Risk perception and public acceptance toward a highly protested Waste-to-Energy facility

ARTICLE *in* WASTE MANAGEMENT · NOVEMBER 2015

Impact Factor: 3.22 · DOI: 10.1016/j.wasman.2015.10.036

4 AUTHORS, INCLUDING:

Xiangyu Ren
East China Normal University
5 PUBLICATIONS **10** CITATIONS

Waste Management xxx (2015) xxx–xxx

Contents lists available at ScienceDirect

Waste Management

journal homepage: www.elsevier.com/locate/wasman

Risk perception and public acceptance toward a highly protested Waste-to-Energy facility

Xiangyu Ren, Yue Che *, Kai Yang, Yun Tao

Shanghai Key Lab for Urban Ecological Processes and Eco-Restoration, East China Normal University, No. 500 Dongchuan Road, Shanghai 200241, China

ARTICLE INFO

Article history:
Received 10 March 2015
Revised 4 October 2015
Accepted 31 October 2015
Available online xxxx

Keywords:
Risk perception
Public acceptance
Protest willingness to accept
Geographical distribution
Waste-to-Energy

ABSTRACT

The application of Waste-to-Energy treatment in Municipal Solid Waste faces strong protest by local communities, especially in cities with high population densities. This study introduces insight into the public awareness, acceptance and risk perception toward Waste-to-Energy through a structured questionnaire survey around a Waste-to-Energy facility in Shanghai, China. The Dichotomous-Choice contingent valuation method was applied to study the willingness to accept of residents as an indicator of risk perception and tolerance. The factors influencing risk perception and the protest response choice were analyzed. The geographical distributions of the acceptance of Waste-to-Energy facility and protest response were explored using geographical information systems. The findings of the research indicated an encouraging vision of promoting Waste-to-Energy, considering its benefits of renewable energy and the conservation of land. A high percentage of protest willingness to accept (50.94%) was highlighted with the effect of income, opinion about Waste-to-Energy, gender and perceived impact. The fuzzy classification among people with different opinions on compensation (valid 0, positive or protest willingness to accept) revealed the existing yet rejected demand of compensation among protesters. Geographical distribution in the public attitude can also be observed. Finally significant statistical relation between knowledge and risk perception indicates the need of risk communication, as well as involving public into whole management process.

1. Introduction

Even though Waste-to-Energy (WTE) facilities offer effective solutions to the Municipal Solid Waste (MSW) surge and global energy issue (Cherubini et al., 2009; Chen et al., 2010), and even though they have been applied worldwide, especially in Japan and European Union, e.g., among total amount of MSW, 74% in Japan, 54% in Denmark, 50% in Switzerland and Sweden were incinerated (The World Bank, 2012; Psomopoulos et al., 2009). WTE facilities face considerably strong protests from local communities in which they are situated, especially in developing countries with high population densities. The location of WTE is an ongoing concern; and population pressure brings even more households closer to existing WTE facilities. Economic compensation that can maintain the environmental welfare of residents, such as tax relief or reduction of utility bills, is widely considered as a useful solution to the not-in-my-backyard (NIMBY) protest (Jenkins-Smith and Kunreuther, 2001).

However, protests among local residents still exist, shedding doubt on the effectiveness of the simple compensation policy (Portney, 1991; Li et al., 2012). This problem seems to be even more severe in China, where there were 172.4 million tons of MSW annually and more than ten anti-incinerator demonstrations that claimed relocation of WTE facilities from 2009 to 2012. Among famous public conflicts toward WTE facilities in Beijing, Guangzhou, Dongguan and other cities, Shanghai is a representative case (Li et al., 2012; Johnson, 2013; Song et al., 2013). The Jiangqiao WTE Plant (JQP) was constructed between the city center and the suburbs of Shanghai in 1999 and has been operating since 2003 to enhance the treatment efficiency for the growing MSW (11,000 tons per day in 2013). Although it is monitored by the government, the local residents show strong adverse public reactions toward the WTE facilities in their neighborhoods.

The rising NIMBY protest movements have aroused an interest in researching public risk assessments. In addition to the studies on uncertainty and causation that are linked to severe environmental outcomes (Ricci et al., 2003), the most popular fields are studying the impact from WTE to human health (Misra and Pandey, 2005; Giusti, 2009), and analyzing the willingness to pay (WTP) i.e. the maximum amount of money that one is willing to sacrifice, to

* Corresponding author.
E-mail addresses: xiangyusherry@gmail.com (X. Ren), yche@des.ecnu.edu.cn (Y. Che), kyang@re.ecnu.edu.cn (K. Yang), tay2009cj@163.com (Y. Tao).

http://dx.doi.org/10.1016/j.wasman.2015.10.036
0956-053X/

prevent the construction of WTE or the offer of other treatments (Basili et al., 2006; Afroz et al., 2009). Besides, some researchers analyzed the association between socioeconomic variables and local attitudes toward sacrifice cost or compensation and found that some variables, such as age, economic risk, treatment method and doubt regarding compensation, will lead to protests (Groothuis and Miller, 1994; Ferreira and Gallagher, 2010). Other studies focused on the public attitude toward WTE and risk. Some social and economic factors were found to influence the public opinion toward environmental pollution and risk (Petts, 1992; Lima, 2004). In some case studies of anti-WTE campaigns, the policy procedures and government activity even played a more important role than assumed (Hsu, 2006; Davies, 2008). Other efforts are directed toward communicating scientific information with the public by focusing on public health risks, psychological analysis and communication systems (Covello et al., 1987; Ishizaka and Tanaka, 2003; Reynolds and Seeger, 2005), and toward decision making methods including all stakeholders (Contreras et al., 2008).

However, the role of environmental education, i.e., whether the levels of risk awareness and knowledge affect the risk perception and protests among the most impacted population around WTE facilities, especially strong protesters, are still opaque, especially in developing countries. It is also unclear if there are other factors that can influence the perception of risk as well as the distribution of risk perception around WTE facilities. Furthermore, given the heterogeneity of risk distribution, the geographical influence on residents' choices to reject compensation has not been clarified.

Therefore, this study displays insight into public awareness, acceptance and risk perception toward WTE based on questionnaire results, using the WTE facility in Shanghai, i.e., JQP, and local risk conflict as a case study. Additionally, we are curious about the factors impacting the perception within local communities and the factors influencing the protest response. To investigate the association between the above WTE-related characteristics (acceptance, risk perception etc.) and geographical characteristics, including the direction and distance to the WTE facility, a face-to-face questionnaire survey was conducted among nearby residents based on an ArcGIS-based division of the study area. Finally, as an economic quantification of the loss of environmental quality and risk perception, the compensation, i.e., the amount of money that respondents are willing to accept (WTA) to put up with a WTE plant operating in their neighborhood, was evaluated based on the Dichotomous-Choice contingent valuation method (DC-CVM).

2. Material and methods

2.1. Study area

As one of the four waste incinerators, the operation of JQP began in 2003 in the Putuo District of Shanghai, 11 km from the city center. It is located between the city center and the suburban area (Fig. 1a). It mainly combusts waste from Putuo District and waste from the bordering Jiading District. The average population density of the Putuo District is 23,564 per km^2 (the 6th in all districts of Shanghai), and the GDP per capita in this district is 55,721 CNY (9082 USD) in 2013, ranking the 14th among the 17 districts of Shanghai. The WTE plant combusts 600,000 tons of wastes each year which are approximately 15% of all that are generated in Shanghai. The heat generated will be recovered into steam and will be used to produce almost 100 million kWh of electricity per year, approximately 0.8% of the electricity consumption in Shanghai. During this period, more residential areas have continued to emerge close to this existing WTE due to the relatively lower prices of real estate compared with other districts. These residential areas are mainly assembled to the south, east and southwest of JQP. Meanwhile, the area to the west and the area close to the incinerator in the north are industrial areas with little population (Fig. 1b). According to the report from the operator and to the *Standard for pollution control on municipal solid waste incineration of China* (*GB 18485–2014*), which sets the national maximum limit of dioxins as 0.1 ng/N m^3, JQP met the limit, as well as other pollution limits such as NO_x and SO_2 (Ministry of environmental protection of the People's Republic of China, General administration of Quality Supervision, Inspection and Quatantine of the People's Republic of China, 2014). However, with a large surrounding population, JQP is often cursed for the existing environmental problems or the potential ones from this process, and there have been anti-WTE demonstrations held by residents. Therefore, it is an interesting case study of the residents' willingness to accept in municipal solid waste management.

In the pre-survey, respondents living farther than 3 km from JQP showed little interest or even unawareness toward the incinerator. Therefore the final study area was set within 3 km from JQP. Additionally, in the pre-survey, the residents in different directions and distances appeared to be exposed to different aspects and levels of risk and concerns. Therefore we assume that the geographical location influences risk perception. The prevailing wind directions in the study area are southerly winds in summer, northerly winds in the winter, and east to southeast in spring, east to northeast in autumn. Moreover, participants in previous demonstrations mostly live in the south, and they showed strongest attitude in the pre-survey. Given all the above, to verify this assumption, the study area was segmented into 5 concentric rings, which were further segmented into 20 grids distributed in 4 directions at 5 levels of distance (Fig. 1b). Each grid was numbered, e.g., grid N1 is the grid to the north and within the distance of 1000 km.

