Effects of economic compensation on public acceptance of waste-to-energy incineration projects: an attribution theory perspective

Yong Liu\textsuperscript{a}\ast, Caiyun Cui\textsuperscript{b}, Chunqin Zhang\textsuperscript{a}, Bo Xia\textsuperscript{c,d}, Qing Chen\textsuperscript{e} and Martin Skitmore\textsuperscript{c}

\textsuperscript{a}School of Civil Engineering and Architecture, Zhejiang Sci-Tech University, Hangzhou, P.R. China; \textsuperscript{b}School of Civil Engineering and Architecture, North China Institute of Science and Technology, Langfang, P.R. China; \textsuperscript{c}School of Civil Engineering and Built Environment, Queensland University of Technology (QUT), Brisbane, Australia; \textsuperscript{d}College of Civil Engineering, Hefei University of Technology, Hefei, P.R. China

\textsuperscript{\ast}Corresponding author. Email: jhly1007@zstu.edu.cn

(Received 27 March 2020; revised 18 August 2020; final version received 21 September 2020)

Economic compensation has been documented in many studies globally as an important strategy for enhancing acceptance by local residents of potentially hazardous facilities. Based on attribution theory, the present study investigates the situation for Waste-to-Energy (WTE) incineration plants using a questionnaire survey conducted with adjacent residents to four selected WTE incineration plants located in the Yangtze River Delta region, China. The results indicate that economic compensation effectively improves residents' acceptance by being positively associated with their perceived economic benefit and trust in the local government, but is negatively associated with their perceived risks. Of these, trust plays the most vital role. The findings contribute to the literature on decision-making of locally unwanted land use siting in China by understanding the effects of economic compensation on local resident acceptance; and is of great significance for other countries involved in establishing sustainable municipal solid waste disposal systems of their own.

\textbf{Keywords:} waste-to-energy incineration; economic compensation; public acceptance; attribution theory; locally unwanted land use

1. \textbf{Introduction}

Waste-to-energy (WTE) incineration provides an effective and sustainable solution for countries with a sharply increasing amount of Municipal Solid Waste (MSW) driven by economic growth and constantly improving living standards, taking advantage of energy recovery, greenhouse gas (GHG) emission mitigation, and resource savings (Wang \textit{et al.} 2017; Ayodele, Ogunjuyigbe, and Alao 2017; Chen 2018). Thus, WTE incineration has achieved rapid development in recent decades, contributing greatly to the sustainable goal of a regional circular economy and global urban development (Haraguchi, Siddiqi, and Narayananamurti 2019). In 2014, more than 800 WTE incinerators were operating in nearly 40 countries around the world (Tan \textit{et al.} 2015), disposing of 74\% of MSW in Japan, 54\% in Denmark, and 50\% in Switzerland and Sweden (The World Bank 2012). In China, approximately 84.63 million tonnes of MSW (40.20\%) were disposed of in this

\*Corresponding author. Email: jhly1007@zstu.edu.cn

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way in 286 plants in 2017, from which approximately 23.7 TWh of sustainable power was generated (National Bureau of Statistics of China 2018).

Even though the scientific and rational nature of WTE incineration has been fully demonstrated, it has faced considerable opposition from the local communities most affected (Achillas et al. 2011; Baxter et al. 2016). As a locally unwanted land use (LULU) facility, a WTE incinerator, which is essential for a sustainable MSW disposal system, has a potentially negative impact on the environment for local residents and their health from environmental pollution and property losses (Schively 2007). In recent decades, WTE incineration has become a controversial issue, with a history of opposition from local residents and environmental groups (Davies 2006), with anti-incinerator campaigns in many countries/regions including North America (Rootes and Leonard 2009; Baxter et al. 2016), Europe (Davies 2006, 2008), and Asia (Lang and Xu 2013). In China, strong public resistance from local communities has resulted in the failure of many WTE incineration projects. Moreover, far from being technical or environmental problems, anti-incinerator campaigns have now evolved into sensitive social issues that may affect social stability in China (Song, Sun, and Jin 2017).

Previous studies indicate that local residents’ acceptance of LULU facilities is influenced by their perceived economic benefits/risks, public trust in the local government, etc. (Slovic, Flynn, and Layman 1991; Siegrist, Cvetkovich, and Roth 2000), and may be encouraged by such strategies as public engagement (Liu, Liao, and Mei 2018; Zheng and Liu 2018), economic compensation, and risk communication (Bacow and Milkey 1982; Siegrist, Cvetkovich, and Roth 2000). Of these, economic compensation is shown by the economic analysis framework to be a reasonable and effective way of enhancing local residents’ acceptance of a LULU siting (Lesbirel and Shaw 2005). Practical experiences gained from the provision of nuclear (Chung and Kim 2009) and waste treatment facilities (Wolsink 2010) stress economic compensation as an important solution to LULU siting conflicts (Gregory et al. 1991).

