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Factors influencing public perception and impact distance of a municipal solid waste dumpsite in Thailand

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Abstract

In Thailand, the continued use of unsanitary disposal sites without sufficient environmental and public health protection has led to a growing negative public perception of local municipal solid waste facilities. While the development of a more environmentally-benign system is underway, it is essential to understand how to handle and prevent negative public perception from escalating into excessive public opposition. In this paper, in-depth interviews and questionnaire-based interviews are used to gather data from 468 respondents, at 28 survey locations, within a 5.7 km radius of the Praeksa Mai dumpsite. The concerns that drive negative public perceptions of the dumpsite, which can be classified into those related to health, environment, and property value of land, are revealed. Non-parametric statistical analysis techniques are used to identify the significant factors influencing the perception of residents living near the dumpsite, and to investigate the change in perception related to 6 impact categories across different distance intervals from the dumpsite. The results show that the odor is the most significant issue faced by the group of residents living within 1 km around the dumpsite. Overall, the impact distance is about 3.5 km away from the dumpsite. Beyond this distance, respondents feel that they are only slightly affected by the dumpsite. The approach used to investigate the impact distance and the change of public perception over distance is the main contribution of this paper.

Keywords: solid waste management, dumpsite, public perception, environmental impact, health concern, odor

1. Introduction

Solid waste management has been one of the major public health and environmental quality concerns for developing countries, as demonstrated in previous municipal waste studies [1 & 2]. The ongoing use of unsanitary disposal practices and facilities is normally observed, due to insufficient waste management budget and inadequate local environmental protection efforts. In Thailand, after the incident of a massive fire at the Praeksa dumpsite in 2014, government agencies and the public had to re-examine their solid waste management and pollution control practices. As a result, all disposal sites are subjected to more stringent environmental regulations. The upgrading of existing municipal solid waste management (MSWM) infrastructures to be more environmentally responsible is underway, but still in the early stage. At present, the unavoidable need to rely heavily on unsanitary and inefficient MSWM practices makes it quite challenging for responsible decision makers to achieve a sustainable solid waste management plan.

The basic causes of unsanitary and inefficient MSWM are numerous. First of all, large-scale systematic waste segregation at source is still a very challenging goal to achieve in developing countries, largely due to insufficient sanitary budgets and public awareness about the importance of waste sorting and waste minimization. Second, waste-processing technologies are used in the absence of adequate waste disposal regulations and ordinances, leading to an uninformed public, resulting in a long-term decline in the well-being of residents around waste sites.

Third, the management of solid waste is not entirely conducted by a local government. Private sector participation is normally examined as a means of improving cost efficiency in MSWM operations, for mainly waste collection, separation, and disposal. However, the role of private contractors in improving existing pollution control practices and becoming more environmentally responsible remains questionable.

The selection of suitable disposal site locations is an important component for efficient MSWM and urban planning. Siting waste disposal facilities, especially in an urban area, is a very complex task, due to the intensive stakeholder involvement in the protection of public health and the ecosystem. The process of site selection requires a thorough consideration of various environmental and socio-economic criteria. The site selection process also involves the geographic analysis of large amounts of spatial and other relevant attribute data governing the suitability of a site [3 & 4] Despite the rigorous evaluation and screening process, a siting decision usually has to be made against significant public resistance, largely due to long-term unresolved MSWM issues that have eroded the confidence of local communities that are in close proximity to waste sites. As a result, the siting process is increasingly complex and more dependent on public support.

Understanding public perceptions and concerns are essential to ensure environmentally and socially sound site selection and effective collaborative efforts in solving MSWM issues. Based on the literature concerning the public perceptions of solid waste disposal, a number of previous studies have attempted to gain an improved understanding of the public perceptions of environmental and health risks from solid waste disposal. The identification of factors influencing public perceptions is the first step in a systematic approach to promoting more socially and environmentally sound MSWM [5]. Among the widely recognized negative impacts of unsanitary MSWM, odor and inadequate air quality have been identified as a major source of public opposition to landfill siting [6]. The degree of odor offensiveness perceived by an individual is dependent on various factors. From a chemical viewpoint, the intensity of an odor is strongly related to the constituents of wastes and the amount of odorous gases released. Hydrogen sulfides and ammonia are known to be the main contributors to landfill odor. Human responses to odor and other environmental stressors can be quite subjective and variable, depending on a number of factors such as age, health status, living duration, and past experience. Based on previous survey studies, the other factors affecting the level of perceived odor annoyance include the frequency of exposure and odor intensity [7], distance from waste sites [8], and meteorological parameters such as wind [9] and weather conditions [10]. In addition to odor, previous perception studies show that a person's perceptions about environmental and health risks are also subjective and differ for individuals, depending on many factors that include socioeconomic status, past experience, and residential proximity to hazardous waste sites.