2.2. Methodology

2.2.1. Evaluation of WTA using DC-CVM

Among several methods of CVM (open-ended questionnaire, payment card method, dichotomous choice method), the payment card (PC) method is a direct, fast and the least expensive, therefore PC method was adopted for in the pre-test (Blaine et al., 2005). DC-CVM is most commonly used to evaluate non-market goods by calculating WTP or WTA. The National Oceanic and Atmospheric Administration of USA (NOAA) panel limits the usage of WTA, whereas WTP has become the leading method for evaluating the environment and ecology other than WTA (Arrow et al., 1993). However, WTA can better characterize the loss by environment degradation or the abrogation of an improvement program (Brookshire et al., 1980). In developing countries, due to more social cost of environmental destruction borne by vulnerable groups, WTA can reveal the loss of environmental benefits (Venkatachalam, 2004). Therefore, WTA was chosen to characterize the loss of benefits in this study. A regression model was applied to explore the factors impacting the WTA.

2.2.2. Comparison among different groups of respondents

The discriminant analysis method (Fisher, 1936) maximizes the linear combination of independent variables between groups and minimizes it within groups. It can be applied to differentiate between groups more effectively than the Logit technique (Halstead et al., 1992; Raymond and Brown, 2006). Therefore, in this study, discriminant analysis was applied to ascertain the differences among respondents who selected different choices when referred to WTA. In total, 22 endogenous factors from 3 categories, including geographical information factors, knowledge and impact factors, and socioeconomic factors, were taken into stepwise discriminant analysis.

Please cite this article in press as: Ren, X., et al. Risk perception and public acceptance toward a highly protested Waste-to-Energy facility. Waste Management (2015), http://dx.doi.org/10.1016/j.wasman.2015.10.036

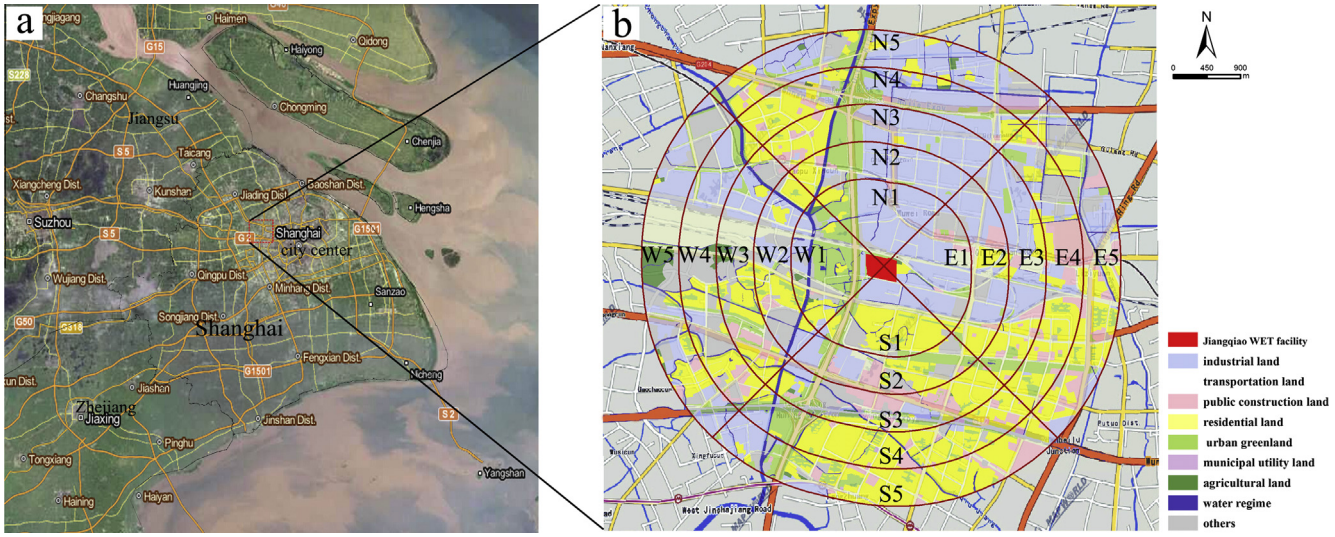

Fig. 1. Land-use types, distribution and scale of households, and the segmentation of the study area.

2.2.3. Questionnaire design

The questionnaire was designed as structured and simple to collect enough information on public opinion regarding the problems of JQP. It included four components. First, *Part 1 Knowledge and acceptance* measured the knowledge of the general method of WTE in China, including the preferred waste treatment method, the benefits and defects of WTE (multiple-choice), and trust in the government and company management (multiple-choice). Second, *Part 2 Perceived risk and complaints* included the awareness of former accidents of JQP, sustained pollution, concerns about potential risk (multiple-choice), and complaint experience.

Then, *Part 3 Willingness to accept* asked the respondents about their WTA for existing and sustained problems. In the pre-test, a series of money amounts representing the monthly compensation widely ranging from 50 to 5000 CNY per month (from 8.05 to 805 USD) were provided in the payment card as choices to get a rough assessment of the WTA among respondents. Based on the pre-test results, 8 bids (100, 200, 400, 600, 800, 1000, 1500, and 2000 CNY, i.e., 16.1, 32.2, 64.4, 128.8, 161, 241.5and 322 USD) were applied into the single bounded dichotomous choice (SBDC) method in CVM in the final investigation. Bases on the impacts that were assessed by the respondents themselves in Part 2 of the questionnaire, respondent were asked to decide whether to accept household financial compensations for the subsequent five years or not. If the answer was yes, a randomly selected bid from the eight numbers would be provided for the decision. If the respondent refused to accept the compensation, the reason was asked. For these 8 kinds of bid, the possibilities to be asked were the same.

Finally, *Part 4 Personal attributes* collected the socioeconomic characteristics (e.g., gender, age, education, occupation), including the time lived in this region, youngest child in the household, and work experience in environment-related careers. In addition, the grid number and residential address of the respondent was recorded.

2.2.4. Field survey and data collection

Fifty respondents were invited in the pre-test, and the results were analyzed to avoid possible misinterpretations and to determine the range of the bids in the formal investigation. Noting that local residents suffered more from environmental problems and concerned more about the potential risk, their WTA revealed more information. Therefore, only local residents were interviewed by household, whereas travelers and commuters were excluded from the sample. Equal amounts of questionnaires (50 questionnaires) were taken in each grid to obtain enough and equivalent information for the whole study area, except for some grids with little (20 questionnaires) or no residential land (0 questionnaires). Each questionnaire had a unique ID, by which it can be located to the right position on map. Anonymous face-to-face interviews were conducted by trained graduate students from East China Normal University. The survey was conducted on sunny weekends in the daytime (from 9 am to 6 pm) on June 28th and June 29th, 2014, when most local residents stayed within the residential area. The data obtained from the survey were analyzed using PASW 18.0.

3. Results

3.1. The distribution and demographic profile of the respondents

After deleting the incomplete questionnaires, the effective sample size was 748 (99.2%). The sample size was largest in the south, where residential areas evidently gather. The sample size in grids closest to the incinerator was otherwise relatively small (Table 1) because the types of land-use in grids E1, N1, and W1 are mostly industrial land. A similar situation appears in grids N5 and E4. This distribution shows a reasonable proportion in compliance with the different residential populations in different areas.

The respondents' socioeconomic characteristics in all of the grids are described in Table 2. The gender proportion as well as age distribution are reasonable and consistent with the demographics in Shanghai. Of the sampled residents, 56.4% live in a nuclear family, 52.9% have juveniles less than 18 years of age at

Table 1
Distribution of questionnaires at different distances and directions of the study area (%).

Distance	Direction			
	East	North	South	West
<1000 m	0*	1.7	7.0	1.6
1000–1500 m	1.7	6.3	7.9	6.4
1500–2000 m	7.6	8.0	5.2	7.1
2000–2500 m	6.8	5.9	6.7	1.9
2500–3000 m	6.7	2.4	6.7	2.4

0*: the type of land-use in grid E1 is monotonously industrial land, therefore no questionnaire was distributed in this grid.

Please cite this article in press as: Ren, X., et al. Risk perception and public acceptance toward a highly protested Waste-to-Energy facility. Waste Management (2015), http://dx.doi.org/10.1016/j.wasman.2015.10.036

Table 2
Demographic profile of the respondents.

