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Influences of Environmental Impact Assessment on Public Acceptance of Waste-to-energy Incineration Projects

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Abstract:

Environmental impact assessment (EIA) plays a vital role globally in siting waste-to-energy incineration facilities because of its potentially positive influences on public acceptance of locally unwanted land use (LULU). However, how EIA influences public acceptance of WTE incineration facilities through risk/fairness/trust local residents perceived has not been verified empirically, especially evidences in the Chinese context. In response, this study aims to empirically verify the influence of EIA on public acceptance through perceived risk/fairness and public trust by using a public acceptance model originating from siting nuclear power facilities and data drawn from a questionnaire survey of 401 residents near to four typical waste-to-energy incinerators in the Yangtze River Delta region, China. Structural Equation Modeling (SEM) analysis shows that EIA tends to increase public trust and perceived fairness, and decrease perceived risk; public trust and perceived fairness tend to decrease perceived risk; while public acceptance of WTE incinerator projects is enhanced by increased public trust and decreased perceived risk. The

findings contribute to the knowledge body of environment management and siting potentially hazardous facilities by exploring the specific impact of EIA on public acceptance, and are of great significance for local governments and other authorities in decision-making and locally unwanted land use.

Key words: Environmental Impact Assessment; Waste-to-energy Incineration Project; Public Acceptance; Locally Unwanted Land Use; Structural Equation Modeling

List of abbreviations including units and nomenclature:

EIA	Environmental impact assessment	LULU	Locally unwanted land use
WTE	Waste-to-energy	NIMBY	Not-in-my-backyard
MSW	Municipal solid waste	DAD	Decide-announce-defend
SEM	structural equation modeling	CMB	Common method bias
EFA	Exploratory factor analysis	χ^2	Chi-square
df	Degree of freedom	GFI	Goodness-of-fit index
CFI	Comparative fit index	NFI	Normed fit index
RMR	Root mean square residual	$RMSEA$	Root mean square error of approximation
$AGFI$	Adjusted goodness-of-fit index	TLI	Tucker–Lewis index

1 Introduction

Although receiving considerable support from governments worldwide as a sustainable approach for municipal solid waste disposal because of the potential benefits in resource saving (e.g., land and labor), carbon emission reduction, energy recovery, and treatment efficiency (Achillas et al., 2011), waste-to-energy (WTE) incineration is also heavily opposed by local communities globally due to such potentially hazardous effects as environmental pollution and property loss (Baxter et al., 2016). Negative public acceptability always brings Not in My Back Yard (NIMBY) campaigns in WTE incineration industry (Liu et al., 2018). Anti-incinerator campaigns have been emerged in many regions of the world, including North America (Baxter et al., 2016), Europe (Davies, 2006), and Asia (Liu et al., 2018) because, as with other locally unwanted land use (LULU) sittings, the costs of WTE incinerators are borne by the local communities while the benefits (economic, ecological, and social) are broadly distributed (Schively, 2007). In China where the incineration adoption sharply increased (National Bureau of Statistics of China, 2009-2019), frequently occurred public resistances to WTE incinerators have caused many proposed new WTE incineration plants to be cancelled and existing ones to be closed before their scheduled date (Ren et al., 2016).

Public acceptance of LULU siting has been the subject of numerous studies, involving a range of compound issues such as economic benefits or risk management, environmental fairness/justice evaluation, and public trust (Mah et al., 2014). As a traditional form of support for rational decision-making, institutionalized environmental impact assessment (EIA) – which assesses the potential environmental impacts caused by a proposed project before the final decision is made and monitors the impacts in the whole life-cycling of a project or activity (Elvan, 2018) – provides structured information to evaluate the influence of proposed new facilities on the environment and health of local communities (Zhu, 2018; Sara et al., 2019). LULU siting studies reveal that EIA can significantly enhance public

acceptance of LULU facilities because of the early public engagement and procedural justice involved (Li et al., 2012). Thus, EIA is of great importance for new infrastructure projects, particularly those with potential local environmental/health hazards.

It is therefore important to understand the detailed influences of EIA on the public acceptance of WTE incinerator projects, and how to best conduct the EIA process in their siting. However, researches on this issue currently are far from sufficient. First, although the impact of EIA on public acceptance has been qualitatively analyzed in such LULU siting worldwide as renewable energy projects (Larsen et al., 2018), nuclear power plants (Kim et al., 2014; Mah et al., 2014), and the oil and gas industry projects (Aung, 2017), there has been no empirical work involving WTE incineration projects using large samples. Second, previous studies usually focus solely on improvements of public acceptance brought by institutionalized EIA (Pölönen et al., 2011; Larsen et al., 2018), while "how" EIA influences public acceptance through public perception such as perceived risk/fairness and public trust remaining largely unknown. Third, cross-cultural comparative researches emphasize that significant differences in public attitudes towards environmental risks may be existing among residents with different economic, social and cultural characteristics (Flynn et al., 1994; Yano et al., 2002). Given that most of the existing studies are conducted in developed countries (Takahashi and Sato, 2015; Paletto et al., 2019), few studies concentrate on providing evidences drawn from developing countries with non-western social and cultural characteristics, especially in the Chinese context.