In the literature concerning the effects of residential proximity to hazardous waste sites, public opinion data have consistently shown that respondents who live closer to waste disposal sites are likely to view the potential health and environmental impacts with greater concern [11 & 12]. The perception of more threat when being close to waste sites is likely to stem from the increasingly reported evidence on the health effects of waste disposal [13]. However, there are surprisingly few studies that have carefully investigated the relationships among the residential proximity to waste sites and public perceptions of the impacts of MSWM. This leaves a gap in MSWM research. When identifying the factors influencing the spatial distributions of perceived environmental and health risks, researchers classify respondents based on their municipal boundaries. Rahardyan et al. [14] used a questionnaire survey to evaluate the environmental and health concerns of MSWM facilities among people from different municipalities. People living in municipalities which receive wastes from other cities are subject to significantly higher environmental stress and have a higher tendency to develop a negative impression of MSWM facilities. Feo et al. [15] evaluated the effects of being in close proximity to waste sites for residents in three different communities. Their findings suggest that communities may have an interest in accepting an unequal distribution of environmental impacts in return for economic compensation. A single specific distance is also used when evaluating the effects of residential proximity to hazardous waste sites. Sankoh et al. [16] evaluated the perception of unsanitary waste disposal within two groups of respondents: those who reside within 50 meters and those who reside outside 50 meters of a dumpsite in Sierra Leone. Al-Khatib et al. [17] asked their respondents to indicate whether they are against the construction of MSWM facilities within 1 kilometer from their home. Another previous questionnaire survey study by Babs-Shomoye and Kabir investigates the perception of the health impact of solid waste disposal among respondents living within and beyond 250 meter of a dumpsite in Nigeria [18]. However, the actual distance tends to be inadequate for explaining the public perceptions of risk associated with hazardous waste sites. There is a need to capture responses from respondents with different residential proximities to a waste site, to investigate the spatial extent to which negative public perceptions towards a waste site exist. In a risk perception study [19], questionnaires were administered to respondents residing at different distances from a waste-to-energy facility in China. The segmentation of survey respondents according to their proximity to the waste site enables the examination of the geographical distribution of the acceptance and risk perception of the waste-to-energy facility. Such information provides researchers with more insight into how public perception problems can be resolved. At any rate, similar studies that explore the spatial distribution of public perception of waste sites are quite limited. Also, public perception towards waste sites should be assessed in relation to impact categories that reflect the ongoing local waste management issues.

This study contributes to the field by presenting the findings of in-depth interviews and questionnaire-based interviews carried out in the surrounding areas of the Praeksa Mai dumpsite in Samut Prakan province, Thailand, from November 2017 to January 2018. The study's goals are to gain an improved understanding of 1) the current environmental and health concerns associated with the dumpsite, 2) the factors influencing these public concerns, and 3) the spatial extent to which local residents perceive the dumpsite to be a threat to their quality of life. The main technical contribution of this paper involves the identification of survey locations across different distance intervals from the dumpsite and the use of non-parametric statistical analysis techniques to investigate the spatial distribution of public perception in relation to different impact categories. The proposed perception assessment approach provides an analytic basis for prioritizing actions to improve public perception associated with local solid waste management issues. The findings will be useful for setting up the basis for analyzing the impact area and the affected population size. Any future site selection decision can use the results of the potential impacts on public perception. The role of spatial planning in improving public perception of MSWM can be further explored based on causes and effects.