Item	Status	Percentage (%)	Item	Status	Percentage (%)
Gender	Male	58.0	Education level	⩽Junior high school	30.2
	Female	42.0		Senior high school	28.5
Age	⩽17	5.6		Junior college	15.8
	18–25	9.1		Undergraduate	21.8
	26–35	25.7		⩾Graduate	3.7
	36–45	11.5	Occupation	Student	8.2
	46–55	12.4		Teacher	1.7
	⩾56	35.7		Doctor	0.5
Household population	⩽3	56.4		Worker	31.0
	4–5	36.5		Civil servant	2.5
	⩾6	7.1		Farmer	0.5
Age of the youngest child in family	No child	21.4		Unemployed	2.3
	0–2	19.5		Retired	34.0
	3–6	16.0		Others	19.3
	7–17	17.4	Personal income (monthly, CNY)	<1000 (161 USD)	14.3
	⩾18	24.9		1000–3000 (161–483 USD)	28.9
When moved to the present house	Before construction	20.9		3000–5000 (483–805 USD)	30.2
	During construction	9.2		5000–8000 (805–1288 USD)	14.0
	After operation	69.9		>8000 (1288 USD)	12.6
Local or NOT	Local	71.5	Family employed in an environment-related career	Yes	8.6
	Non-local	28.3		None	91.4
Possession of real estate	Yes	77.9	Visited JQP	Yes	4.6
	No	22.1		None	95.5

home, and 35.6% have preschoolers at home. In the survey, 71.5% are Shanghainese in accordance with the proportion that possessed real estate (77.9%). Among the respondents, 30.1% had moved to their current houses before JQP was constructed or put into operation, and 69.9% moved into the study area after the operation of JPQ was started. An education level of junior high school or lower composed 30.2% of the sample, and 25.5% of the respondents had at least an undergraduate education. A monthly wage less than 3000 CNY (483 USD) was earned by 43.2% of the respondents, including 14.3% with a monthly wage less than 1000 CNY (161 USD). The residents in the study area had a lower middle income level compared with the monthly minimum wage (1820 CNY, i.e. 295 USD) and the average monthly income (5036 CNY i.e. 816 USD) in Shanghai, 2013. Finally, only 4.6% of the sampled residents had ever visited JQP, and in 8.6% of the sampled families, there was at least one person employed in an environment-related career.

3.2. The acceptance and knowledge of Waste-to-Energy facilities

3.2.1. Acceptance

On the whole, the respondents' most preferred terminal treatment for MSW is WTE, supported by 49.9% of the respondents in total. Fig. 2 shows the distribution of the preference of terminal treatments in each residential community, and the area of each pie represents the number of questionnaires taken in this residential community. Even when considering the direction and distance, WTE still occupies the majority of responses. This optimistic result indicates a relatively optimistic prospect for the promotion of WTE. However, in the south, the support rate for WTE is relatively lower than that in other directions. Additionally, it is obvious that the shorter the distance to JQP, the lower the support rate for WTE will be, e.g., the acceptance is not more than 50% in any residential community within a distance of 1000 m.WTE received a support rate of 0 in 8 communities in the south, which did not occur in other directions.

Then, all of the respondents were asked about their main concerns regarding WTE in China; 51.7% of them worry that the lack of MSW source separation will lead to opacity in combustion material and in the subsequent emissions. A number of residents, 47.2% and 46.9% respectively, doubt the supervision and the technique of combustion, i.e., the government and operator are widely doubted. A number of respondents (38.8%) consider the population around the WTE facilities in China to be too large, possibly multiplying the potential risk.

3.2.2. Knowledge

To all of the respondents' opinion, the ranking of benefits of WTE facilities are as following: renewable energy (56.3%), conservation of land (40.2%), high treatment efficiency (32.1%), and reduction of greenhouse gases (11.9%). This ranking remains stable in different directions and distances (Fig. 3), i.e., the residents have obtained knowledge about WTE, especially on renewable energy, and WTE is viewed relatively positively. In addition, 12.0% of respondents selected no benefits at all. This percentage shows a geographical distribution, as it declines as the distance from the WTE facility lengthens, from 16.9% in grids within 1000 m to 6.6% in grids between 2500 m and 3000 m. Moreover, these "no benefit" percentages in the south and west (15.6% and 13.1%, respectively) are larger than to the north and east (11.5% and 6.4%, respectively). This distribution of percentage indicates a certain degree of antipathy toward WTE in the highly impacted areas.

In regard to the defects, a similar distribution appears. The average selection rate for "no defects" in all grids is 3.7%, and this percentage increases with distance, from 1.3% in grids within 1000 m to 6.6% in grids between 2500 m and 3000 m. Additionally, the most mentioned defects are: other air pollution, stench and harm to health (respectively 60.4%, 56.0% and 54.3% in total). In detail, stench is viewed as the biggest defect both in the south and west (with percentages of 68.0% and 65.5%, respectively), whereas it ranks second and fourth in the north and east, respectively.

Please cite this article in press as: Ren, X., et al. Risk perception and public acceptance toward a highly protested Waste-to-Energy facility. Waste Management (2015), http://dx.doi.org/10.1016/j.wasman.2015.10.036

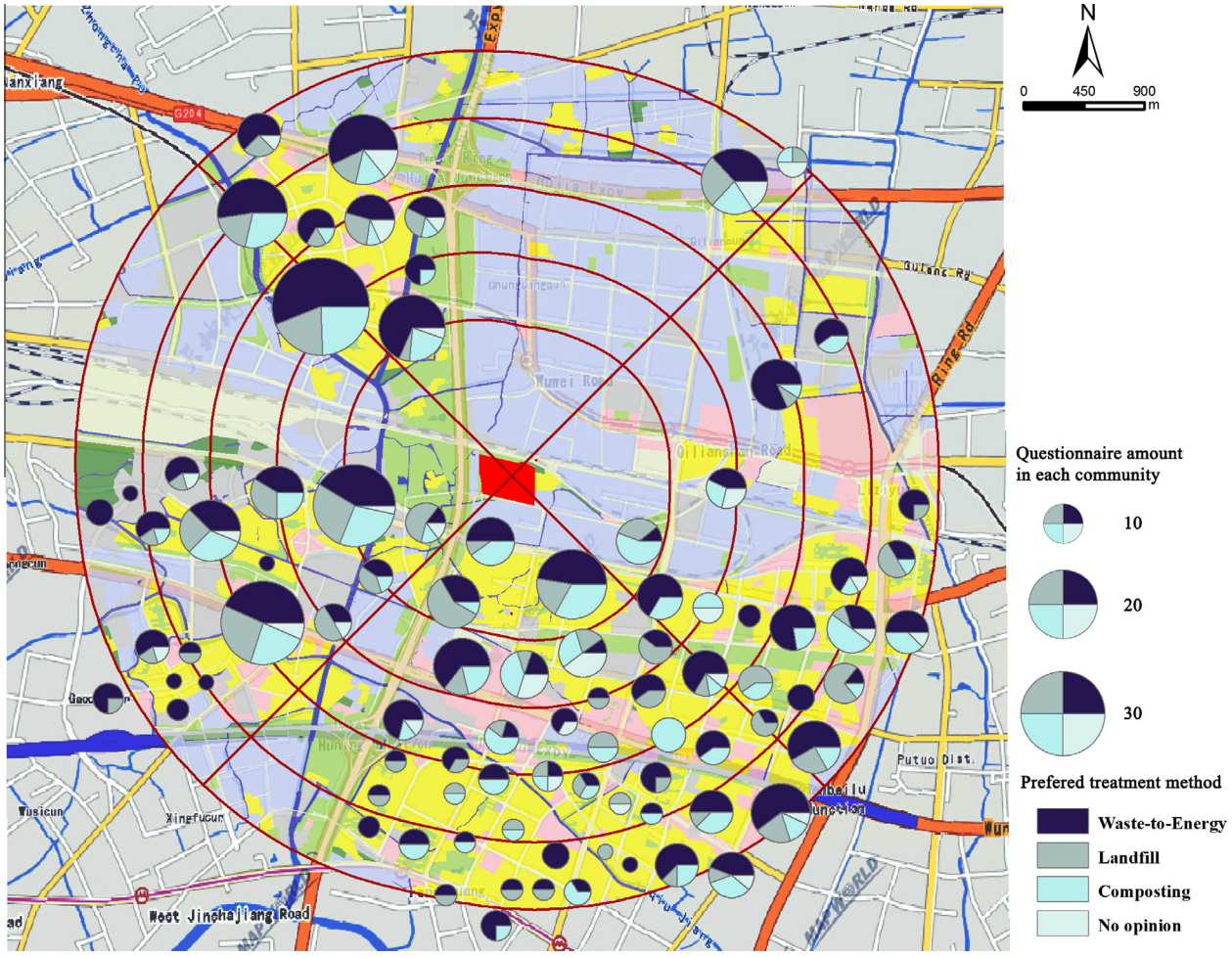

Fig. 2. Distribution of respondents' preferred facility for MSW treatment.