The present study attempts to fill the mentioned knowledge gap and aims to analysis the influences of EIA on public acceptance of WTE incineration projects through three stages. Firstly, public acceptance model widely used in siting nuclear power facilities globally is adopted as the theoretical analysis framework to propose research hypotheses. Then, questionnaire survey of the local communities of four WTE incinerator projects located in China's Yangtze River Delta region is conducted. Thirdly, the relationship

among EIA, public trust, perceived fairness, perceived risk and public acceptance of WTE incinerator projects is analyzed through structural equation modeling (SEM). The findings contribute to the knowledge body of environmental risk management, and potentially hazardous facilities siting, by revealing the specific impact mechanism of EIA on public acceptance. This is also of great significance for local governments and other authorities in LULU siting decisions.

2 Theoretical framework and research hypotheses

2.1 Environmental impact assessment

As a decretory, participatory environmental management tool, EIA evaluates various effects likely to arise from projects or actions affecting individuals, communities and surroundings in a significant way (Jay et al., 2007), and has been considered as an essential procedure in projects/actions planning and decision-making globally because it is able to incorporate environmental values into the proposed projects/actions (Morgan, 2012; Arts et al., 2013). EIA can be seen as a systematic process for assessing the scope and consequences of harmful environmental impacts on surrounding environments prior to a decision being made (Hanna and Kevin, 2017). Obliging certain investments to be a subject to an EIA has become a legal requirement in most countries around the world, and this requirement is not only applied to projects, but also applied to actions such as policies and planning (Bilgin, 2015). Although EIA system and regulation framework varies in countries with different contexts and circumstances, some core elements such as the publication of an EIA report, public consultant and engagement, and the necessary follow-up are achieved a wide agreement (Jay et al., 2007).

How to evaluate the effectiveness of EIA, which can be defined to what extent EIA actually achieved its objectives, has been discussed intensively in the past decades. Gallardo and Bond (2011) classified the effectiveness of EIA into two aspects: procedural and substantive effectiveness, from which the former refers the assessment complies with

the principles of the EIA process while the latter means the extent of set objectives achieved. Although there is no commonly accepted model in evaluating the effectiveness of EIA in relevant literature, the most frequently mentioned framework includes legislation, Environmental Protection Agency (EPA) capacity, community engagement and follow-up issues such as monitoring and EIA administrations (Khan et al., 2020; Loomis and Dzidzic, 2018; Khosravi et al., 2019). Thus, for laypeople such as local residents and the public, it is logical to determine the effectiveness of EIA in LULU siting process through whether the EIA complies with relevant legislation, capacity and past performance of EIA agency, public participation, and transparency and information disclosure in the EIA process.

Since 1969 when it was formally enshrined in legislation in the United States, EIA has become legal and institutional procedures in projects/actions decision-making in more than 100 developed and developing countries (Jay et al., 2007; Lyhne et al., 2017). EIA was first introduced to China in 1973 and formally implemented in 1979 when the central government promulgated *the Environmental Protection Law of People's Republic of China (for Trial Implementation)*. After the 40 years of practices, EIA has gradually become one of the most well-known environmental management tools, and played an important role in China's environmental protection and sustainable development (Wu et al., 2014). Compared with common practices in other developed countries, EIA in China follows the same regulation framework and similar steps, but there are still differences existing both procedural and substantial elements (Chen et al., 2007; Suwanteep et al., 2016). Unlike applied to government actions in USA and Europe, EIA in China mainly evaluates the potential environmental impacts that large and medium-sized projects raised (Chen et al., 2007). Meanwhile, due to differences in political, economic, social and cultural contexts, there are other particular aspects from the Chinese EIA procedure in

comparison to those in USA and Europe, such as alternatives, public engagement and follow-up issues (Chang et al., 2018; Aryal et al., 2020).

2.2 Theoretical framework

Originating from risk perception studies involving the well-known question of "how safe is safe enough" (Starr, 1969), public acceptance refers to how much the public accepts a new technology or approach (Du and Zhu, 2019). This is now widely used in such public attitude and behavioral research as LULU siting, policy-making, and technological innovation (Renn and Schweizer, 2009). Of these, public acceptance of nuclear power plants is one of the most representative issues in risk perception studies. Early acceptance studies relating to nuclear power mainly focused on such topics as global warming and public attitudes to nuclear power, while a series of such issues as electricity technologies and portfolios, acceptance of policy division, and imaginary-specific affect has emerged in recent years (Greenberg, 2009a; Jenkins-Smith et al., 2011). Based on a comprehensive literature review of existing studies, Du and Zhu (2019) present a unified analytical framework for these issues by integrating the determinants of public acceptance of nuclear power plants (See **Fig. 1**).

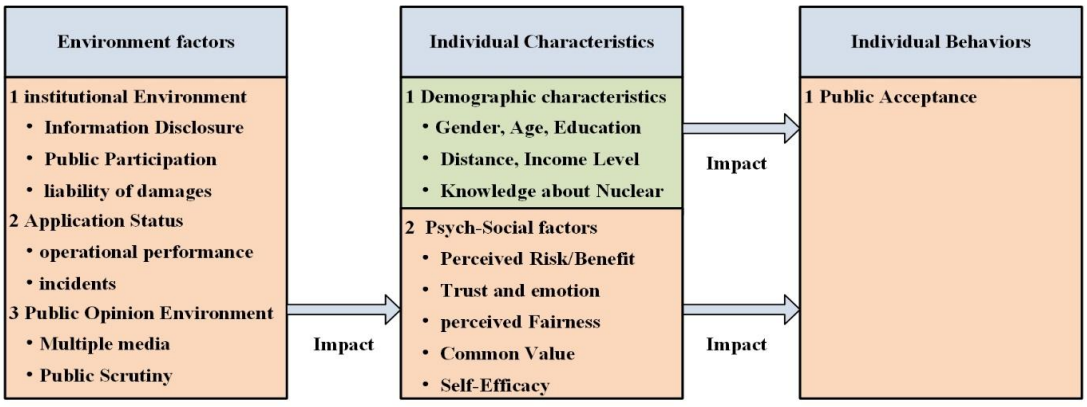

Fig. 1. Analytical framework of public acceptance towards nuclear energy

Following the analytical framework, public acceptance of nuclear power plants is significantly affected by associated environmental factors, individual characteristics, and