2. Background of Praeksa Mai Dumpsite

The Praeksa Mai dumpsite was established in 2004 in Samut Prakan province, northern Bangkok metropolitan region. At present, the province has a population of about 1.3 million people. There are three dumpsites located in Wat Chiruang, Praeksa, and Praeksa Mai districts. The Praeksa Mai dumpsite covers a total area of 512,000 square meters and is the only active site that still receives about 4,000 tons of municipal solid wastes from 18 municipalities in Samut Prakan. Of these wastes, only about 500 tons are properly sorted into organics, recyclable, and combustible wastes. The remaining 3,500 tons are sent directly to the dumpsite. The surrounding areas of the Praeksa Mai dumpsite consist predominantly of residential properties of various characters, with some industrial facilities. The issues of municipal solid waste accumulation and inadequate waste disposal have been a topic of much public concern and debate for quite a long time, along with the steadily changing socioeconomic context of population and rapid growth of solid waste generation. There is a clear research need to obtain accurate and objective knowledge of the local community reaction to specific MSWM issues. Therefore, the surrounding area of the Praeksa Mai dumpsite was chosen for public perception assessment in this study.

3. Methodology

The overall research framework of this paper is presented in Figure 1. To develop a questionnaire which can accurately reflect and describe the MSWM problems experienced by local residents, preliminary in-depth interviews were conducted for issue identification and classification. The interviews were conducted using open-ended questions, which allow the respondents to engage in a wide range of comments about how their quality of life has been affected by the dumpsite. The interview results are used as a basis for questionnaire development. The questionnaire is developed and divided into 2 sections to evaluate: 1) demographic, education, and residency characteristics and 2) perception related to the effects of the Praeksa Mai dumpsite on their health, environment, and property value. The first section contains independent variables: gender, age, type of residency, educational level, and living duration. The responses to these questions are considered as independent variables. The second section consists of 16 questions with a 7-point Likert scale that ask respondents how the dumpsite affects their health, environment, and their property values. The responses to these questions are used as dependent variables. After a review by a panel of experts in the MSWM field, the questionnaire was revised and tested on a sample of 80 respondents before conducting a full-scale survey. Some of the dependent-variable questions in the questionnaire are as follows.

- Do you feel that the dumpsite has a negative impact on health and sanitation?
- Are you affected by the foul odor of the dumpsite?
- To what extent are you concerned about the air contamination problem caused by dumpsite emissions?
- Do you think that the presence of the dumpsite negatively affects the scenic quality of areas surrounding your community?
- Are you concerned about dumpsite fires and their effects on adjacent residential properties?
- Do you think the presence of the dumpsite negatively affects the market value of local residential properties?

3.1 Sample size

According to formula (1) which was introduced by Cochran, 1953, a sample size of 188 respondents is required, when the margin of error (e) is 5% at the 95% confidence level ($z = 1.96$). The impacts of the dumpsite are evaluated on a 7-level Likert scale. The values of p and q are 1/7 and 6/7, respectively.