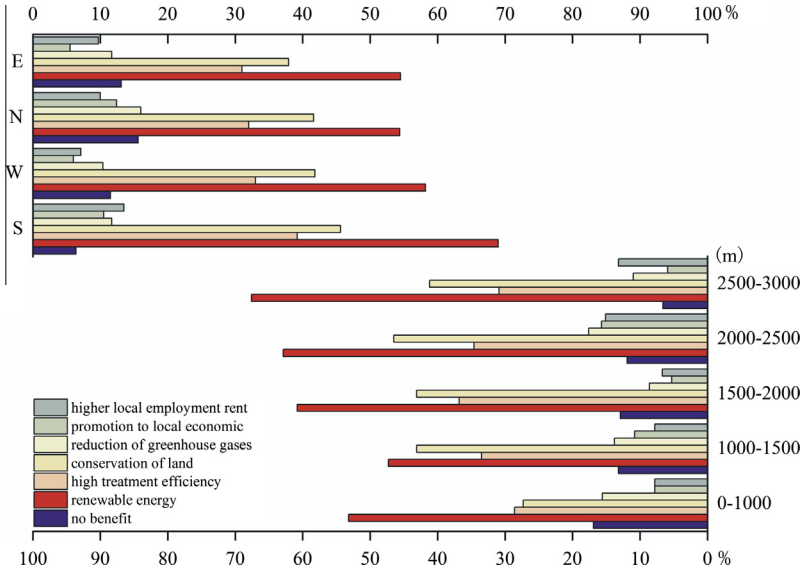

Fig. 3. Benefits of Waste-to-Energy facilities (multi-selection).

3.3. Risk perception and satisfaction on JQP

Overall, the top three most concerning impacts, including perceived and potential impacts, of the residents around the WTE facility are harm to health (55.5%), stench and other air pollution (both are 49.2%), followed by dust (32.9%) and dioxins (23.3%). It is important to note that the most concerning problems all relate to air pollution. Moreover, these anxieties about air pollution do

Please cite this article in press as: Ren, X., et al. Risk perception and public acceptance toward a highly protested Waste-to-Energy facility. Waste Management (2015), http://dx.doi.org/10.1016/j.wasman.2015.10.036

not have geographical diversities, except stench and accidents, such as exposure. These two are viewed as more serious in the south and the west than in the east and the north, and their rankings declined with greater distance.

Given these anxieties, however, only 5.8% of respondents made complaints in the past year. Among these, stench was most commonly complaint (83.7%), followed by other air pollution (9.3%), dust and noise (both 4.7%). These complaints mostly came from the residents in the west (60.5%) and south (25.6%) and mostly from within distances of 1000 m (34.9%), 1500 m (39.5%), and 2000 m (20.9%). Moreover, more direct approaches, such as telephone complaints (34.9%), petitions (23.3%) and even demonstrations (16.3%), were taken rather than written complaints or complaints made on the Internet.

3.4. Risk communication

3.4.1. Information source

Only 20.1% of all respondents had been informed about the operation of JQP before the survey (Fig. 4). This percentage is larger in the south (33.6%) and within a distance of 1000 m (51.9%) than in other areas. The nearer the respondents live to the WTE facility, the higher the possibility they knew about its operation. Thus, it seems appropriate to say that the coverage of the risk communication program is highly centralized. However, for the majority of respondents informed, 10.8% and 9.0% were informed through discussions within their neighborhood and through the Internet, respectively, and unexpectedly, the government and the WTE operator played a minor role (only 1.2% and 1.3%, respectively). Therefore, the lack of information and the concern among residents, especially among those who live farther from the facility, are ascribed to the shortcomings of the risk communication program.

Then, if available, which is the most preferable solution for risk communication? The most preferred solution of the respondents is the Internet (36.8%), followed by brochures (31.2%) and experts (27.9%). Approximately 25.7% of the respondents had no interest, which is greater than the percentage of those who preferred information from the government (21.4%). This lack of interest and mistrust in the government appear to be one of the obstacles to risk communication, especially in developing countries.

3.4.2. Awareness about former accidents

During the operation of JQP in 2013, there was one explosion accident on December 5th. Assuming that the awareness of former accidents will lead to greater risk perception and concerns, the questionnaire asks the respondent if he or she was aware of former accidents and, if so, how. Among the 748 respondents, 31.3% were aware of former accidents. The percentage of awareness increased significantly with a shorter distance to the WTE facility, and in grids within 1000 m, the percentage was 55.0% (Table 3). Most of them were informed through TV reports (35.0%), their neighborhoods (29.1%) and the Internet (25.6%), and 7.3% of them experienced or saw the accident personally. Only 3.4% and 3.0% were informed by the JQP operator and the government, respectively.

3.5. CVM estimation results

3.5.1. The identification of protest WTA

The proportion of positive WTA and 0 WTA shows a significantly large percentage for 0 WTA, which is 60.2% (450 people), and only 39.8% of all of the respondents (298 people) report

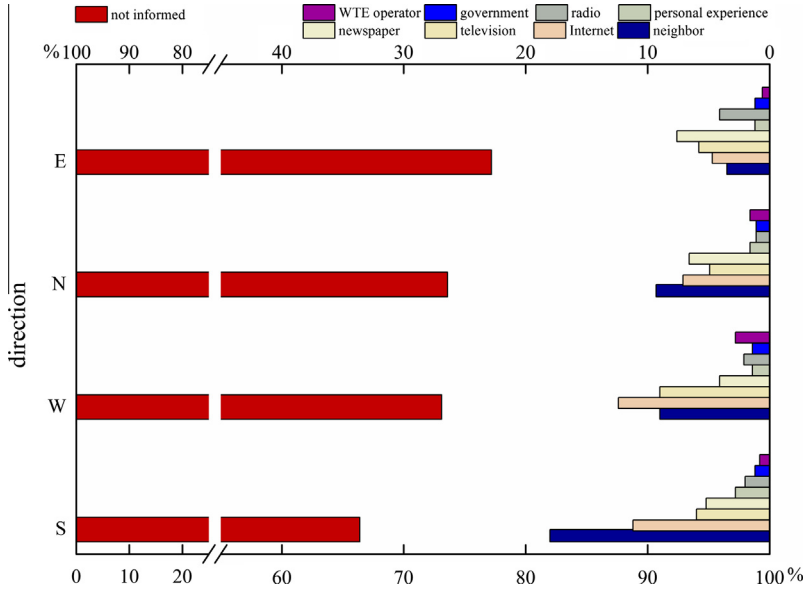

Fig. 4. Source of information regarding the operation of JQP (multi-selection).

Table 3
Respondents' awareness of former accidents of JQP (%).

	0–1000 m	1000–1500 m	1500–2000 m	2000–2500 m	2500–3000 m
Not informed	44.2	65.9	68.9	77.4	75.7
Exposure	52.0	31.1	29.2	21.4	22.1
Fire	3.9	0.6	1.0	1.5	0.7
Casualties	0	1.8	0.5	0	1.5
Others	0	0.6	0.5	0	0

Please cite this article in press as: Ren, X., et al. Risk perception and public acceptance toward a highly protested Waste-to-Energy facility. Waste Management (2015), http://dx.doi.org/10.1016/j.wasman.2015.10.036

Table 4
Comparison between positive WTA, valid 0 and protest WTA.

	No.	Percentage (%)
Positive WTA	298	39.8
0 WTA	450	60.2
Protest WTA	381	50.9
Valid 0	69	9.2
Financial compensation cannot make up for the loss	290	64.4
Declare anti-incinerator attitude	125	27.8
Do not believe in the appropriate apportionment of compensation	35	7.8
The impact is too small to require compensation	60	13.3
The compensation budget should be applied to solve pollution problems	7	1.6
Others	2	0.4

positive WTA (Table 4). When referring to the reasons (multiple-choice), 64.4% of the respondents feel that no financial compensation can make up for their loss, especially of health, and 27.8% want to declare their strong anti-incinerator attitude. Of the 0 WTA respondents, 7.8% do not believe that the compensation will be distributed appropriately, and 13.33% answer that there is no need for compensation because the impact is small; 1.56% of these respondents consider that the budget should be applied to improve the environment rather than to pacify the residents.

The first 3 reasons are considered to be protest WTA responses (for ethical reasons or for suspicion against the method), and others are seen as valid 0. Although the reasons are multiply selected, no respondent selected both a protest reason and a valid-0-WTA reason. Therefore, the 0 WTA respondents are divided into valid 0 (9.2% of all respondents) and protest WTA (50.9%). High rejection percentages between 50% and 91% have also been recorded in previous studies (Rowe et al., 1980; Ferreira and Gallagher, 2010).