environmental/health incidents. Specifically, environmental factors consist of the institutional environment, application status, and public opinion environment. The institutional environment refers to such institutional factors as information disclosure, public engagement, and liability for environmental damage (Renn and Schweizer, 2009); while application status indicates the operational performance of existing nuclear power facilities, especially incidents that threaten local residents' environment/safety/health. Empirical evidence from the Chernobyl and Fukushima Daiichi nuclear disasters revealed that incidents at existing nuclear plants can significantly affect public attitude to nuclear power (Huang et al., 2013b) – the multiple media environment reflecting public opinion of nuclear energy (Mercado-Sáez et al., 2018). On the other hand, individual characteristics, including demographic characteristics (i.e. gender, age, education, distance from the nuclear power plant, and income level) (Yim and Vaganov, 2003), and psycho-social factors (e.g., public trust, perceived risk/benefit, and fairness) and perceptions (Slovic, 1987; Van der Horst, 2007; Visschers and Siegrist, 2013) are verified as pivotal in public acceptance of nuclear power.

It is well recognized that environmental decision-making requires not only a balance of technical and economic issues, but the integration of social and ecological aspects, and EIA is considered a feasible way to achieve sustainable environment and health goals through a global "anticipate and prevent" strategy (Elvan, 2018). In addition to providing fundamental knowledge to support government decision-making, EIA offers a valid approach for the public to understand information concerning the potential impact of the proposed projects on their environment and health (Glucker et al., 2013). Due to the fact that provides a concrete manifestation of the institutional environment in LULU siting, and reflects many institutional and environmental factors such as information disclosure and public engagement, it is likely that the quality of EIA processes becomes a vital factor in shaping public's attitudes towards WTE incinerators through trust/emotion, perceived

benefit/risk, and fairness. Thus, following the framework of the nuclear power public acceptance model, the theoretical framework of the present study is shown in **Fig. 2**.

Fig. 2. Theoretical framework of the current study

2.2 Research hypotheses

(1) EIA, public trust, and public acceptance

According to Siegrist and Cvetkovich (2000), "trust" is a kind of dependence, which refers to the subjective belief of decision-makers and implementers in the application of technology and policy. The clients, who voluntarily assume the risk in a relationship of trust, determine that the trustee will act to maximize their interests (Warkentin et al., 2002). Residents usually do not oppose WTE incinerator projects when they trust that public interest has been fully taken into account by the government in decision-making, technology selection, and policy implementation (Siegrist, 2000). For WTE incinerator projects, public acceptance relies on independent judgments based on sufficient knowledge and adequate information. Since it is quite difficult for individuals outside the industry to have enough knowledge about WTE incinerator projects, most people's acceptance level accords with the opinions of experts (Siegrist and Cvetkovich, 2000; Sjöberg, 2009). A substantial body of studies on nuclear power, waste treatment, and the chemical industry show that the trust level of local residents in the government, experts, and operators has positive impact on the public acceptance of LULU facilities (Chung and Kim, 2009; Molnar et al., 2018; Mercer-Mapstone et al., 2018).

In addition to being a global evaluation tool to ensure there will be an appropriate environmental and social impact, EIA is also an effective approach to democratic decision-

making and building a broad consensus over proposed large-scale projects (Elvan, 2018). Larsen et al. (2018) stress that less public engagement in EIA will reduce the public trust in the government, therefore leading to public opposition and NIMBY campaigns to LULU siting, while more effective engagement has a significant advantage in emphasizing access to "secret" information and obtaining expressions of willingness in the decision-making phase, which could lead directly to public acceptance (Simpson and Basta, 2018). In siting WTE incinerators, the timely disclosure of EIA information can promote the public trust in the government remarkably well (Wang and Tan, 2014), and public engagement, the EIA assessor's capability, and procedural justice create a common ground for generating acceptable solutions for WTE incinerator projects (Spath et al., 2018).

Thus, the current study proposes the following hypotheses:

H1a: *Public trust* has a significant positive influence on the *public acceptance* of WTE incinerator projects.

H2a: *EIA* of WTE incinerator projects has a significant positive impact on *public trust* in local governments and other authorities.

(2) EIA, perceived risk, and public acceptance

Perceived risk is the comprehensive judgment of the probability and consequence of the public's negative impact on "potentially hazardous facilities" (Wang et al., 2019). Psychology studies suggest that perceived risk is a fundamental factor in forming public attitudes, and the public (individuals) usually have deep concerns about unknown, uncontrollable, and disastrous risk factors (Slovic et al., 1991). Meanwhile, individual perceived risk is affected by personal experience, and cultural knowledge and values, and is quite different between experts and laypeople (Siegrist, 2000). People's perceived risk causing by the tension in NIMBY is an important factor affecting the public acceptance of WTE incinerator projects (Lima, 2006). Other studies also show that, in such LULU siting as nuclear power plants, a waste treatment facility, and waste water treatment plants, the

higher the perceived risk of local residents, the lower the public acceptance (Eiser et al., 2002; Chung and Kim, 2009).