$$n \frac{z^2 \sigma}{e^2} = \frac{z^2 pq}{e^2} \tag{1}$$

where,

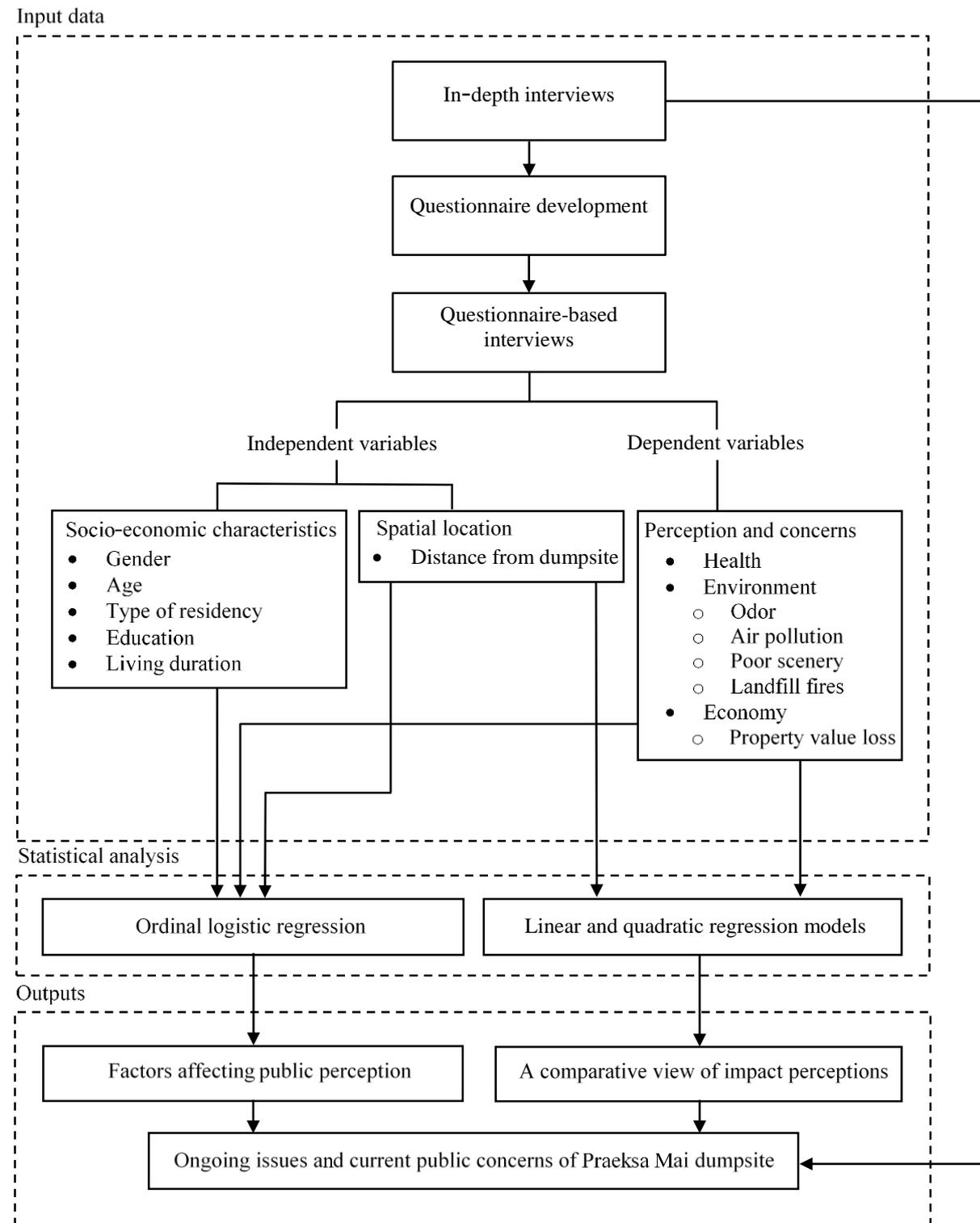|	
n	Sample size
z	Standard normal score
p	Proportion of elements in the population that has a particular attribute
q	Proportion of elements in the population that does not have a specified attribute
e	Margin of error

Figure 1 Overall Research Framework

3.2 Survey locations

The selection of survey locations is one of the most important tasks in this study. It is crucial that the designated survey locations provide access to residential areas located at different directions and distances from the dumpsite. During this process, 28 survey locations are identified, as shown in Figure 2. The study area is divided into 8 overlapping circular zones, where the dumpsite is located at the center. This covers about 113 km^2 of the area around the dumpsite. The separation of survey locations into zones is made to investigate the changes in the level of impact perceived by people over different distances from the dumpsite. The displacement distance between each survey location and the dumpsite is also regarded as an independent variable.

Figure 2 Survey locations around Praeksa Mai dumpsite

During the survey period, from November 2017 to January 2018, the questionnaires were administered by interview to randomly selected households from all the selected survey locations. Structured interviews were used rather than self-completion, to facilitate improved accuracy of interpretation and response rate. At the completion of the survey period, the total number of respondents was 468. The expected margin of error is 3.17%, based on this sample size. The surveyed data are summarized and analyzed using statistical methods, described in detail in the next section.

3.3 Statistical analysis

To achieve the objectives of the study, this section utilizes statistical analysis techniques, namely ordinal logistic regression and linear and quadratic regressions. Ordinal logistic regression is mainly used to identify the significant factors influencing the public perceptions of the dumpsite. Linear and quadratic regressions are primarily used to observe the relationships among the levels of perception of the impacts and distance from the dumpsite. An estimation of the dumpsite's impact distance is made. Minitab version 17 is used in this study. A summary of the analysis details is given as follows.

