopt reasonable operation methods and improve their service levels, which can better respond to possible environmental and health risks in the construction and operation of NIMBY facilities, improve public satisfaction, and even promote green and sustainable development; 3) It improves

community engagement, deepening the understanding of WTE facilities, breaking the stereotypes of NIMBY facilities, and easing the opposition of residents.

This study was limited to the WTE incineration projects located in Zhejiang Province. Zhejiang is one of the most economically developed provinces in China. However, there are significant regional differences and imbalances in regional economic and social development in China. Thus, it is not clear if these results can be extrapolated to other provincial administrative regions and cities, given the differences in economic, cultural, and geographical characteristics. While the understanding of differences in public acceptance between Jiufeng and Jinhua is mainly based on relevant literature and is merely speculative, with no conclusive proof. Finally, although this paper discusses the influence of spatial distance on public perception, no consensus has yet been reached on the inherently complex mechanism of this influence. It is currently difficult to establish an appropriate probability model or structural equation model to further analyze its impact. Future research will benefit from addressing these issues and understanding their influence on the public's psychological state.

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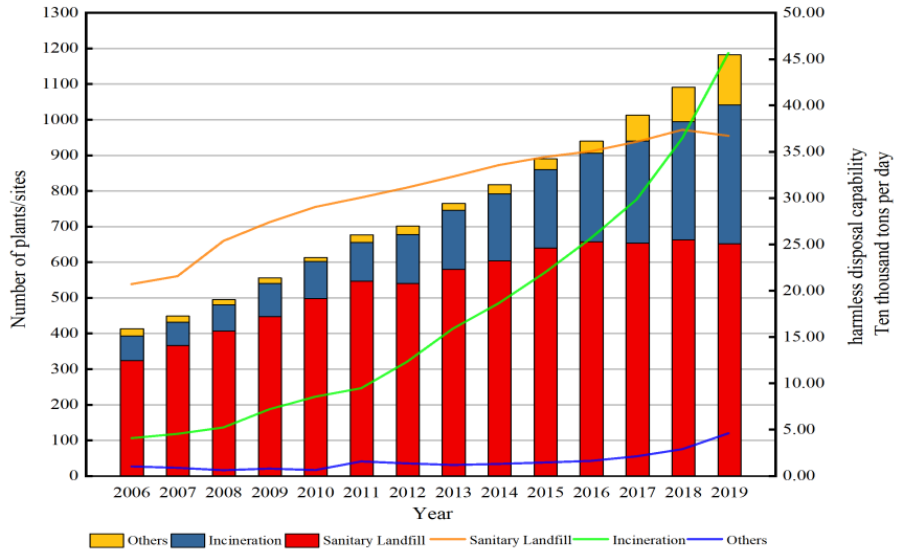

Figure 1. Harmless treated MSW during 2006–2019

(Data Source: Statistical Yearbook of China, 2007-2020)

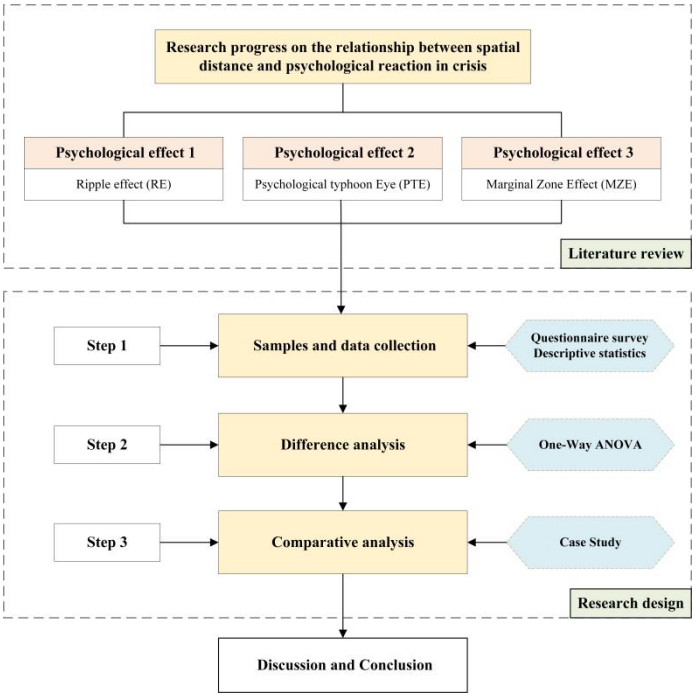

Figure 2. Overall research framework

556 **Table 1.** Questionnaire reliability and validity

Constructs	Items	Cronbach's α	Total variance explained	KMO	Bartlett's test of sphericity
Perceived risk	0.921	0.65	79.33%	0.8689	x^2=2822.66 df =351 Sig.=.000
Perceived economic benefits	0.926				
Perceived justice	0.909				
Public trust	0.939				
Public acceptance	0.913				

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558

559 **Table 2.** Respondents' socio-demographic data (N=573)

Profile	Category	Frequency		
		Jiufeng	Jinhua	Overall
Gender	Male	133(47.50%)	145(49.50%)	278(48.5%)
	Female	147(52.50%)	148(50.50%)	295(51.5%)
Age	18–25	38(13.60%)	20(6.80%)	58(10.1%)
	26–35	45(16.10%)	28(9.60%)	73(12.7%)
	36–44	47(16.80%)	33(11.30%)	80(14.0%)
	45–60	85(30.40%)	86(29.40%)	171(29.8%)
	≥60	65(23.20%)	126(43.00%)	191(33.3%)
Education level	≤Junior high school	121(43.20%)	194(66.20%)	315(55.0%)
	Senior high school	65(23.20%)	50(17.10%)	115(20.1%)
	Junior college	41(14.60%)	27(9.20%)	68(11.9%)
	Undergraduate	42(15.00%)	17(5.80%)	59(10.3%)
	≥Graduate	11(3.90%)	5(1.70%)	16(2.8%)
Distance from WTE incinerator	0–1500 m	42(15.00%)	63(21.50%)	105(18.3%)
	1500–3000 m	141(50.40%)	120(41.00%)	261(45.5%)
	3000–6000 m	47(16.80%)	54(18.40%)	101(17.6%)
	≥6000 m	50(17.90%)	56(19.10%)	106(18.5%)