The systematic defects of EIA (e.g., inconsistency of the content, time limit, and scope of the EIA announcement) are the trigger for the accumulation of the public perception of risks and public dissatisfaction (Gwimbi, 2017). To provide advice for decision-making, EIA agencies emphasize not only avoiding project delays caused by public opposition, but also reducing residents' perceived risk caused by lack of necessary information (Hansen and Wood, 2016). Effective EIA usually addresses residents' perceived risk of environmental influence and neighborhood disturbances, which are vital in shaping the public acceptance of LULU facilities (Dendena and Corsi, 2015).

Therefore, the following research hypotheses are proposed:

H1b: *Perceived risk* has a significant negative influence on *public acceptance* of WTE incinerator projects.

H2b: *EIA* has a significant negative impact on local residents' *perceived risk* towards WTE incinerator projects.

(3) EIA, perceived fairness, and public acceptance

In economic and social activities, people not only pay attention to their own gains and losses, but also exhibit a series of behaviors that tend towards equality, reciprocity, and mutual benefits (Rootes and Leonard, 2009). LULU siting are often considered as unfair because of damage to the public interest, and thus can result in mass protests (Mercer-Mapstone et al., 2018). Therefore, the perceived environmental/economic fairness of the local residents also plays a vital role in shaping the public acceptance of LULU facilities (Rootes and Leonard, 2009; Wolsink, 2010; Li et al., 2019). Being dealt with fairly has a huge impact on people's psychological perceptions of such matters as trust and perceived risk (Baxter et al., 2013), and thus perceived environmental justice/fairness should be considered in siting LULUs (Smith, 1983; Visschers and Siegrist, 2013a). Building waste

treatment facilities in local communities and bearing the burden of waste generated in other areas, which hinders local residents' awareness of social equity, leads to public acceptance of WTE incineration facilities being reduced (Rahardyan et al., 2004; Besley, 2010).

Public engagement with a deliberative democracy is important in the EIA process, to characterize fairness and a willingness to deliver the sustainable goal of the proposed development. The EIA process, public engagement, and suitable policies need to be considered as a commitment to a healthy environment, as well as a promise of truthfulness and fairness on the part of investors (Masalu, 2003). In addition, the rational implementation of EIA can promote intra-generational and inter-generational fairness (Bruhn-tysk and Eklund, 2002). Due to substantive WTE incinerator project risks being high or unknown, the public needs to be involved intensively to ensure fairness, protect their autonomy, and clarify the public interest, following which public satisfaction with participatory processes and the final decision is expected to be improved (Hourdequin et al., 2012).

Therefore, the following research hypotheses are raised:

H1c: *Perceived fairness* has a significant positive influence on *public acceptance* of WTE incinerator projects.

H2c: *EIA* has a significant positive influence on local residents' *perceived fairness* towards WTE incinerator projects.

(4) Perceived fairness, public trust, and perceived risk

People accept risks only if they perceive that risks are distributed fairly (Chung and Kim, 2009), which indicates that perceived fairness influences the public's acceptance and tolerance of risks. Individuals' active behavior is directly influenced by their fairness judgments, which means that the commitment toward an individual action could reduce risk and solve technology problems (Syme et al., 2006). The intended function of fairness provides a neutral foundation that is valued by all stakeholders for the resolution of disputes

in contemporary environmental risk management (Earle and Siegrist, 2008). When harmfulness and possibility reach a balance, perceived risk is reduced, which can lead to efficient and rational public behaviors (Feng and Reisner, 2011).

Trust is a prerequisite for multiplicited and multifaceted risk management (Mah et al., 2014). When faced with a decision, people make risk judgments based on acquired information and personal emotions (Finucane, et al., 2000). When unable to obtain sufficient professional knowledge, the public can only judge the risks and benefits from "potentially hazardous facilities" based on their trust in the associated authorities or experts (Simon-Friedt et al., 2016). Therefore, most studies adopt trust as a critical indicator affecting residents' perceived risk, assuming that the public's perceived distrust will lead to its biased understanding of perceived risk (Chung and Kim, 2009; Stebbing et al., 2006).

Consequently, the following hypotheses are proposed:

H3: *Perceived fairness* has a significant negative impact on *perceived risk* towards WTE incinerator projects.

H4: *Public trust* has a significant negative impact on *perceived risk* towards WTE incinerator projects.

Fig. 3 provides the conceptual model to integrate the hypothesized links between EIA, perceived fairness/risk, public trust, and public acceptance based on the four hypotheses proposed above.