Ordinal logistic regression

Ordinal logistic regression is used for the investigation of demographic and socio-economic variables, to determine whether they significantly affect the public perception of the impacts of the dumpsite. In this study, the independent variables are age, gender, education, length and type of residency, and distance from the dumpsite. Dependent variables are the levels of public perception towards the impacts, which include health issues, odor, air pollution, poor scenery, landfill fires, and decreased property values. The hypothesis of the ordinal logistic regression analysis is presented as follows.

H_0*:* The independent variable has no significant impact on the dependent variable.
H_1*:* The independent variable has a significant impact on the dependent variable.

Since there are 6 independent variables and 6 dependent variables, there are totally 36 sets of the hypothesis. The p-values for all the combinations of independent and dependent variables are calculated and compared to the significance level of 0.05. If the p-value is less than or equal to the significance level, there is sufficient evidence to conclude that the independent variable has a significant impact on the dependent variable. In the analysis, the regression coefficients and odds ratios are also calculated to explain the direction and strength of associations among the variables.

Linear and quadratic regressions

Linear regression analysis is applied to model the relationships among the levels of perception and distance from the dumpsite. This investigates the effects of distance to the dumpsite on a resident's perception, to determine the spatial extent of the negative public perception towards the dumpsite. In this case, the levels of perception and distances are considered as continuous variables. When linear regression provides an R-square adjusted value of less than 50%, a linear model may not be suitable. In such a case, quadratic regression is applied to improve modeling accuracy.

4. Result and Discussion

The results of the study are presented in three parts. First, from the in-depth interviews, current public concerns about the effects of Praeksa Mai dumpsite on the living conditions of local people are summarized. Second, the effects of demographic, educational, and residency characteristics are analyzed to determine whether these factors significantly affect public perceptions and concerns on health, environmental, and economic impacts of the dumpsite. Third, the relationships among the degrees of public concerns on health, environmental, and economic impacts, and the distance from the dumpsite are evaluated.

Before showing the interview and data analysis results, the basic data of the respondents who were interviewed are visualized using pie charts, as shown in Figure 3. The characteristics of 468 respondents are summarized based on gender, age, type of residence, living duration, and level of education. The proportion of female respondents is slightly more than the male respondents. Respondents (85%) have an age range of 20 to 60 years. Respondents live (76%) or work (24%) in the areas. About 19% of respondents lived in the area before the dumpsite was established. Only 27% of respondents hold a bachelor's or higher degree.

4.1 Current public concerns and perceptions

Some of the important findings based on the in-depth interviews conducted during the first stage of questionnaire development are summarized as follows.