3.5.2. Estimated mean WTA

First, logistic regression is used to analyze the influence of the respondents' willingness to receive the bid when the sample only included 298 positive WTAs. Because the positive WTA represents a small percentage of all respondents (39.8%) and valid 0 represents 9.2%, positive WTA and valid 0 are introduced into the calculation to reduce the bias. Due to the small variances associated with the log transformations, valid 0 respondents were substituted by small values (0.1 CNY) and were taken into log linear estimation (Amigues et al., 2002). The factors in the results were presented using abbreviations which are described in Appendix A. The regression results (Table 5) show that education level (EDU), employed in an environment-related industry (MEM), distance to the WTE facility (DIS), and the amount of compensation provided to respondent (BID) affect the WTA (at the 5% significance level). BID and DIS are positive, signifying that the nearer to JQP that the respondent lives, the lower the possibility of accepting compensation will be. In the same circumstance, the larger the compensation is, the larger the possibility of acceptance will be. Regression also indicates that respondents with a higher education level tend to refuse the compensation and that having a family member employed in an environment-related industry increases the possibility of respondents refusing the compensation.

Table 5
Results from the binary logistic regression explaining the factors influencing the acceptance of provided bids.

	Positive bids and valid 0, $n = 367$				
	B	S.E.	Wald	Sig.	Exp (B)
EDU	−0.433	0.135	10.238	0.001	0.649
MEM	−1.108	0.437	6.433	0.011	0.330
DIS	0.316	0.138	5.245	0.022	1.371
LBID	−0.932	0.388	5.758	0.016	0.394
BID	0.001	0.000	4.103	0.043	1.001
Constant	3.965	0.999	15.760	0.000	52.732
-2LL	236.673				
H&L Sig.	0.873				
Chi-square	3.821				

The formula suggested by Hanemann (1989) is used in the WTA calculation:

$$E(\mathrm{WTA}) = \int_0^{2000} (1 + e^{-\alpha+\beta \mathrm{BID}})^{-1} \mathrm{dBID} \quad (1)$$

where E(WTA) is the estimated mean WTA, e is the natural logarithm, α is the constant in logistic regression result, βBID is the coefficient of parameter BID. The mean WTA for the sample is 1887.6 CNY (303.9 USD) per household per month.

4. Discussion

4.1. Geographical distribution of valid 0, positive WTA and protest WTA

Given that the risk leaded by WTE is spatially arranged, it is usually assumed that the distributions of the three choices, i.e., valid 0, positive WTA and protest WTA may show a certain consistency. It is thus intriguing to study the geographical distribution among respondents (Fig. 5). The protesters do not show a clear geographical distribution. It is true that most residential communities in the east and north have smaller protest rates than others. But some communities at the farthest distances to the east and north show a larger protest rate than communities in the south and west. However, the direction has a correlation with the choice of valid 0 at the 0.01 level (correlation coefficient = −0.142, Sig = 0.000). In other words, residents in the east and north tend to choose valid 0 more than in the south and west. This can also be read from Fig. 5.

In addition to risk perception, the spatial distribution is also a consequence of many underlying socio-demographic factors, such as income and education level (Bateman et al., 2006). This spatial distribution indicates the uneven distribution of benefits. Similar results can be referred that the WTP/WTA of the sampling point cannot be applied to the whole area, but can be a beneficial transfer method to predict the WTP/WTA (Troy and Wilson, 2006; Campbell et al., 2009). Therefore, the compensation policy as well as the risk communication policy should consider the different tolerances of risk and loss of the residents.

Apart from all the above, some other risk resources may affect the geographical distribution as well, such as waste transportation. Most of the wastes are collected by back-loading compacting trucks and transported directly to JQP, and the loading capacity for each is 5 t or 8 t. Other wastes are collected and sent to transfer station to be compacted, and sent to JQP by containers then. The volume of each container is 15 m^3. Given the large workload and the potential risk (Bellander et al., 2001); even though there is merely any complain about the traffic from the residents for now, there may be some existing but ignored risk from the busy traffic. In the forthcoming research some more risk resources should be taken into consideration.

4.2. Knowledge and concern toward WTE among protesters

Protesters who show a strong anti-WTE attitude are commonly assumed to have less knowledge about WTE. However, the further analysis of knowledge and acceptance in this study reveals that the

Please cite this article in press as: Ren, X., et al. Risk perception and public acceptance toward a highly protested Waste-to-Energy facility. Waste Management (2015), http://dx.doi.org/10.1016/j.wasman.2015.10.036

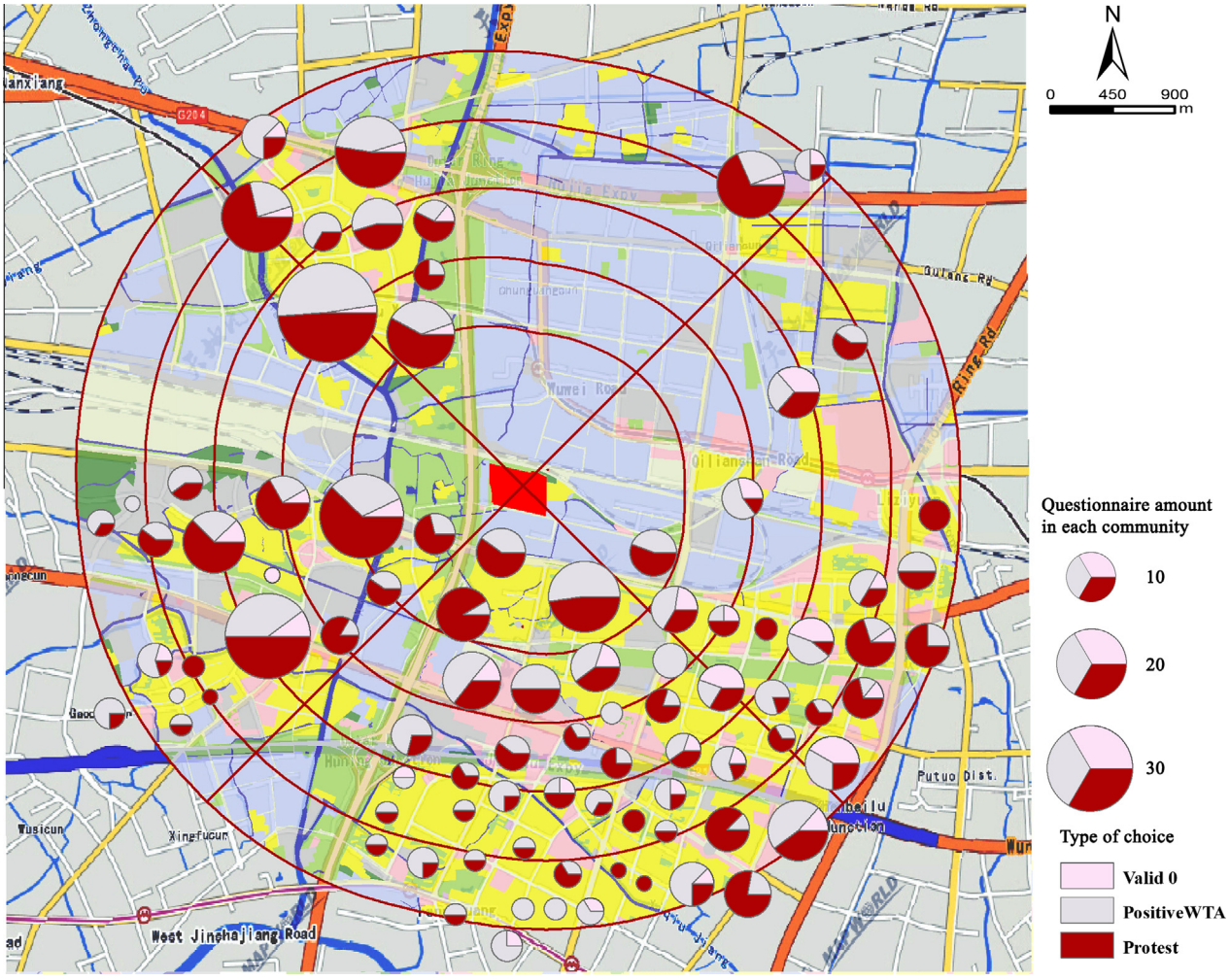

Fig. 5. Geographical distribution of protest WTA, valid 0 and positive WTA in each residential community.