However, while it is clearly important to fully understand how economic compensation enhances local residents’ acceptance of WTE incinerators, the studies conducted to date are far from complete. Although many indicate that economic compensation is able to improve public acceptance of LULU siting significantly (Chung and Kim 2009; Kunreuther, Fitzgerald, and Aarts 1993; Siskind and Susskind 1989), others have not found any definite causal relationship (Frey, Oberholzer-Gee, and Eichenberger 1996; Frey and Oberholzer-Gee 1997; Jenkins-Smith and Kunreuther 2001). Meanwhile, although the unified analytical framework of public acceptance of nuclear power has appeared intensively in the literature (Mercado-Sáez, Marco-Crespo, and Álvarez-Villa 2018; Du and Zhu 2019), no study has been conducted from the perspective of attribution theory, which provides a viable and classic analytical framework for understanding what drives people to make risky decisions. Moreover, excepting Chiou, Lee, and Fung’s (2011) identification of the key variables of negotiated compensation in Taiwan, no studies focus on the effects of economic compensation on public acceptance of LULU siting in the Chinese context.

Based on a longitudinal study conducted to investigate the mechanism behind the public opposition toward the WTE incineration facilities in an anti-incineration campaign that occurred in the siting of an incinerator (Liu et al. 2019), Liu et al. (2018) initiated an empirical study to investigate the impact of community engagement on public acceptance through the perceived risk/trust of local residents. Following Liu et al.’s (2018) research framework, this study adopts attribution theory as its theoretical base in carrying out a
questionnaire survey with residents adjacent to four selected WTE incineration plants located in China’s Yangtze River Delta region to understand how economic compensation affects public acceptance of WTE incineration projects, and the roles local residents’ perception played, by using structural equation modeling (SEM) and one-way ANOVA. The findings contribute to the current body of knowledge concerning LULU siting in understanding the effects of economic compensation on the local residents’ acceptance in the Chinese context, and provide a useful reference for other countries involved in establishing their own sustainable municipal solid waste disposal systems.

2. Literature review and theoretical framework

2.1. Attribution theory

The factors affecting individual decision-making under an uncertain environment have been the subject of studies across various fields in the literature, inspiring a variety of theoretical analysis frameworks (e.g. prospect theory and attribution theory) in recent decades (Healey, Vuori, and Hodgkinson 2015; Powell, Lovallo, and Fox 2011). Of these, attribution theory, firstly established by Heider (1958) and systematically developed by Kelley (1967) and Weiner (1979), provides a viable analytical framework for understanding what drives people to make risky decisions.

Attribution theory holds that “individuals concoct common sense explanations of the world in order to make sense of, predict, and control events” (Heider 1958), and “the locus of causality for the behavior or event is the person (internal) or the environment (external), or both” (Hewett et al. 2018, 89), and thus the actions or events the individuals’ perceive affect the perceiver’s next responses and actions (Weiner 2008). Meanwhile, the attributions individuals perceive may change with time according to the conditions involved, because people consider the reasons for their behavior or actions after the event (Weiner 1979; Weiner, Heckhausen, and Meyer 1972).

According to attribution theory, both environmental factors and personal characteristics can affect individual risk behavior directly or indirectly (Hewett et al. 2018), the former referring to multiple contingent outcomes with an uncertain/risky probability distribution, while the latter can be divided into two dimensions of cognitive attribution and affective attribution. Cognition, which is frequently posited to affect individual risky behavior and recognized as one of the most critical factors in understanding risky choices, lies in the processing of mental content driven by appraisals of self, others, and the environment (Bazerman and Moore 2008; Hodgkinson and Healey 2008). Affective behavior, on the other hand, refers to the conscious and unconscious processing of emotions and feelings and has been identified as a vital component shaping individual risk behavior (Zajonc 1980). Specifically, individual cognitive sources of risk attitudes, or positive and negative emotions, have an impact on individual risky decision-making, and environmental (contextual) factors influence an individual’s risk behavior through the individual’s cognitive and affective state (Hönl, Meissner, and Wulf 2017).

2.2. Factors affecting public acceptance of WTE incinerators

In recent decades, along with the rising anti-LULU movement, studies relating to the factors affecting the public acceptance of such LULU facilities as nuclear facilities, waste treatment plants, and high voltage substations have become increasingly intensive (Larock and Baxter 2013; Liu et al. 2018). These indicate that a variety of critical
factors are involved, such as perceived economic benefits/risks, public trust, perceived justice/fairness, and even competition (Gross 2007; Kunreuther, Fitzgerald, and Aarts 1993; Achillas et al. 2012).

For WTE incineration projects, perceived economic benefits/risks and public trust have a direct effect (Portney 1984; Davies 2006; Achillas et al. 2011), and perceived environmental justice/fairness has a critical impact (Rootes and Leonard 2009; Wester-Herber 2004; Wolsink 2010). In addition, competition (Kunreuther, Fitzgerald, and Aarts 1993; Chung and Kim 2009), different values (Baxter et al. 2016), and even other demographic characteristics such as gender and age (Ren et al. 2016; Liu et al. 2018), are also acknowledged as key factors.

2.3. The role of economic compensation

Along with the rising anti-LULU movement against various potentially hazardous facilities, studies of strategies that may enhance their public acceptance have been made continuously by both practitioners and academics. Generally, economic compensation, public engagement, Environmental Impact Assessments (EIA), and transparency are all emphasized as being possible approaches (Chung and Kim 2009; Johnson 2013; Liu et al. 2019). Both academics and practitioners stress that economic compensation – an effective and direct way to make up for the potentially hazardous risks that local communities may suffer – should be adopted as effective strategies to improve public acceptance of LULU facilities (Siskind and Susskind 1989; Sjöberg and Drottz-Sjöberg 2001; Chiu, Lee, and Fung 2011).