- Odor is the most common underlying cause of dizziness and poor living conditions among the interviewed residents. Strong offensive odor usually developed 3-4 hours after every rainfall.
- People are concerned about environmental contamination problems caused the uncontrolled release of rainfall-induced wastewater from the dumpsite's waste compression process.
- There have been public complaints about waste trucks that regularly carry excessive loads while driving at high speeds. These trucks tend to drop waste and leave trails of liquid garbage on the roads, putting local motorists at risk of slip-related accidents.
- The government's efforts to improve the local road system conditions play an important part in developing positive public perspectives and satisfaction with the dumpsite.
- Many respondents were not aware that the dumpsite was already in the area when they moved in.
- The consideration of these findings is useful in developing a constructive and relevant questionnaire to be distributed to local residents.
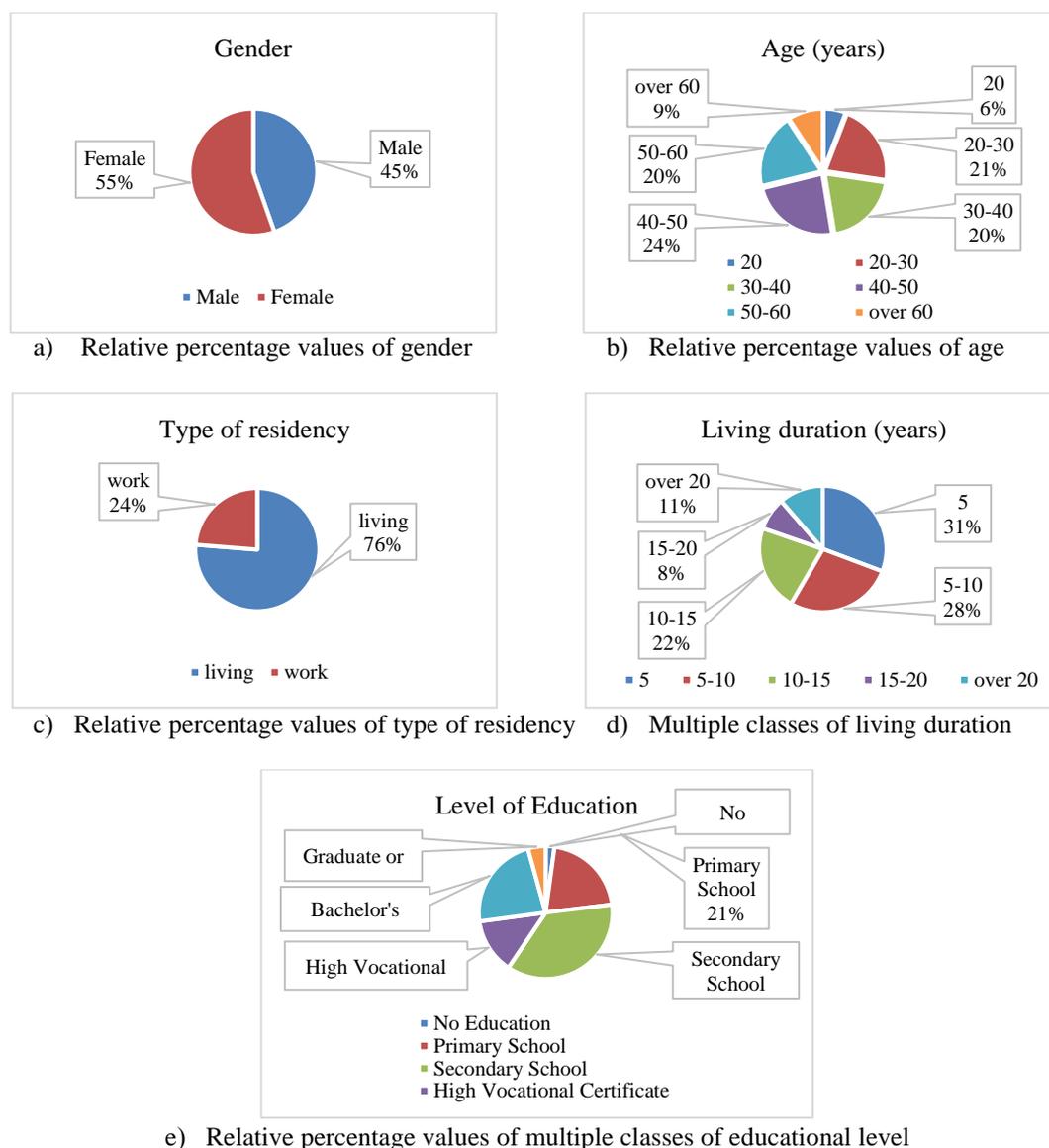
Gender

a) Relative percentage values of gender

Age (years)

b) Relative percentage values of age

Type of residency

c) Relative percentage values of type of residency

Living duration (years)

d) Multiple classes of living duration

Level of Education

e) Relative percentage values of multiple classes of educational level

Figure 3 Important respondent characteristics

4.2 Significant factors affecting public perceptions using ordinal logistic regression

To analyze the significant effects of independent variables on the levels of public perception of the dumpsite's impacts in terms of health, odor, air pollution, scenery, landfill fires, and property values of land, ordinal logistic regression is applied. The details of p-values, regression coefficients, and odds ratios are shown in Table 1.

Effect of distance from the dumpsite

The effects of distance from the dumpsite on public perceptions on all impact categories are highly significant. All the p-values are zero. All the coefficients are positive. None of the odds ratios is less than one. This implies that the respondents who live or work closer to the dumpsite perceive greater impacts from the dumpsite than those who are far away. This result is consistent with the expectation that the impact of waste disposal should be higher with closer proximity to waste sites.