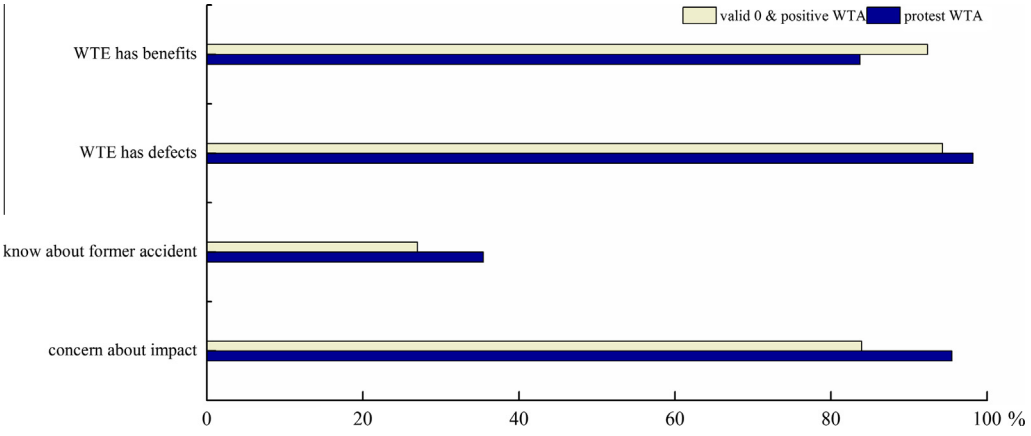

Fig. 6. Comparison of the knowledge, concern and awareness of former accidents between protesters and other respondents.

protesters have similar knowledge as the other respondents (Fig. 6). The "no benefits" percentage in protesters (16.3%) is higher, but not significantly greater than that in other respondents (7.6%). Additionally, 1.8% of protesters selected "no defects", which is slightly less than the non-protesters (5.7%). Given that this result contains possible emotional bias, if any, it is legitimate to assume the knowledge gap between protesters and non-protesters to be even smaller in reality. However, between protesters and other respondents, the differences of impact perception, i.e., the percentage of selecting "no impact" seems to be slightly larger when referring to concerns (respectively are 4.5% and 16.1%). Some interview researches revealed a preference of WTE as the treatment method of MSW, and significant information gaps between communities (Achillas et al., 2011), but the information gaps were studied

Please cite this article in press as: Ren, X., et al. Risk perception and public acceptance toward a highly protested Waste-to-Energy facility. Waste Management (2015), http://dx.doi.org/10.1016/j.wasman.2015.10.036

among different residential communities, not among people with different opinions. More similar results can be showed in other study that scientific arguments will contribute little to changing the public's attitude against WTE (Tang and Tang, 2000).

In the result, there is a certain consistency between the knowledge gap and the concern gap, explained according to the classic knowledge theory, which indicates that people tend to perceive a new technology or service as more dangerous when they know it to be dangerous (Dake and Wildavsky, 1990). As in the survey, the awareness of former accidents (Fig. 6) was higher in protesters (35.4%) than in other respondents (27.0%). Still, the high protest percentage can be accounted for by how "risk" is defined among respondents. This definition can be affected by emotive stimulation, concerns and/or mental fears even more importantly than scientific evidence (Kikuchi and Gerardo, 2009). And the high concerns will be a direct result of involuntary risks, potentially catastrophic risks, and risks to the health of future generations according to psychometrics. Besides all the possible impact factors, laypeople tend to place greater weight on potential catastrophes and damage to health than experts (Petts, 1992; Fischhoff, 1995; Huang et al., 2013). Moreover, given that the anti-WTE demonstrations show a strong conflict toward the WTE policy, it is difficult for respondents to distinguish between valuing the policy and valuing the "goods". It is therefore valid to assume that the outrage toward the facility affects the concerns and protest WTA greater than the risk and hazard perception or that the WTA might be canceled by the negative valuation toward the policy (Randall, 1986; Blomquist and Whitehead, 1998; Macmillan and Duff, 1998).

Thus, the respondents who protest the bidding have similar knowledge about WTE to non-protesters, and they know even more about the potential risk of WTE. At the same time, they also have concerns. Therefore, they might have a positive, yet canceled WTA, which is supposed to represent their real impact and concerns.

4.3. Population characteristics of the protesters

Previous research regarding the protest of compensation has shown its association with certain characteristics, such as age, gender, income and homeowner status (Groothuis and Miller, 1994; Ferreira and Gallagher, 2010). Given the assumption that geographical information will influence the respondent's selection, we introduce distance, direction, and opinion on WTE facilities as regression variables to explain the influence on the possibility that a resident supports a protest. Table 6 summarizes the regression results. Respondents with a greater perception of impact, higher income, and more experience of sensing stench from the WTE facility will be more likely to protest the WTA bids. Additionally, women tend to protest the WTE facility more than men.

However, these results confound some of the assumptions, but the geographical information is excluded. Additionally, this regression does not perfectly predict the reality, as represented by low H&L Sig and C&S R^2.

The existing but non-valid results induce one further question, i.e., do protest bidders substantially differ from respondents who selected valid 0 and positive WTA? In other words, are the differences in socioeconomic status between protesters and others significant enough to lead to different WTAs as Freeman (1993) stated?

Stepwise discriminant analysis results between 3 groups show that among all of the factors tested, the classification model is determined by 5 endogenous factors: perception of impact or not (IMP), the respondent's age (AGE), respondent's income(INC), the direction (DIR), and opinion on the benefits of WTE(BEN) (sorted according to influence). In other words, it should be possible to predict a respondent's choice among protest WTA, valid 0 and positive WTA by introducing the perception of impact, age, income, direction and opinion toward WTE into the classification model.

It is interesting to note that besides the commonly related factors, such as income and age, the results show that different value judgment positions, such as the opinion about the benefits of WTE and the perceived impact, as well as the geographical origin, i.e., the direction from the WTE facility, are determinants of protest behavior. Similar results have been proven by other studies (Meyerhoff and Liebe, 2010).

However, this classification model shows a poor fit. Merely 60.9%, 55.4% and 45.0% of respondents from 3 groups (valid 0, protest WTA, and positive WTA, respectively) could be sorted into their appropriate groups. Moreover, the first two most important functions take relatively low percentages of variation (56.6% and 43.4%, respectively) of the sample. In addition, a high Wilks' Lambda (0.846 and 0.930) and low Canonical Correlation (124.305 and 54.241) indicate that the differentiation of grouping is not ideally clear compared with other similar research (Halstead et al., 1992).

Therefore, the respondents' socioeconomic characteristics do not significantly differ among the three types of bidding choices in this case study. In other words, the average potential WTA of protesters is not the same with positive bidders or the valid 0. Fortunately, the different treatments of protest WTA (Heckman, 1977) may not lead to unacceptable sample-selection bias in WTA estimates, as per the insignificant classification, and the elimination may lead to a relatively smaller bias (Strazzera et al., 2003).

4.4. Risk perception and risk communication

Previous researches assumed that environmental pollution and potential risk will affect residents' concerns about substantial environmental impacts (Miranda and Hale, 1997; Cheng et al., 2007; Shekdar, 2009; Kothari et al., 2010). If this is taken as the assumption in this study, respondents' risk perception should be associated with their opinion about WTE, the real risk and other socioeconomic factors. The regression results (Table 7) show that

Table 6
Results from the binary logistic regression explaining the factors influencing protest.

	B	S.E.	Wald	Sig.	Exp (B)
IMP	1.344	0.300	20.029	0.000	3.835
INC	0.267	0.066	16.460	0.000	1.306
BEN	−0.822	0.258	10.163	0.001	0.439
GEN	−0.389	0.161	5.861	0.015	0.678
STE	0.376	0.175	4.588	0.032	1.456
Constant	−1.471	0.445	10.914	0.001	0.230
-2LL	959.813				
C&S R^2	0.098				
H&L Sig.	0.597				
Chi-square	6.450				

Table 7
Results from the binary logistic regression explaining the factors influencing risk perception.

	B	S.E.	Wald	Sig.	Exp(B)
DEF	2.923	0.513	32.503	0.000	18.599
STE	2.967	0.741	16.046	0.000	19.429
GEN	−0.849	0.290	8.562	0.003	0.428
EDU	0.335	0.122	7.488	0.006	1.397
Constant	−1.145	0.533	4.615	0.032	0.318
-2LL	383.480				
C&S R^2	0.135				
H&L Sig.	0.091				
Chi-square	13.675				

Please cite this article in press as: Ren, X., et al. Risk perception and public acceptance toward a highly protested Waste-to-Energy facility. Waste Management (2015), http://dx.doi.org/10.1016/j.wasman.2015.10.036

risk perception and concerns are influenced by 4 factors: the opinion on the defects of WTE (DEF), perception of stench, gender and education level. The opinion played the most important role. Respondents with more experiences of stench and a higher education level will perceive more risk and have more concern. Women and respondents with the viewpoint that WTE has defects tend to perceive more risk as well.

This result indicates that one way to reduce emotional protests and to reduce the "overpriced" risk perception is to improve public relation and risk education i.e. risk communication (Petts, 1992), as the opinion on the defects of WTE played a significant role. However, one must see that the strong characteristic i.e. the high percentage of "no interest" in WTE information and the high protest of making trade-offs between risks, benefits and costs in this case study will cause receiver problems during risk communication. Moreover, neighborhoods and new media, such as the Internet, play a more important role in China (Zhang et al., 2012; Che et al., 2013) rather than the government or operator. This noticeable lack of trust in government and WTE operators will promote biased media reporting as well as the spread of the premature disclosure of information (Covello, 1989).