560

561 **Table 3.** Statistical results of the descriptive variables

Factor	Indicator	Mean	Std. dev
Perceived risk	Q1	3.71	0.983
	Q2	3.67	0.975
	Q3	3.44	0.990
	Q4	3.08	0.933
	Q5	3.34	1.041
	Q6	3.00	0.895
Perceived economic benefits	Q7	2.58	1.079
	Q8	2.52	1.062
	Q9	2.74	1.151
	Q10	2.59	1.006
	Q11	2.82	0.986
Perceived fairness	Q12	2.55	1.008
	Q13	2.02	0.913
	Q14	2.61	0.916
	Q15	2.70	1.003
	Q16	2.77	0.986
	Q17	2.32	1.014
	Q18	2.35	0.970
Perceived trust	Q19	2.88	0.907
	Q20	3.19	0.917
	Q21	2.68	0.904
	Q22	2.69	0.960
	Q23	2.81	1.125
	Q24	3.00	1.032
Public acceptance	Q25	2.83	0.973
	Q26	2.12	0.934
	Q27	2.01	0.899

562

563 **Table 4.** Overall distance difference analysis of each dimension: one-way ANOVA

Construct	Distance from the WTE facilities	Mean	Standard deviation	F	Sig	Multiple comparisons
Perceived risk	⩽1500 m	3.90	0.58	64.262	.000	1>2>3, 1>4>3
	1500–3000 m	3.48	0.66			
	3000–6000 m	2.59	0.79			
	⩾6000 m	3.35	0.80			
Perceived economic benefits	⩽1500 m	2.00	0.54	74.659	.000	4-3>2>1
	1500–3000 m	2.44	0.78			
	3000–6000 m	3.08	0.86			
	⩾6000 m	3.40	0.89			
Perceived fairness	⩽1500 m	2.01	0.61	62.067	.000	4-3>2>1
	1500–3000 m	2.25	0.74			
	3000–6000 m	2.89	0.61			
	⩾6000 m	3.11	0.83			
Perceived trust	⩽1500 m	2.33	0.68	51.599	.000	4-3>2>1
	1500–3000 m	2.71	0.75			
	3000–6000 m	3.29	0.56			
	⩾6000 m	3.42	0.94			
Public acceptance	⩽1500 m	1.90	0.68	36.696	.000	4-3>2>1
	1500–3000 m	2.15	0.75			
	3000–6000 m	2.66	0.64			
	≥6000 m	2.84	1.00			

564 Note: in multiple comparisons: 1, 2, 3, and 4 represent 0–1500 m, 1500–3000 m, 3000–6000 m, and over 6000 m,
565 respectively; “>” indicates that when the confidence interval is 95%, the difference between the data on both sides of
566 the symbol is statistically significant – the value on the left is significantly greater than the right; “-” indicates that
567 when the confidence interval is 95%, the difference between the values on both sides of the symbol is not statistically
568 significant.

569 **Table 5.** Results of distance difference analysis of each dimension for each plant: one-way ANOVA

Construct	Distance from the WTE facilities	Jiufeng				Jinhua			
		M ± SD	F	sig	Multiple comparisons	M ± SD	F	sig	Multiple comparisons
Perceived risk	≤1500 m	3.97±0.42	34.601	.000	1>2>3, 1>4>3	3.86±0.67	32.610	.000	1>2>3, 1>4>3
	1500–3000 m	3.61±0.57				3.32±0.73			
	3000–6000 m	2.67±0.82				2.51±0.77			
	≥6000 m	3.47±0.78				3.25±0.81			
Perceived economic benefits	≤1500 m	2.31±0.39	24.214	.000	4-3>2>1	1.78±0.52	55.687	.000	4>3>2>1
	1500–3000 m	2.61±0.73				2.23±0.78			
	3000–6000 m	3.25±0.83				2.94±0.87			
	≥6000 m	3.31±0.77				3.48±0.98			
Perceived fairness	≤1500 m	1.84±0.35	47.118	.000	4-3>2>1	2.11±0.71	23.192	.000	4>3>2>1
	1500–3000 m	2.13±0.75				2.40±0.71			
	3000–6000 m	3.07±0.51				2.73±0.65			
	≥6000 m	3.05±0.81				3.16±0.86			
Perceived trust	≤1500 m	2.11±0.31	30.294	.000	4-3>2>1	2.49±0.80	25.405	.000	4-3>2>1
	1500–3000 m	2.53±0.73				2.92±0.72			
	3000–6000 m	3.20±0.56				3.38±0.55			
	≥6000 m	3.23±0.93				3.58±0.93			
Public acceptance	≤1500 m	1.87±0.50	17.138	.000	4-3>2-1	1.92±0.78	20.312	.000	4-3>2>1
	1500–3000 m	2.07±0.75				2.24±0.75			
	3000–6000 m	2.67±0.66				2.64±0.63			
	≥6000 m	2.71±1.01				2.95±0.99			

570 Note: As **Table 4** note.