The rationality of using economic compensation has been shown within an economic analysis framework (Lesbirel and Shaw 2005), in that residents will tend to accept potentially hazardous facilities when it is sufficient to compensate for the potential losses involved (Chung and Kim 2009). This appears to have the empirical support of a study of the public acceptance of a radioactive waste depository plant in Switzerland, for instance, revealing a U-shaped curve of public acceptance dropping at first, then stabilizing, and then rising as the amount of compensation offered increased (Frey, Oberholzer-Gee, and Eichenberger 1996; Frey and Oberholzer-Gee 1997). Similarly, with Ren et al.’s (2016) waste incinerator study found that residents in closer proximity, and therefore placed in a more hazardous situation, tend to be less influenced by economic compensation offered.

However, others point to the paucity of empirical evidence of a causal relationship between public acceptance of LULU facilities and economic compensation, holding such acceptance to be a result of multiple economic, social, and psychological factors (Sjöberg and Drottz-Sjöberg 2001; Kunreuther, Fitzgerald, and Aarts 1993). Moreover, contemporary studies also show that economic compensation does not always result in public acceptance, especially in a high-risk LULU siting (Kunreuther, Fitzgerald, and Aarts 1993; Li, Liu, and Li 2012; Jørgensen, Anker, and Lassen 2020), where economic compensation may be considered as a bribe and thus trigger increased resistance (Sjöberg 2009; Jenkins-Smith and Kunreuther 2001).

2.4. Theoretical framework

The current study argues that the formation of acceptance toward WTE incineration projects is a risky decision-making process carried out by individuals from local
communities. With WTE incinerator siting, there are two options for local communities: accept or reject. Thus, the risk behavior of local residents can be fully dominated by acceptance. Following the attribution theory framework and literature review above, the theoretical framework of the current study is established (see Figure 1).

Specifically, economic compensation, which aims to compensate the potential losses of local communities and may thus have an impact on multiple contingent outcomes, significantly changes the environment of risky decision-making during WTE incinerator siting. Meanwhile, perceived economic benefits/risks, as well as trust in the local government, are identified as being associated with acceptance by the public of WTE incineration projects.

3. Research hypotheses

Following the theoretical framework constructed above, the research hypotheses of the current study were presented below.

3.1. Economic compensation, perceived economic benefit, and public acceptance

Perceived economic benefit is believed to be able to boost public acceptance and to be considered a critical factor affecting the public acceptance of LULU facilities. A study related to the siting of environmental protection facilities in Japan, for instance, indicated that the stronger the local residents perceive the future economic benefit to be, the greater their public acceptance of the LULU facilities (Tokushige, Akimoto, and Tomoda 2007). Previous experience of siting nuclear power facilities is that low acceptance from local communities is mainly due to the potential loss of tourism income (Slovic, Flynn, and Layman 1991), which might be effectively improved by promised economic benefits and job opportunities (Chung and Kim 2009). Similarly, perceived potential benefits have been found to be the key motivation for lay people to accept marble quarrying activity (Pelekasi, Menegaki, and Damigos 2012).

Meanwhile, according to the benefit-cost analysis framework of economics, the negative externalities of LULU facilities lead to an unbalanced distribution between the costs and benefits to the local communities (Schively 2007). When the potential benefits derived from LULU facilities cannot compensate for the potential losses to the local communities, appropriate economic compensation is essential to improve their perceived economic benefit (Garrone and Groppi 2012). Studies of the MSW disposal and wind power industries have shown that economic compensation is able to ease local residents’ perceived economic benefit effectively and thus significantly improve public acceptance (Bacot, Bowen, and Fitzgerald 1994; Baxter, Morzaria, and Hirsch 2013).

Consequently, the following hypotheses are proposed:
**H1a:** Economic compensation has a positive influence on the local residents’ perceived economic benefit of WTE incineration projects.

**H2a:** The perceived economic benefit has a positive influence on public acceptance of WTE incineration projects.

### 3.2. Economic compensation, public trust, and public acceptance

The local residents’ trust in the local government is considered the key determinant for the public acceptance of LULU facilities. Trust is the willingness to rely on authorities who are responsible for decision-making and action-taking of technical management and policy implementation (Siegrist 2000). Normally, non-professional individuals have difficulty in acquiring knowledge about LULU facilities, and many determine their level of acceptance by trusting the opinions of governments, professional authorities, and relevant experts (Siegrist 2000; Sjöberg 2009). Previous studies of the nuclear, MSW disposal, and chemical industries have shown that higher public trust leads to higher public acceptance of LULU facilities (Mah, Hills, and Tao 2014; Liu et al. 2018; Hou et al. 2019).

In market transactions, economic compensation is an effective way to rebuild trust (Lewicki, Wiethoff, and Tomlinson 2005; Ren and Gray 2009) and is able to effectively restore public trust undermined by the disproportionate distribution of benefits (De Cremer 2010). It is therefore clear that economic compensation can enhance local residents’ trust in the local government in relation to LULU facilities.

Consequently, the following hypotheses are proposed:

**H1b:** Economic compensation has a positive influence on local residents’ trust in the local government related to WTE incineration projects.