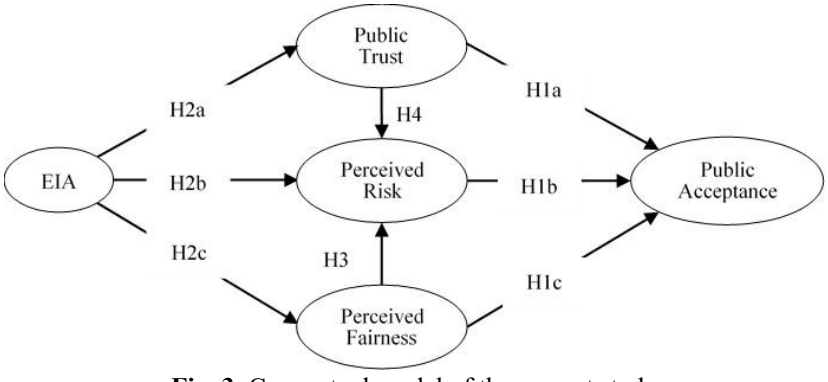

Fig. 3. Conceptual model of the current study

3 Research design

Traditional hypothesis testing is adopted by the present study to verify the influence of EIA on public acceptance of WTE incinerator projects empirically using a combination of research methods including literature analysis, questionnaire survey, and Structural Equation Modeling (SEM) analysis. The empirical study comprises three steps. First, based on the public acceptance model originating from the public acceptance of nuclear power plants, a conceptual model was established, comprising proposed hypotheses and corresponding measurement scales for data collection. Second, a large-scale questionnaire survey was conducted of four typical WTE incinerator projects located in four central cities of the Yangtze River Delta region to obtain data about EIA, perceived fairness/risks, public trust, and public acceptance of the projects. Third, the ensuing data are analyzed by such statistical methods as SEM and the Mann-Whitney U test to examine the validity of the proposed links empirically.

3.1 Questionnaire design

The questionnaire has two parts. Part 1 elicits such socio-demographic information as gender and age, while Part 2 is designed to evaluate the proposed five constructs (see **Appendix A**). Most measurement items in Part 2 are derived from the existing literature. These comprise: 15 questions from Liu et al. (2018) relating to the respondents' perceived risk of, public trust in, and public acceptance towards the incinerator project; 8 questions from Wolsink (2007) concerning the respondents' perceived fairness of the incinerator project. Another 6 questions (see **Table 1**) concerning the respondents' assessment of the EIA implementation in the siting and operating processes of incinerators are designed by referring the EIA effectiveness evaluating framework raised by Khan et al. (2020), Loomis and Dzidzic (2018) and Khosravi et al. (2019). The questions are all assessed on a five-point Likert scale ranging from 1 (very much disagree) to 5 (very much agree).

A preliminary survey was carried out in a pilot survey of 86 residents near to the Hangzhou Jiufeng WTE incineration plant to test the reliability and validity of the designed six items. The results of the reliability and validity test using Cronbach's Alpha and Exploratory Factor Analysis (EFA) respectively are presented in **Table 1**, indicating the questionnaire is sufficiently reliable and structurally valid.

Table 1. Results of questionnaire reliability and validity tests (N=86)

Constructs	Items	Cronbach's α	KMO	Bartlett's test of sphericity
EIA	Sound EIA system and standardized procedures Reliable and authoritative EIA agencies Highly available EIA information Timely sharing of EIA information Various forms of public engagement Effective public engagement results	0.829	0.820	x^2=169.976 df =15 Sig.=.000

3.2 Samples and data collection

According to the China statistical yearbook 2018 (National Bureau of Statistics of China, 2019), of the country's total 286 WTE incineration plants, 96 are located in the Yangtze River Delta region. This comprises four provinces/municipalities on the east coast and is considered China's most densely populated and economically developed region. In 2018, a total of 31.2 million tons of MSW was incinerated in this region, accounting for 30.60% of the country's total amount incinerated. There have been intensive anti-incineration campaigns in the Yangtze River Delta regions over the past decade, and many incinerators have been cancelled or closed as a result. Four WTE incineration plants located in four central cities of this region constitute the research cases: namely, the Shanghai Tianma MSW Incineration Plant (Tianma Plant), Hangzhou Jiufeng MSW Incineration Plant (Jiufeng Plant), Nanjing Jiangbei MSW Incineration Plant (Jiangbei Plant), and Ningbo Mingzhou MSW Incineration Plant (Mingzhou Plant). Of these, the Jiangbei and

Jiufeng Plants had to be re-sited by the local government because of strong public opposition, while the others were also considerably beset with public opposition.

Based on similar questionnaire surveys by Ren et al. (2016) and Liu et al. (2018) for example, the survey areas are set within 5 km of the Plants in consideration of their population distribution, sampling size, and administrative division. A stratified random sampling process is used to select valid respondents from residential communities or villages involved. Each area is divided into residential communities based on such factors as population and location, and local residents within randomly selected residential communities randomly invited to partake in the survey.

The survey was conducted from 10 May to 28 June 2018. To minimize the social desirability bias, the questionnaire surveys were conducted anonymously, by which the pre-numbered questionnaires were distributed randomly and no other identities (except demographic characteristics: age, gender, education level and distance from the WTE facilities) of the respondents was permitted to be collected. To help respondents authentically understand and definitely answer the questionnaire items, three specific measures were conducted during the face-to-face questionnaire survey. Firstly, investigator emphasized the anonymity of the survey, and totally explained the project's background, EIA process, meaning of each item at the beginning to help inexperienced and less-educated respondents understanding questionnaire items. Secondly, under the precondition of ensuring that the respondents completed the survey independently, investigators responded respondents' queries during the survey process timely. Then, for respondents who are older and less-educated, final confirmation for each question was conducted to make sure their ideas were expressed completely and authentically. In total, 500 questionnaires were evenly distributed to 125 pre-selected local residents in each survey area, and finally 401 valid responses were obtained, with 95 (76.0%), 105 (84.0%), 101 (88.0%), and 100 (80.0%) from the Tianma, Jiangbei, Jiufeng, and Mingzhou Plants

respectively. Although the overall response rate of 80.2% is generally higher than the conventional social surveys reported in the literature, similar studies by Ren et al. (2016) and Huang et al. (2013a) have an equally high response rate – the face-to-face approach ensuring that the majority of questionnaires were recovered promptly and validly.