Also, the results show that residents around the WTE facility care less about the compensation than residents living farther from the facility. On one hand, the high protest rate toward WTE represents an increasing public environmental awareness and public concern about risk and health in China. At the same time, residents have more channels to express their opinions or protests. On the other hand, it reflected the doubt about local policy and government control, which are also considered as the main obstacle in compensation policy in other study (Hsu, 2006). And public confidence in government ability and injustice will decline if the public are excluded from the planning of WTE (Kikuchi and Gerardo, 2009).Therefore it is important to involve the public in the whole process: from initial location issue to the operation of WTE, than to simply pay compensation to local communities. However, as basic legal protection of the public participation in risk communication, legislation about environmental risk and risk communication is unsound in China and many developing districts (Misra and Pandey, 2005). Some experience can be learned from EU, where "including the public" is mandatory through legislation and should be a long-term process that includes the planning, construction, and operation periods of a new facility (Jupp, 1989; Walker et al., 1999).

On this basis, these results fostered completing the risk communication method and improving decision support tool in developing countries with high percentages of protest. The public definition of risk, besides the concerns of experts, should be included into risk assessments. If the public is informed that the potential risk is acceptably low and that it can take advantage or compensation from the facility, the communication will meet less resistance (Ishizaka and Tanaka, 2003). Some process analysis method, such as analytical hierarchical process and life cycle assessment can be applied to make ideal decision through quantizing pollution and risk of different stakeholders (Contreras et al., 2008).

5. Conclusions

This study revealed the characteristics of public awareness, acceptance and risk perception toward WTE. High proportions of protest among local communities in which the WTE facility is constructed were highlighted as the focus of this study, with an analysis about their distribution and a further analysis about their interrelationships. Risk communication was statistically analyzed, followed by discussion about cultural influence, legislation, and decision support methods.

The opinion about WTE is optimistic. WTE was the most preferred terminal treatment among residents, regardless of the distance to the WTE facility or the direction from the WTE facility, although the rating percentage was slightly lower in the most-impacted area. And renewable energy and conservation of land were highly noted by public without a geographical heterogeneity. At the same time, local communities criticized WTE for the stench and other air pollution. This leads to the conclusion that the local residents are able and willing to get access to information, which is positive news for promoting WTE as the terminal treatment of MSW in China or other developing districts.

The opinion about the defects of WTE, the education level, the previous experience of stench, and gender influenced the perception of risk, whereas the geographical location showed an insignificant relationship with the perception of risk. These results confounded the assumption about the geographical influence, indicating that knowledge and information about WTE played a more important role, indicating the advantage of effective risk communication in reducing the psychological resistance to WTE.

A high percentage of protest WTA regarding compensation was not a research deficiency but a part of reality. Risk perception, income, opinion about the benefits of WTE, gender and previous experience of stench influenced the choice of protest. This indicated that more existing and conceived risk and pollution would lead to a higher possibility of protesting the WTA bids. In other words, occurred environmental damage should be treated or compensated before the new action.

Residents showed less interest in compensation overall and whether the respondent accepted it or not had little statistical association with the amount of compensation, which corresponded with the high protest attitude. However, it was significant that respondents with a higher education level or who lived a shorter distance to the WTE facility tended to reject the bid.

After analyzing the differences among groups of people divided by their choices (protest WTA, valid 0 or positive WTA), an interesting conclusion was that three groups showed an existing but fuzzy statistical classification according to their characteristics. The classification model involved risk perception, age, income, direction, and opinion about the benefits of WTE as division factors. From the similarity between respondents who protested the WTA and those who selected positive WTA, it is appropriate to conclude that the protesters also had a need for compensation but rejected it for ethical reasons. Therefore in the managerial practice of compensation policy, these protesters should be involved. For them, the willingness to accept may be similar to the estimated mean WTA, but profound risk communication should be applied to get the ideal amount.

Statistical results revealed that the poor risk communication, together with limited education fostered the "overpriced" public concern and protest to a certain degree. The high percentage of "no interest" in WTE information and the noticeable lack of trust in government made the risk communication more difficult. The increasing environmental awareness among public shows the importance of involving the public in the whole process, as well as decision making methods taking each stakeholder into waste management.

This study concentrated on the risk and impact caused by WTE facility, excluding other risk resources. Associated risk resources such as waste transportation may lead to impact with different geographical distribution as well. The following research should include these resources. Another limit of the study is that only the perceived impact was taken into consideration, the pollution in reality, e.g. concentration of air pollution at ground level, was excluded. Further study can make insight into the relationship between pollution and public attitude, and the uncertainty and measurement.

Please cite this article in press as: Ren, X., et al. Risk perception and public acceptance toward a highly protested Waste-to-Energy facility. Waste Management (2015), http://dx.doi.org/10.1016/j.wasman.2015.10.036

Table A
Abbreviations in the statistical analysis.

Abbreviation	Description
Factors	
EDU	respondent's education level
MEM	whether there is family member who is employed in an environment-related industry
DIS	distance from the dwelling to the WTE facility
BID	the amount of compensation provided to respondent
LBID	the logarithm of BID
DEF	respondent's opinion on the defect of WTE
IMP	respondent's perception of impact or not
INC	respondent's income
BEN	respondent's opinion on the benefits of WTE
GEN	respondent's gender
STE	perception of stench or not
Statistical indicators	
B	partial regression coefficients
S.E.	standard error
Wald	Wald statistic
Sig.	significance
Exp(B)	the odds ratio

Acknowledgements

The research was supported by the National Natural Science Foundation of China (No. 41130525), the Ministry of National Science and Technique (No. 2013GS310202) and Shanghai Pujiang Program (15PJC023). We greatly appreciate the survey work executed by the graduate students from East China Normal University. We also appreciate all of the helpful comments provided by Prof. Serena Righi of the University of Bologna.

Appendix A

See Table A.

References

Achillas, Ch., Vlachokostas, Ch., Moussiopoulos, N., Banias, G., Kafetzopoulos, G., Karagiannidis, A., 2011. Social acceptance for the development of a Waste-to-Energy plant in an urban area: application for Thessaloniki, Greece. Resour., Conserv. Recycl. 55, 857–863.

Afroz, R., Hanaki, K., Hasegawa-Kurisu, K., 2009. Willingness to pay for waste management improvement in Dhaka city, Bangladesh. J. Environ. Manage. 90 (1), 492–503.

Amigues, J.P., Boulatoff, C., Desaigues, B., Gauthier, C., Keith, J.E., 2002. The benefits and costs of riparian analysis habitat preservation: a willingness to accept/willingness to pay contingent valuation approach. Ecol. Econo. 43, 17–31.

Arrow, K., Solow, R., Portney, P.R., Leamer, E.E., Radner, R., Schuman, H., 1993. Report of the NOAA panel on contingent valuation. Fed. Reg. 58 (10), 4601–4614.

Basili, M., Matteo, M.Di., Ferrini, S., 2006. Analysing demand for environmental quality: a willingness to pay/accept study in the province of Siena (Italy). Waste Manage. 26 (3), 209–219.

Bateman, I.J., Brouwer, R., Davies, H., Day, B.H., Deflandre, A., Di-Falco, S., Georgiou, S., Hadley, D., Hutchins, M., Jones, A.P., Kay, D., Leeks, G., Lewis, M., Lovett, A.S., Neal, C., Posen, P., Rigby, D., Turner, R.K., 2006. Analysing the agricultural costs and nonmarket benefits of implementing the Water Framework Directive. J. Agric. Econo. 57, 221–237.

Bellander, T., Berglind, N., Gustavsson, P., Jonson, T., Nyberg, F., Pershagen, G., Järup, L., 2001. Using geographic information systems to assess individual historical exposure to air pollution from traffic and house heating in Stockholm. Environ. Health Perspect. 109 (6), 633–639.

Blaine, T.W., Lichtkoppler, F.R., Jones, K.R., Zondag, R.H., 2005. An assessment of household willingness to pay for curbside recycling: a comparison of payment card and referendum approaches. J. Environ. Manage. 76, 15–22.

Blomquist, G.C., Whitehead, J.C., 1998. Resource quality information and validity of willingness to pay in contingent valuation. Resour. Energy Econ. 20, 179–196.

Brookshire, D.S., Randall, A., Stoll, J.R., 1980. Valuing increments and decrements in natural resource service flows. Am. J. Agric. Econo. 62 (3), 478–488.

Campbell, D., Hutchinson, W.G., Scarpa, R., 2009. Using choice experiments to explore the spatial distribution of willingness to pay for rural landscape improvements. Environ. Plan. A 41, 97–111.

Che, Y., Yang, K., Jin, Y., Zhang, W., Shang, Z., Tai, J., 2013. Residents' concerns and attitudes toward a municipal solid waste landfill: integrating a questionnaire survey and GIS techniques. Environ. Monitor. Assess. 185 (12), 10001–10013.

Chen, H., Chang, N., Chen, J., Tsai, S., 2010. Environmental performance evaluation of large-scale municipal solid waste incinerators using data envelopment analysis. Waste Manage. 30, 1371–1381.