**H2b:** Public trust perception has a positive influence on public acceptance of WTE incineration projects.

### 3.3. Economic compensation, perceived risks, and public acceptance

Perceived risk is a fundamental factor shaping public attitudes (Slovic, Flynn, and Layman 1991), and the public usually prefers to choose a lower perceived risk option when making decisions (Weber and Milliman 1997). The perceived risk of individuals is affected by their own experience, cultural characteristics, knowledge, and values, and may be different between professionals and laypeople (Siegrist and Cvetkovich 2000). Evidence from studies conducted in such LULU facilities as nuclear power stations, MSW disposal plants, and water treatment projects shows a higher perceived risk to be associated with a lower public acceptance of a LULU siting (Chung and Kim 2009; Ross, Fielding, and Louis 2014).

It has been shown that economic compensation can relieve the level of perceived risks of local residents (Chung and Kim 2009). The public may perceive a lower risk if economic compensation can meet their demands and will tend to accept the LULU facilities accordingly. A survey conducted by Visschers, Keller, and Siegrist (2011) reveals that economic compensation offered by the local government (e.g. cutting energy expenses and offering job opportunities) effectively lowers the local communities’ perceived nuclear facilities’ siting risks in Switzerland.
Consequently, the following hypotheses are proposed:

**H1c:** Economic compensation has a negative influence on local residents’ perceived risks of WTE incineration projects.

**H2c:** Public acceptance of WTE incineration projects is negatively influenced by perceived risk.

### 3.4. Perceived economic benefit and public trust

Public trust is described as local residents’ attitude as to whether the government has directly or indirectly disclosed accurate risk information, and may be reflected in the public’s trust in the government’s intentions and ability to deal with certain events (Afullo 2015). Previous studies of the healthcare and chemical industries have shown that an enhanced perceived economic benefit may help increase public trust (Siegrist 2000; Hou et al. 2019). Likewise, the same conclusions have been drawn from the e-commerce industry (Xu et al. 2015).

Thus, the following hypothesis is proposed:

**H3:** Perceived economic benefit has a positive effect on public trust in the local government related to WTE incineration projects.

### 3.5. Public trust and perceived risks

Quite how the uninformed public perceives the risks associated with a LULU facility depends on its trust in the local government (Liu et al. 2018). Ross, Fielding, and Louis (2014) point out in a study of wastewater recycling initiatives that an increase in public trust may enhance its sense of identity in the local government, and then reduce the risks perceived toward LULU facilities. In environment-related (e.g. wastewater treatment, nuclear facilities, wind power plants) decision-making, numerous studies indicate that public trust in the local government can effectively mitigate the perceived risks associated with potentially hazardous facilities or other similar risks (Johnson and Scicchitano 2000; Hou et al. 2019).

Thus, the following hypothesis is proposed:

**H4:** Public trust in the local government has a negative effect on the perceived risks of WTE incineration projects.

Based on the hypotheses raised above, the present study proposes a conceptual model to integrate the hypothesized relationship between economic compensation, perceived economic benefits/risks, public trust, and public acceptance, as shown in Figure 2.

### 4. Research design

#### 4.1. Research methods

This study follows the hypothesis-testing paradigm and employs a combination of methods including literature analysis, questionnaire survey, and Structural Equation Model (SEM) analysis. SEM, regarded as an extension of standard regression modeling, makes it possible to estimate several correlated paths simultaneously and is widely
employed in extensive research fields (Xiong, Skitmore, and Xia 2015). This study combines SEM analysis and questionnaire data to understand the effects of economic compensation on the public acceptance of the siting of WTE incineration projects. A single factor Analysis of Variance (ANOVA) is adopted to further explore the differences in public acceptance between the four cases, and a comparative analysis between surveyed data and practical materials is further conducted to elucidate the possible reasons involved. The overall research framework is as follows:

1. The conceptual model is established from literature review, the proposed research hypotheses, as well as corresponding measurement scales for data collection.
2. An extensive questionnaire survey was conducted for a typical WTE incineration plant project located in four central cities (Shanghai, Hangzhou, Nanjing, and Ningbo) in the Yangtze River Delta region. SEM is applied to assess and verify the relationships between the economic compensation, perceived economic benefits, perceived risks, public trust, and public acceptance of the WTE incineration plants.
3. The differences in public acceptance of the projects are examined by a one-way ANOVA, and the economic compensation policies adopted for the projects with significant differences in public acceptance are further summarized by desk research of the documents involved (e.g. compensation agreement), collected from the websites of local governments or provided by community directors and survey respondents. A comparative analysis of economic compensation received by local communities is then conducted to help understand the possible reasons for the public acceptance differences.

4.2. Variable measurement

The questionnaire designed for the study (see Appendix A [online supplemental material]) is comprised of two parts. The first is used to elicit the socio-demographic characteristics of respondents, including gender, age, education level, and distance from the plant. The second part is designed to measure the respondents’ attitude. Five constructs are assessed in the survey. These are the respondents’

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Figure 2. Conceptual model of the hypothesized relationships.
1. assessment of the actual economic compensation, measured by a variety of variables comprising cash compensation, housing relocation, surrounding infrastructure improvement, social security system enhancement, and job opportunities, offerings commonly used in China

2. perceived economic benefits (measured by five items) and perceived risks (measured by six items) of the projects, level of trust in the local government (six items), and acceptance of siting of WTE incineration projects (three items) drawn from the literature, as shown in Table 1.

All the target respondents were required to rate their degree of agreement with statements using a 5-point Likert scale where 1 = extremely disagree, and 5 = extremely agree. To ensure the reliability and validity of the scale used to assess the actual economic compensation level offered to the local communities, a pilot study was conducted with residents adjacent to Hangzhou’s Jiufeng WTE incineration plant. Among 100 questionnaires distributed, 86 valid ones were returned. The results of the Cronbach reliability analysis and Exploratory Factor Analysis (EFA) validity test are provided in Table 2, indicating that the questionnaire designed is good in terms of reliability and structural validity.