Table 2 provides details of the demographic characteristics of the respondents. The sample distribution in gender and age conforms to the overall population characteristics of the surveyed four cities by comparing the collected data with resident data drawn from the Sixth Census Report 2010. In term of educational level, only 14% have a junior college degree or above. The reason for this phenomenon may be attribute to that WTE incinerators are usually located in urban-rural areas or even rural areas where resident education levels are significantly lower than in urban areas. Most respondents' residences (workplace or village) are within 3km of the Plant to analysis whether there is difference among local residents with low public acceptance level (Liu et al., 2018).

Table 2. Demographic characteristics of the respondents

Profile	Category	Frequency (%)				
		Shanghai	Nanjing	Hangzhou	Ningbo	Overall
Gender	Male	57 (60%)	47 (44.76%)	55 (54.46%)	52 (52.00%)	211(52.62%)
	Female	38 (40%)	58 (55.24%)	46 (45.54%)	48 (48.00%)	190(47.38%)
Age	18-25	3 (3.16%)	9 (8.57%)	7 (6.93%)	12 (12.00%)	31(7.73%)
	26-35	13 (13.68%)	20 (19.05%)	17 (16.83%)	21 (21.00%)	71(17.71%)
	36-44	25 (26.32%)	22 (20.95%)	17 (16.83%)	27 (27.00%)	91(22.69%)
	45-60	38 (40%)	28 (26.67%)	30 (29.7%)	22 (22.00%)	118(29.43%)
	≥ 60	16 (16.84%)	26 (24.76%)	30 (29.7%)	18 (18.00%)	90(22.44%)
Education Level	≤Junior High School	68 (71.58%)	57 (54.29%)	44 (43.56%)	57 (57.00%)	226(56.36%)
	Senior High School	22 (23.16%)	36 (34.29%)	35 (34.65%)	25 (25.00%)	118(29.43%)
	Junior College	4 (4.21%)	11 (10.48%)	18 (17.82%)	12 (12.00%)	45(11.22%)
	Undergraduate	1 (1.05%)	1 (0.95%)	3 (2.97%)	4 (4.00%)	9(2.24%)
	≥Graduate	0 (0.0%)	0 (0.0%)	1 (0.99%)	2 (2.00%)	3(0.75%)
Distance from the WTE facilities	≤500 m	6 (6.32%)	0 (0.0%)	10 (9.9%)	0 (0.0%)	16(3.99%)
	500-1000 m	5 (5.26%)	30 (28.57%)	24 (23.76%)	0 (0.0%)	59(14.71%)
	1000-2000 m	34 (35.79%)	47 (44.76%)	26 (25.74%)	52 (52.00%)	159(39.65%)

	2000-3000 m	50 (52.63%)	18 (17.14%)	38 (37.62%)	37 (37.00%)	143(35.66%)
	≥3000 m	0 (0.0%)	10 (9.52%)	3 (2.97%)	11 (11.00%)	24(5.99%)

3.3 Data analysis

The data analysis process is divided into four steps. First, the potential threat of common method bias was checked with Harman's single-factor test. Second, the respondents' attitudes towards WTE incinerator projects are assessed by using descriptive statistical analysis. Then, SEM, an important statistical method for quantitative research in the social sciences, is well suited to the analysis of questionnaires with a sample size between 250 and 500 (Schumacker and Lomax, 1996), and is therefore used to analyze the 401 valid responses in the current study to empirically test the hypothesized relationships between constructs. All fit indices and their recommended values used to assess the goodness-of-fit of the SEM model are drawn from Xiong et al. (2015). Finally, the Mann-Whitney U test is used to clarify whether different demographic groups (by age, gender, and education) have different public acceptance levels.

4 Results

4.1 Common method bias

Common method bias (CMB), which is considered the main source of measurement error, has a negative impact on the validity on the empirical findings, leading to misleading conclusions (Campbell and Fiske, 1959; Khan and Mir, 2019). The method of minimizing CMB of the current study comprises the following four aspects. Firstly, the academic and confidential statements at the beginning of the questionnaire is helpful to eliminate the concerns of the respondents and obtain the true situation. Secondly, investigators explained to respondents that questionnaire items are aims to obtain different information and will be analyzed independently before they answer the questionnaire. Meanwhile, investigators ask respondents some irrelevant questions during the process of answering questions to reduce the possibility of common source bias causing by respondents' subjective

consistency between different questions. Finally, the potential threat of common method bias was checked with Harman's single-factor test via confirmatory factor analysis. The single-factor model accounted for only 31.46 percent of the total variance, and it reveals that CMB issues are not present in our dataset. Similarly, when all items of the six variables were located onto one factor, the result of model fit ($\chi 2$=3399.56, df=377; GFI=0.357; AGFI=0.258; NFI=0.157; CFI=0.166; RMSEA=0.142) was worse than that of a six-factor model. Consequently, common method bias was not a critical threat in current study.

4.2 Descriptive statistics

The descriptive statistics of variables surveyed was firstly conducted (see **Appendix B**). The means of three items used to reflect the public acceptance of WTE incinerator projects range from 1.62 to 1.78, indicating a relatively low acceptance received by the selected four plants. This is expected because of the frequent anti-incinerator campaigns in China and considerable resistance from local communities. The mean ranges of perceived risk, perceived fairness, and public trust are 3.79~4.14, 1.78~2.26, and 2.06~2.18 respectively, which are relatively high, while the EIA means range from 2.12 to 2.30, indicating that "disagreement" with EIA processes meeting expectations in terms of procedural fairness, public engagement, information disclosure and transparency, etc. The kurtosis coefficient and skewness coefficients of all the variables conform to Multivariate Normality, and thus meet the requirements for SEM analysis (Hu and Bentler, 1999).