Cheng, H., Zhang, Y., Meng, A., Li, Q., 2007. Municipal solid waste fueled power generation in China: a case study of Waste-to-Energy in Changchun City. Environ. Sci. Technol. 41 (21), 7509–7515.

Cherubini, F., Bargigli, S., Ulgiati, S., 2009. Life cycle assessment (LCA) of waste management strategies: landfilling, sorting plant and incineration. Energy 34 (12), 2116–2123.

Contreras, F., Hanaki, K., Aramaki, T., Connors, S., 2008. Application of analytical hierarchy process to analyze stakeholders preferences for municipal solid waste management plans, Boston, USA. Resour., Conserv. Recycl. 52, 979–991.

Covello, V.T., 1989. Informing people about risks from chemicals, radiation, and other toxic substances: a review of obstacles to public understanding and effective risk communication. In: Leiss, W. (Ed.), Prospects and Problems in Risk Communication Canada: Institute for Risk Research. University of Waterloo Press.

Covello, V.T., Lave, L.B., Moghissi, A., Uppuluri, V.R.R., 1987. Communicating scientific information about health and environmental risks: problems and opportunities from a social and behavioral perspective. Uncertainty in Risk Assessment, Risk Management, and Decision Making. Springer, US, pp. 221–239.

Davies, A., 2008. Civil society activism and waste management in Ireland: the Carrans town anti-incineration campaign. Land Use Policy 25, 161–172.

Ferreira, S., Gallagher, L., 2010. Protest responses and community attitudes toward accepting compensation to host waste disposal infrastructure. Land Use Policy 27 (2), 638–652.

Fischhoff, B., 1995. Risk perception and communication unplugged: twenty years of process. Risk Anal. 15 (2), 137–145.

Fisher, R.A., 1936. The use of multiple measurements in taxonomic problems. Annals Eugen. 7 (2), 179–188.

Freeman, A.M., 1993. Measurement of Environmental and Resource Values: Theory and Methods. Resources for the Future, Washington D.C..

Giusti, L., 2009. A review of waste management practices and their impact on human health. Waste Manage. 29 (8), 2227–2239.

Groothuis, P.A., Miller, G., 1994. Locating hazardous waste facilities: the influence of NIMBY beliefs. Am. J. Econo. Sociol. 53 (3), 335–346.

Halstead, J.M., Luloff, A.E., Stevens, T.H., 1992. Protest bidders in contingent valuation. Northeastern J. Agric. Resour. Econo. 21 (2), 160–169.

Hanemann, W.M., 1989. Welfare evaluations in contingent valuation experiments with discrete response data. Am. J. Agric. Econo. 71, 1057–1061.

Heckman, J.J., 1977. Dummy Endogenous Variables in a Simultaneous Equation System, No 0177, NBER Working Papers, National Bureau of Economic Research, Inc.

Hsu, S., 2006. NIMBY opposition and solid waste incinerator siting in democratizing Taiwan. Soc. Sci. J. 43 (3), 453–459.

Huang, L., Zhou, Y., Han, Y., Hammitt, J.K., Bi, J., Liu, Y., 2013. Effect of the Fukushima nuclear accident on the risk perception of residents near a nuclear power plant in China. Proceedings of the National Academy of Sciences of the United States of America 110 (49), 19742–19747.

Ishizaka, K., Tanaka, M., 2003. Resolving public conflict in site selection process—a risk communication approach. Waste Manage. 23 (5), 385–396.

Jenkins-Smith, H., Kunreuther, H., 2001. Mitigation and benefits measures as policy tools for siting potentially hazardous facilities: determinants of effectiveness and appropriateness. Risk Anal. 21 (2), 371–382.

Johnson, T., 2013. The health factor in anti-waste incinerator campaigns in Beijing and Guangzhou. China Quart. 214, 356–375.

Jupp, A., Irwin, A., 1989. Emergency response and the provision of public information under CIMAH. Disaster Manage. 1 (4), 33–38.

Kikuchi, R., Gerardo, R., 2009. More than a decade of conflict between hazardous waste management and public resistance: a case study of NIMBY syndrome in Souselas (Portugal). J. Hazard. Mater. 172, 1681–1685.

Kothari, R., Tyagi, V.V., Pathak, A., 2010. Waste-to-energy: a way from renewable energy sources to sustainable development. Renew. Sustain. Energy Rev. 14 (9), 3164–3170.

Li, W., Liu, J., Li, D., 2012. Getting their voices heard: three cases of public participation in environmental protection in China. J. Environ. Manage. 98 (15), 65–72.

Lima, M.L., 2004. On the influence of risk perception on mental health: living near an incinerator. J. Environ. Psychol. 24 (1), 71–84.

Macmillan, D.C., Duff, E.I., 1998. Estimating the non-market costs and benefits of native woodland restoration using the contingent valuation method. Forestry 71 (3), 247–259.

Meyerhoff, J., Liebe, U., 2010. Determinants of protest responses in environmental valuation: a meta-study. Ecol. Econo. 70 (15), 366–374.

Ministry of environmental protection of the People's Republic of China, General administration of Quality Supervision, Inspection and Quatantine of the People's Republic of China, 2014. Standard for pollution control on the municipal solid waste incineration (GB 18485–2014). Beijing.

Miranda, M.L., Hale, B., 1997. Waste not, want not: the private and social costs of waste-to-energy production. Energy Policy 25 (6), 587–600.

Misra, V., Pandey, S.D., 2005. Hazardous waste, impact on health and environment for development of better waste management strategies in future in India. Environ. Int. 31, 417–431.

Petts, J., 1992. Incineration risk perceptions and public concern: experience in the U. K. improving risk communication. Waste Manage. Res. 10 (2), 169–182.

Portney, P.R., 1991. Siting Hazardous Waste Treatment Facilities: The NIMBY Syndrome. Auburn House, Boston, MA.

Psomopoulos, C.S., Bourka, A., Themelis, N.J., 2009. Waste-to-energy: a review of the status and benefits in USA. Waste Manage. 29 (5), 1718–1724.

Randall, A., 1986. The possibility of satisfactory benefit estimation with contingent markets. In: Cumming s, R.G., Brookshire, D.S., Schulze, W.D. (Eds.), Valuing Environmental Goods: An Assessment of the Contingent Valuation Method. Rowman and Allanheld, Totowa.

Raymond, C., Brown, G., 2006. A method for assessing protected area allocations using a typology of landscape values. J. Environ. Plan. Manage. 49 (6), 797–812.

Reynolds, B., Seeger, M.W., 2005. Crisis and emergency risk communication as an integrative model. J. Health Commun. 10 (1), 43–55.

Ricci, P.F., Rice, D., Ziagos, J., Cox Jr., L.A., 2003. Precaution, uncertainty and causation in environmental decisions. Environ. Int. 29 (1), 1–19.

Rowe, R.D., D'Arge, R.C., Brookshire, D.S., 1980. An experiment on the economic value of visibility. J. Environ. Econo. Manage. 7, 1–19.

Shekdar, A.V., 2009. Sustainable solid waste management: an integrated approach for Asian countries. Waste Manage. 29, 1438–1448.

Song, Q., Wang, Z., Li, J., 2013. Environmental performance of municipal solid waste strategies based on LCA method: a case study of Macau. J. Cleaner Prod. 57 (15), 92–100.

Strazzera, E., Genius, M., Scarpa, R., Hutchinson, G., 2003. The effect of protest votes on the estimates of WTP for use values of recreational sites. Environ. Resour. Econo. 25 (4), 461–476.

Tang, C.P., Tang, S.Y., 2000. Democratizing bureaucracy: The political economy of environmental impact assessment and air pollution prevention fee in Taiwan. Comparative Polit. 33 (1), 81–99.

The World Bank, 2012. What a Waste: A Global Review of Solid Waste Management. Washington, DC.

Troy, A., Wilson, M.A., 2006. Mapping ecosystem services: practical challenges and opportunities in linking GIS and value transfer. Ecol. Econo. 60, 435–449.

Venkatachalam, L., 2004. The contingent valuation method: a review. Environ. Impact Asses. Rev. 24 (1), 89–124.

Walker, G.P., Simmons, P., Irwin, A., Wynne, B., 1999. Risk communication, public participation and the Seveso II directive. J. Hazard. Mater. 65 (1), 179–190.

Wildavsky, A., Dake, K., 1990. Theories of risk perception: who fears what and why? Daedalus 199 (4), 41–60.

Zhang, W., Che, Y., Yang, K., Ren, X., Tai, J., 2012. Public opinion about the source separation of municipal solid waste in Shanghai, China. Waste Manage. Res. 30 (12), 1261–1271.

Please cite this article in press as: Ren, X., et al. Risk perception and public acceptance toward a highly protested Waste-to-Energy facility. Waste Management (2015), http://dx.doi.org/10.1016/j.wasman.2015.10.036