4.3. Samples and data collection

Since Shenzhen built the first WTE incineration plant in 1987, central and local governments in China have promulgated a series of policies and regulations to facilitate the development of the WTE incineration industry. In the Yangtze River Delta – comprising four provinces and considered the country’s most densely populated and economically developed region – the governments at diverse levels have vigorously adopted WTE technologies to achieve the goal of 100% harmless treatment rate of MSW raised by the 13th Five-year Plan on National Facility Construction of MSW Harmless Disposal. At the end of 2017, 96 of the 286 WTE incineration plants being operated in China were located in this region. However, many WTE incinerators have failed due to strong public opposition or have been heavily affected by endless complaints from local communities. The four incineration plants selected are 4 typical plants located in the Yangtze River Delta, namely the Shanghai Tianma MSW Incineration Plant (operated in 2016 and with a capacity of 2,000 tons/d), Hangzhou Jiufeng MSW Incineration Plant (operated in 2017 and with a capacity of 3,000 tons/d), Nanjing Jiangbei MSW Incineration Plant (operated in 2015 and with a capacity of 2,000 tons/d), and Ningbo Mingzhou MSW Incineration Plant (operated in 2017 and with a capacity of 2,250 tons/d). The reason for choosing these four plants is that all were typical in terms of incineration technology, capacity, and geographical distribution (all plants are close to residential communities), and were constructed and operated at the rising stage of the anti-incineration campaign in China. All four selected cases were subjected to strong protests from the local communities, and public opposition to the Jiufeng Plant eventually escalated to a mass incident, where a fierce conflict between the government and local residents occurred.

In relation to the survey area, Ren et al. (2016) found that residents living further than 3 km away from the incinerator are unlikely to be engaged in these issues, although Liu et al. (2018) argues that residents living further than 10 km away may also be affected by the LULU siting. After considering such factors as population
distribution, sample size, and administrative division, the final survey areas were set within 5 km of the selected plants. Due to a large-scale housing relocation plan having been implemented during the siting process for the Jiangbei Plant and almost all local residents living within 1.0 km having migrated to a new residential community 5 kilometers away from the plant, migrated residents were also considered to be within the scope of the survey area.

The questionnaire survey was conducted from 10 May to 25 June 2018. A stratified random sampling process was employed to select the respondents. First, each

| Construct | Items | Literature |
|-----------|-------|------------|
| Economic compensation | Cash compensation 0.739 | Liu et al. (2018) |
| Housing relocation 0.741 |
| Surrounding infrastructure improvement 0.747 |
| Social security system enhancement 0.729 |
| Job opportunities offered 0.744 |
| Perceived economic benefits | S6: Community image 0.739 | Slovic, Flynn, and Layman 1991; Chung and Kim 2009 |
| S7: Real estate values 0.741 |
| S8: Job opportunities 0.747 |
| S9: Infrastructure system 0.747 |
| S9: Residents’ income 0.747 |
| Perceived risk | S5: Health risk 0.741 | Liu et al. (2018) |
| S6: Environmental risk 0.747 |
| S7: Economic benefit risk 0.747 |
| S8: Social reputation risk 0.747 |
| S9: Damage to traditional culture or style 0.747 |
| S10: Negative psychological effects 0.747 |
| Public Trust | S11: Fair procedures 0.741 | Liu et al. (2018) |
| S12: WTE technologies 0.747 |
| S13: Environmental impact assessment 0.747 |
| S14: Scientists and experts 0.747 |
| S15: WTE related enterprises 0.747 |
| S16: Local governments 0.747 |
| Public Acceptance | F1: Psychological acceptance 0.741 | Liu et al. (2018) |
| F2: Accept in practice 0.744 |
survey area was divided into residential communities or villages based on their location and administrative divisions. Then, considering their population and distance from the WTE projects, households living in these communities or villages were randomly selected as target respondents by systematic sampling. Finally, the selected target households were invited to complete the questionnaire face-to-face.

From the 500 questionnaires (125 in each survey area) dispatched, 386 valid responses were returned, comprising 91, 102, 96, and 97 from the Tianma Plant, Jiangbei Plant, Jiufeng Plant, and Mingzhou Plant, respectively. The high response rate (77.2%) is mainly attributed to similar social surveys having a similar high response rate (e.g. Ren et al. 2016) and that the face-to-face survey method used helps to ensure the majority of responses are recovered promptly and validly.

Table 3 contains the respondents’ socio-demographic data. This shows that both the gender and age distribution of the respondents, are substantially consistent with the overall populations of the local communities. In terms of education level, only 14.5% of the respondents have a college or higher degree, which is lower than the urban residents of the four cities (an average of 22.0% according to data from the 2010 6th National population census data Gazette). However, the WTE incinerators are usually located in urban-rural areas or even rural areas, where the education level of residents is significantly lower than that of urban residents. Thus, it is reasonable to conclude that the respondents’ socio-demographics are comparable with those of the local communities. No respondents came from communities or villages within 1,000 m of the Mingzhou Plant because it is located on a mountainside with almost no residents living within this distance.