4.3 Structural equation analysis

The model fit indices of the SEM analysis obtained (see **Table 3**) indicate that, except the χ^2 significance (P), all parameters meet the predetermined recommended values. However, P is affected by the number of samples and it is usually difficult to meet the recommended value when the sample size is large (Kline, 2011). The index of $\chi^2/d.f.$ is therefore adopted to measure the goodness of fit of the structured model, and its value of

1.697 meets the requirement of less than 2.0, indicating a good fit between the hypothesized model and the survey data.

Table 3. Model fit indices of the SEM model (N=401)

Statistic	Recommended Value	Preset Model Test Values
Chi - square		626.264
df		369
P value	>0.05	.000
Chi - square/df	< 2.0	1.697
RMR	< 0.05	0.041
RMSEA	< 0.05	0.042
GFI	> 0.9	0.903
AGFI	> 0.8	0.885
CFI	> 0.9	0.929
NFI	> 0.8	0.845
TLI	> 0.9	0.922

The SEM mode, its standardized path loadings, and significance levels are shown in **Fig. 4**. Except for H1c, all the hypothesized links between EIA, perceived risk/fairness, public trust, and public acceptance are supported at significance level $P < 0.05$. Specifically, EIA has a positive influence on perceived fairness (0.706, $P < 0.001$) and public trust (0.800, $P < 0.001$), while reducing perceived risk (-0.270, $P < 0.05$). Similarly, public trust is positively associated with public acceptance of WTE incinerator projects (0.606, $P < 0.001$), while reducing perceived environmental/health risk (-0.359, $P < 0.01$). However, although previous studies argue that public acceptance of LULU siting is heavily influenced by perceived fairness/justice, the evidence indicates otherwise. Moreover, the overall influence of EIA on public acceptance is 0.776 ($P < 0.01$), indicating that EIA can effectively affect public acceptance of WTE incinerator projects indirectly, and that public trust plays an important role.

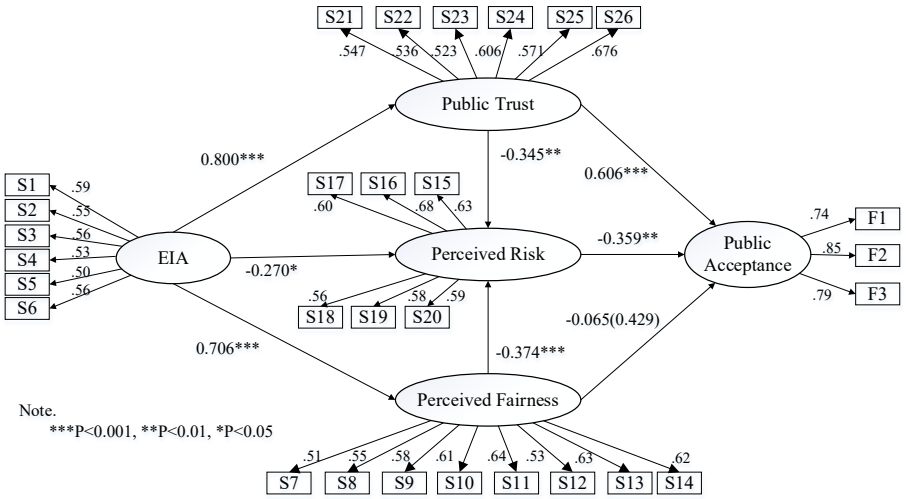

Fig. 4. Standardized estimates of the SEM model

4.4 Demographic difference exist in public acceptance

The Mann-Whitney U test is used to clarify whether there are differences between groups with different demographic characteristics (i.e. age, gender, education level, and distance from the Plant) (See **Table 4**). The results show that people under the age of 35 and more educated (junior college and above) are more willing to accept the Plants. There is no significant difference between males and females, nor those living further than 2 km and less than 2 km from the Plants.

Table 4. Results of Mann-Whitney U test with two independent samples

Demographic Characteristics		Public Acceptance					
		F1: Psych. Acceptance		F2: Accept in Practice		F3: Persuade Others	
		Mean	Z	Mean	Z	Mean	Z
Gender	Male	1.77	0.903	1.68	1.290	1.60	0.505
	Female	1.78		1.75		1.65	
Age	≤ 35	1.98	2.658**	2.01	3.580***	1.83	2.408*
	> 35	1.71		1.61		1.55	
Education Level	≤ Senior High school	1.71	3.463**	1.64	3.188**	1.56	2.763**
	> Senior High school	2.18		2.12		2.00	
Distance from the WTE facilities	≤ 2km	1.74	0.407	1.62	1.725	1.55	1.193
	>2km	1.82		1.84		1.72	

Note: * P < 0.05; ** P < 0.01; *** P < 0.001.

5 Discussion

Although WTE incinerations have achieved remarkable progress in the MSW disposal industry in China over the past decade, the survey indicates that their public acceptance is still at a very low level while the perceived potential risks to the environment/health of the local communities is relatively high. The fundamental reason for this may lie in the technical-based, undemocratic top-down decision-making approach to LULU siting adopted by the local government (Ren et al., 2016), because being dealt with fairly matters in shaping public attitudes (Smith, 1983), and public concerns relating to government ability or injustice will decline if it is not effectively involved in siting decisions (Kikuchi and Gerardo, 2009). Despite the importance of transparency and democracy strategies in siting LULUs emphasized by a range of literature (Jones & Richard Eiser, 2010), the traditional Decide-Announce-Defend (DAD) decision-making approach is still the primary mode for local governments (Johnson, 2013). Instead of adopting an open and democratic decision-making policy, local governments are more likely to mitigate public resistance by increasing opacity, or initiating a new siting process (Johnson, 2013).