4.4. Data process

The surveyed data was then processed in three steps. First, a descriptive statistical analysis was conducted to assess the perceived economic benefits/risks, public trust, and

| Profile | Category | Frequency |
|---------|----------|-----------|
| Gender | Male | 204 (52.8%) | 56 (61.5%) | 44 (43.1%) | 55 (57.3%) | 49 (50.5%) |
| | Female | 182 (47.2%) | 35 (38.5%) | 58 (56.9%) | 41 (42.7%) | 48 (49.5%) |
| Age | 18–25 | 29 (7.5%) | 2 (2.2%) | 9 (8.8%) | 7 (7.3%) | 11 (11.3%) |
| | 26–35 | 71 (18.4%) | 13 (14.3%) | 20 (19.6%) | 17 (17.7%) | 21 (21.6%) |
| | 36–45 | 89 (23.1%) | 25 (27.5%) | 21 (20.6%) | 16 (16.7%) | 27 (27.8%) |
| | 46–60 | 114 (29.5%) | 37 (40.7%) | 28 (27.5%) | 27 (28.1%) | 22 (22.7%) |
| | 60+ | 83 (21.5%) | 14 (15.4%) | 24 (23.5%) | 29 (30.2%) | 16 (16.5%) |
| Education level | ≤Junior high school | 216 (56.0%) | 64 (70.3%) | 55 (53.9%) | 42 (43.8%) | 55 (56.7%) |
| | Senior high school | 114 (29.5%) | 22 (24.2%) | 35 (34.3%) | 33 (34.4%) | 24 (24.7%) |
| | Junior college | 44 (11.4%) | 4 (4.4%) | 11 (10.8%) | 17 (17.7%) | 12 (12.4%) |
| | Undergraduate | 9 (2.3%) | 1 (1.1%) | 1 (1.0%) | 3 (3.1%) | 4 (4.1%) |
| | ≥Graduate | 3 (0.8%) | 0 (0.0%) | 0 (0.0%) | 1 (1.0%) | 2 (2.1%) |
| Distance from the WTE incinerator | ≤500 m | 14 (3.6%) | 4 (4.4%) | 0 (0.0%) | 10 (10.4%) | 0 (0.0%) |
| | 500–1000 m | 56 (14.5%) | 4 (4.4%) | 28 (27.5%) | 24 (25.0%) | 0 (0.0%) |
| | 1000–2000 m | 158 (40.9%) | 34 (37.4%) | 47 (46.1%) | 25 (26.0%) | 52 (53.6%) |
| | 2000–3000 m | 135 (35.0%) | 49 (53.8%) | 18 (17.6%) | 34 (35.4%) | 34 (35.1%) |
| | ≥3000 m | 23 (6.0%) | 0 (0.0%) | 9 (8.8%) | 3 (3.1%) | 11 (11.3%) |
public acceptance of WTE incineration projects. Then, SEM, widely used in social studies, was employed to empirically test the hypothesized relationships. Finally, an ANOVA analysis was used to explore whether there are differences in public acceptance between the projects, and the effect of different economic compensation policies on public acceptance was further investigated by a comparative study of the policies adopted when the difference was significant.

5. Results

5.1. Descriptive statistics

The descriptive statistics for the scaled variables was first conducted. Due to the frequently occurring anti-incinerator campaigns, it is not unexpected that the means of the three indicators used to evaluate the public acceptance of WTE incinerators are 1.67, 1.64, and 1.67, respectively, indicating the responses range between “disagreement” and “extreme disagreement” over the acceptance of an incinerator sited near the community. The mean agreement levels of the perceived economic benefits, perceived risks, and public trust are 1.99 ~ 2.25, 3.61 ~ 3.65, and 2.13 ~ 2.40 respectively, indicating that the respondents perceive the risks to be more important than the economic benefits, and with a low level of trust in the local government. The mean of economic compensation is approximately 3.0 (ranging from 2.89 to 3.11), suggesting that the respondents fail to be strongly motivated by this. Unsurprisingly, the most commonly used cash compensation and house relocation have the highest value (3.04 and 3.11, respectively), while the least commonly used compensation measures, i.e. offering job opportunities, obtained the lowest value (2.89) because the WTE industry is highly professional and cannot significantly boost the local job market. The descriptive analysis also shows that the coefficients of skewness and kurtosis are lower than 2.0 for all the variables, indicating that the data generally meet the requirements of the Multivariate Normality hypothesis and are therefore valid for SEM with Maximum Likelihood Estimation (MLE).

5.2. Structural equation model

SEM normally requires sample sizes of at least 200–500 observations (Schumacker and Lomax 1996) and therefore the 386 valid responses are sufficient. The MLE approach in SEM is applied to conduct a confirmatory factor analysis of the constructs in the hypothetical model. Fit indices, including the root mean square error of approximation (RMSEA), root mean square residual (RMR), goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), normed fit index (NFI), comparative fit index (CFI), Tucker–Lewis Index (TLI), and their recommended values drawn from Xiong, Skitmore, and Xia (2015) are adopted to evaluate the goodness-of-fit of the SEM model.

Table 4 provides the model fit indices of the SEM analysis. It can be concluded that except $\chi^2$ significance ($P$) and GFI, all model fit indices met the predetermined requirements. However, the $P$ and GFI are very close, while the $p$ is very sensitive with large sample sizes (Xiong, Skitmore, and Xia 2015). The index $\chi^2/d.f.$ is usually employed to assess the model fit when the observed sample size is large, with values less than 2.0 indicating a good fit (Xiong, Skitmore, and Xia 2015). Thus, it is
concluded that the overall indices indicate a sufficient fit between the hypothesized model and the data.

Figure 3 shows the hypothesized SEM model with assessment of standardized path loadings and significance levels. All the hypothesized relationships are empirically verified at the 1% significance level or better.

5.3. Differences in acceptances

The single-factor ANOVA results indicate that three indicators of public acceptance differences between respondents of the Jiangbei and the Tianma Plants are significant at the 5% level, with that of the former being significantly higher than the latter. The results are shown in Figure 4.

A comprehensive analysis of the economic compensation measurements the two plants adopted based on materials collected from government websites or questionnaire survey identified the following details:

(1) The Jiangbei Plant: a package of economic compensation policies was promulgated by the local communities. First, the local residents were relocated to new housing (of an equivalent area to their original) located in Xingxun County, which is 5 km away from the plant. This was generally to property of the same area as their original housing, with any area exceeding this being purchased at a discount price of CNY 3,500/m² (approximately USD 540/m²). Second, an opportunity for residents with rural hukou to register as urban hukou-holders was provided as compensation, meaning that all local residents affected by the Plant joined the same social security system as the unaffected urban residents. Moreover, the operators of the Plant promised to offer job opportunities to the local communities over the next few decades.

(2) The Tianma Plant: This is located at the boundary of the Songjiang and Qingpu administrative districts. A small number of local residents from the Songjiang District were compensated by an economic package comprising housing relocation and cash. However, except for job opportunities promised by the plant operators, most local residents from the Qingpu District did not receive any economic compensation.

Clearly, the level of public acceptance is highly dependent on the economic compensation provided, with the Jiangbei Plant’s multiple compensated local communities having a relatively higher degree of acceptance than the Tianma Plant’s less economically compensated communities.

Table 4. Model fit indices (N = 386).

| Statistic | Recommended value | Obtained value |
|-----------|-------------------|----------------|
| $\chi^2$  | –                 | 559.902        |
| df.       | –                 | 267            |
| $p$       | > 0.05            | 0.000          |
| $\chi^2$/df. | < 3.0          | 2.097          |
| RMR       | < 0.08            | 0.080          |
| RESEA     | < 0.08            | 0.053          |
| GFI       | > 0.90            | 0.897          |
| AGFI      | > 0.80            | 0.875          |
| CFI       | > 0.90            | 0.913          |
| NFI       | > 0.80            | 0.848          |
| TLI       | > 0.90            | 0.903          |
6. Discussion

The results show that economic compensation has a salient effect on perceived economic benefits, perceived risks, and public trust, and ultimately has an indirect influence on local residents’ acceptance of WTE incineration projects, which is consistent with such previous studies as Chung and Kim (2009) and Visschers, Keller, and Siegrist (2011). Reducing the perceived risks and compensating the potential losses of local residents are considered two effective approaches for enhancing the local communities’ acceptance of LULU siting (Gregory et al. 1991). This has been verified both theoretically by the economic analysis framework (Lesbirel and Shaw 2005) and from practical evidence from such LULU facilities as nuclear facilities (Chung and Kim 2009), the MSW disposal industry (Wolsink 2010), and even marble quarrying activity (Pelekasi, Menegaki, and Damigos 2012).

In terms of how economic compensation influences public acceptance, the empirical evidence shows that this occurs through multiple paths. On the one hand, economic compensation has a positive effect on acceptance via perceived economic benefits because it can reimburse the potential losses involved. On the other hand, it has a positive effect through its direct or indirect influence on public trust and perceived risks. Although the direct impact on trust is relatively small (0.182, $P<0.01$), it can still be concluded that economic compensation plays the most critical role because public acceptance is heavily affected by public trust (0.483, $P<0.001$) and economic compensation may also have an indirect impact on public trust through perceived economic benefit. The diminishing credibility of local governments concerning environmental issues and the frequent LULU conflicts in China highlights the importance of public trust (Tan and Hu 2013). Hence, in addition to economic compensation, such other strategies as community engagement and transparency need to be adopted by local governments in LULU siting to promote public trust (Liu et al. 2019).

Economic compensation can be direct or indirect (Bacow and Milkey 1982). The former compensates the potential losses of local residents directly by such strategies as cash compensation and housing relocation, while the latter affects their perceived economic benefit through such indirect approaches as improving the surrounding
infrastructure and offering job opportunities (Bacot, Bowen, and Fitzgerald 1994).

Baxter, Morzaria, and Hirsch (2013), for example, found that an optimized wind turbine installation plan that helped maintain the community’s image, as well as extra investment in community park improvements, effectively enhanced perceived economic benefit. In the four cases of the current study, the Jiangbei Plant mainly adopted direct compensation such as cash compensation and housing relocation. On the contrary, the Jiufeng Plant implemented a variety of indirect compensation arrangements for the surrounding community, such as a special environmental improvement foundation, a range of tourism industry boosting programs and an industrial development plan package (Liu et al. 2019). There is also a ceiling effect in economic compensation. When the economic compensation is sufficient to compensate the potential losses caused by LULU facilities, any further increase may not result in higher public acceptance (Okimoto and Tyler 2007), but may instead create a higher risk of being considered as a kind of bribe (Sjöberg 2009; Li, Liu, and Li 2012). It is thus necessary for local governments to adopt a systematic solution that combines various forms of economic compensation and other response strategies to deliver WTE incineration projects with different characteristics (Kunreuther, Fitzgerald, and Aarts 1993).