The results of the Mann-Whitney U test indicate that public acceptance varies according to people's age and education level, with the younger, and better educated, being more willing to accept the Plants. This aligns with the conclusions from Huang et al. (2013a) and Mah et al.'s (2014) studies. A possible reason is that less educated people perceive potentially hazardous risks to be more severe and that older people in China are usually less educated (Liu et al., 2018). In terms of gender, although previous studies reveal that the acceptability of women is significantly less than men (Harris and Jenkins, 2006), Liu et al. (2018) found men and women in China have a similar attitude to LULU once such factors as ethnic/cultural characteristics and highly stressed environment/health conditions are taken into account. The lack of significant gender differences in the present study may therefore be because the people involved have similar characteristics to each

other and are in similar conditions. Previous studies have also shown that women tend to accept unfairness more easily in both behavioral and neural responses in high-pressure contexts (Zheng et al., 2017).

In relation to distance from the Plant, a substantial body of research suggests that residents living closer to the proposed LULU facilities perceive more risk and have a more negative attitude (Van der Horst, 2007). Huang et al. (2015) and Liu et al. (2018), for instance, found that residents living further than 3 km from WTE incineration plants have a completely different attitude than and those living nearer. One possible reason for this not being the case here is that usually only residents living within 3 km are involved in EIA WTE incinerator decision processes in China. The possible effect of LULU facilities on the human body means that strong social interactions of people living close by easily turn individual grievances into group opposition when professional knowledge and information concerning proposed projects is lacking (Coppens et al., 2018). Thus, different levels of participation in incinerator siting result in significant differences in attitudes. On the other hand, there is also evidence to show that people living near facilities have a higher acceptance (Greenberg, 2009b; Jenkins-Smith et al., 2011) because they are more familiar with them (Greenberg, 2009a; Silva et al., 2007) and may be motivated by their economic and social benefits (Venables et al., 2005), while people living further away are more concerned about potential risks and adverse consequences (Silva et al., 2007).

These results verify expectations concerning whether and how EIA influences public acceptance of WTE incinerator projects, and show it has an indirect positive impact through perceived risk/fairness and public trust, which would help MSW incineration in getting rid of NIMBY claims. Specifically, EIA has a significant positive influence on perceived fairness and public trust while reducing the perceived risks of local residents, which is similar to Lima (2006), Wang and Tan (2014), and Larsen et al.'s (2018) findings on the public perception of WTE incineration facilities by EIA elements. Likewise, as with

the findings of a substantial body of research (e.g., Eiser et al., 2002; Wolsink, 2010; Molnar et al., 2018), the current study also stresses that public acceptance of WTE incinerator projects is significantly affected by public trust and the perceived risks of local residents. In addition, the results provide empirical evidence for supporting the expected links between public trust, perceived fairness, and perceived risk, in which public trust and perceived fairness significantly reduce perceived risk, which further strengthens similar findings in the same field (Chung and Kim, 2009; Stebbing et al., 2006). It is worth noting from the current study that EIA is more related to trust and fairness, and mainly enhances public acceptance by improving its trust in the government.

What is surprising is that the link between perceived fairness and public acceptance is missing in the current study. Previous work has clearly revealed that perceived environmental fairness/justice plays an important role in enhancing public acceptance of LULU siting (Rootes & Leonard, 2009; Wolsink, 2010). However, there is also literature arguing that being treated fairly is more related to such individual psychological perceptions as perceived risk and trust (Baxter et al., 2016). Syme et al. (2006) show that fairness provides a strong motivation for individuals to voluntarily undertake more risks, which means people will accept risks (low perceived risk) only if the harm and benefits involved are distributed fairly (Chung and Kim, 2009). Consequently, it is intuitively reasonable for the findings of the current study to show that perceived fairness affects public acceptance indirectly through perceived risk.

6 Conclusions

Given the vital role EIA plays in the successful siting of LULU facilities, this paper describes an empirical study to understand how EIA influences local residents' public acceptance of WTE incinerator projects by following the public acceptance model of nuclear power. The findings contribute to the body of knowledge of environmental management and potentially hazardous siting by understanding the specific impact of EIA

on public acceptance, and is of significance for governments and other relevant authorities in siting WTE incineration plants and other LULUs.

The principal findings are:

(1) Public acceptance towards WTE incineration plants in the Yangtze River Delta region of China is still at a very low level while the potential risk perceived by the public is relatively high.

(2) People under the age of 35, that are more educated, and local residents living within 3 km tend to be more accepting of WTE incineration plants.

(3) EIA tends to increase public trust and perceived fairness, and decrease perceived risk; public trust and perceived fairness tend to decrease perceived risk; while public acceptance of WTE incinerator projects is enhanced by increased public trust and decreased perceived risk.

The research is limited by all four studied cases being selected from China's most economically and socially developed Yangtze River Delta region, which means the principal findings have not been cross-verified in multiple socio-economic environments. Meanwhile, the impact of the knowledge of MSW disposal system individuals owned on their public acceptance towards incinerators, and the role EIA played in, should be explored in-depth in further studies. Moreover, more efforts should be made to understand how the specific nature of EIA (e.g. community engagement and information disclosure in EIA processes, the stages of the EIA) influence the results.

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