The results of the ANOVA test indicate that public acceptance of the Jiangbei Plant is significantly higher than the Tianma Plant, with a further comparative study revealing their local governments’ economic compensation policies to be quite different — the level of economic compensation provided by the former being significantly higher than the latter. However, the differences in public acceptance should not be attributed solely to different economic compensation policies, as previous studies show that a range of strategies (e.g. public engagement, transparency, environmental impact assessment, and compensation) can be influential (Wolsink 2010; Achillas et al. 2011). Meanwhile, public acceptance is generally considered to be a result of multiple economic, social, and psychological factors (Sjöberg and Drottz-Sjöberg 2001), and may be affected by such factors as economic development levels and regional industrial structures. The relatively higher level of economic development, as well as the most affected industrial structure (such as the tea planting or the tourism industry in local communities to the Jiufeng Plant), may also be the reasons for the low public acceptance of the Tianma Plant and the Jiufeng Plant. In addition, previous studies have verified that the distance from the hazardous facilities strongly affects public acceptance of LULU siting (Ren et al. 2016; Liu et al. 2018). Given that the social and cultural characteristics of the respondents selected from local communities surrounding the

Figure 4. Differences between the respondent groups.
four selected plants are basically consistent, their (unevenly distributed) distances from the incinerators may play a role in shaping public acceptance of the plants because no residents are living within 1,000 m of the Mingzhou Plant while all respondents that used to live within 1,000 m of the Jiangbei Plant have migrated to a new community 5 km away from the incinerators through a housing relocation plan. The specific mechanism involved, therefore, needs to be further studied.

The local residents’ perceived environmental/economic fairness is also known to play a vital role in shaping public acceptance of LULU facilities (Wester-Herber 2004; Rootes and Leonard 2009; Wolsink 2010). In economic and social activities, people are generally not only keen on the benefits owned by themselves and others, but also exhibit a series of behaviors that tend to be equally and mutually beneficial. Being dealt with fairly has a huge impact on people’s psychological perceptions, such as trust and perceived risks (Baxter, Morzaria, and Hirsch 2013; Snary 2002), and thus perceived environmental justice/fairness needs to be taken into account in LULU siting (Smith 1983; Jørgensen, Anker, and Lassen 2020). Chiou, Lee, and Fung (2011) argued that economic compensation has to be supplemented by such measures as open negotiation and transparency, and a fair and open negotiated process of economic compensation is important for enhancing public acceptance of LULU siting. In the present study, the local residents from the two different administrative districts of Songjiang and Qingpu near the Tianma Plant received vastly different economic compensation, resulting in those from Qingpu District feeling unfairly treated during the Tianma incinerator siting. Although this needs to be verified by further investigation, the unfairness perceived by local residents in the process of economic compensation may be the main reason for lower public acceptance of the Tianma Plant.

7. Conclusions

Public opposition has been regarded as the key obstacle to the sustainable development of the WTE incineration industry, which has played a vital role in the regional circular economy and sustainable urban development globally. Based on attribution theory, the present study uses SEM to investigate how economic compensation affects the local residents’ acceptance of WTE incineration facilities from a questionnaire survey conducted with nearby residents of four WTE incineration plants in China’s Yangtze River Delta region. The principal findings reveal firstly that economic compensation is positively associated with local residents’ perceived economic benefits and their public trust in the local government, while being negatively associated with their perceived risks. Meanwhile, economic compensation can effectively improve local residents’ acceptance through their perceived economic benefits/risks and public trust, of which public trust plays the most significant role.

The findings theoretically contribute to the literature relating to WTE incineration decision-making and LULU siting, by understanding the effects of economic compensation on local residents’ acceptance, and is thus of great significance for other developing countries aiming to establish a sustainable municipal solid waste disposal system. The findings also have valuable practical implications for local governments and relevant professionals in siting incinerators or LULU. Economic compensation, aimed at compensating the negative effects on local residents and can take many forms, significantly enhancing the level of public acceptance and thus heavily affecting the likelihood that the incinerators or LULUs will be suitably sited. Second, instead of
simply raising the compensation amount, taking an appropriate compensation form, as well as establishing an open and fair compensation negotiation process to involve the public, is a more effective way to increase the level of public acceptance. Third, maintaining public trust in local governments and relevant professionals through a variety of means, such as compensating the local residents fairly, effectively involving the public, and the timely disclosure of critical information is vital in siting incinerators or LULU.

Although the effects of economic compensation on the acceptance of WTE incineration projects are verified empirically, the study has some limitations in terms of theoretical analyses and choice of cases. First, the role played by perceived fairness/justice needs deeper analysis. Similarly, the mechanism driving the differences in acceptance caused by different forms of economic compensation (i.e. direct and indirect compensation) should be enhanced in further studies. Moreover, more cases need to be studied beyond the highly developed Yangtze River Delta region. Further studies are also needed on the level of economic and social development issues on the effects of economic compensation.

Disclosure statement
No potential conflict of interest was reported by the authors.

Funding
This work was supported by the National Natural Science Foundation of China (NSFC) (Grant No 71672180, 72072165 and 72001079), and the Fundamental Research Funds of Zhejiang Sci-Tech University (Grant No 2019Q054).

Supplemental data
Supplemental data for this article can be accessed here.

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