Effect of age

Age has a significant impact on public perceptions of the dumpsite for odor, air pollution, scenery, and property value of land. The positive coefficients and greater-than-one odds ratios imply that younger respondents are more

concerned about the impacts than older people. This may be due to the fact that older people are more familiar with the living conditions in the areas.

Table 1 Results of ordinal logistic regression

Independent variables	Impact variables	Coefficient	Odds ratios	P-value	Significant factor
Distance (Short-long)	Health	0.400	1.78	0.000	Significant
	Odor	0.648	1.91	0.000	Significant
	Air pollution	0.451	1.57	0.000	Significant
	Scenery	0.391	1.48	0.000	Significant
	Landfill fires	0.144	1.15	0.000	Significant
	Property values of land	0.237	1.27	0.000	Significant
Age (Young-old)	Health	0.020	1.02	0.711	-
	Odor	0.160	1.17	0.008	Significant
	Air pollution	0.140	1.15	0.018	Significant
	Scenery	0.230	1.25	0.000	Significant
	Landfill fires	0.000	1.00	0.972	-
	Property values of land	0.220	1.25	0.000	Significant
Gender (Male, female)	Health	-0.251	0.78	0.125	-
	Odor	-0.107	0.90	0.514	-
	Air pollution	-0.113	0.89	0.488	-
	Scenery	0.038	1.04	0.816	-
	Landfill fires	-0.185	0.83	0.260	-
	Property values of land	0.076	1.08	0.647	-

Independent variables	Impact variables	Coefficient	Odds ratios	P-value	Significant factor
Level of education (Low-high)	Health	-0.227	0.80	0.001	Significant
	Odor	-0.168	0.85	0.011	Significant
	Air pollution	-0.205	0.81	0.002	Significant
	Scenery	-0.323	0.72	0.000	Significant
	Landfill fires	-0.111	0.90	0.095	-
	Property values of land	-0.372	0.69	0.000	Significant
Living duration (Short-long)	Health	0.075	1.08	0.230	-
	Odor	0.174	1.19	0.005	Significant
	Air pollution	-0.005	0.99	0.931	-
	Scenery	0.032	1.03	0.612	-
	Landfill fires	-0.036	0.96	0.562	-
	Property values of land	0.045	1.05	0.477	-
Type of residency (Living, work)	Health	0.516	1.67	0.001	Significant
	Odor	0.197	1.22	0.172	-
	Air pollution	0.477	1.61	0.001	Significant
	Scenery	0.428	1.53	0.006	Significant
	Landfill fires	0.384	1.47	0.009	Significant
	Property values of land	0.398	1.49	0.010	Significant

Effect of gender

Gender is not a significant factor. Statistically, the levels of perception across all the impact categories are the same for male and female respondents.

Effect of educational level

The level of education significantly affects the public perception of the impacts related to health, odor, air pollution, scenery, and property values of land. The negative coefficients and odds ratios of less than one indicate a stronger perception of the dumpsite's impacts among respondents with higher education. This result is in line with the general assumption that people with a higher educational background usually have higher environmental awareness.

Effect of living duration

When analyzing the effect of living duration on odor, a positive coefficient and odds ratio greater than one are obtained. This means that respondents with longer living duration are associated with a lower perceived level of odor impact. This finding supports the general assumption that people who live around the dumpsite for a prolonged period of time are accustomed to the odor.

Effect of residency type

In this study, there are two residency types: living and working. Statistically, there is no difference between the degrees to which both groups of people are concerned about odor. However, for other impacts including the negative effects on health, air pollution, scenery, landfill fires, and property values, people who live in the area tend to be affected more than those who just come to work in the area.

*4.3 Changes in the levels of perception over distance*

The effects of distance on impact perception are quite significant for all impact categories, as shown in Figure 4. In the scatter plots, the Y-axis represents the degree of impact perception, ranging from 1 to 7. Responses of perception levels 1 to 7 are in ordinal scales, indicating 7 variable levels with a natural ordering of the possible values from the lowest to the highest impact, depending on respondent perception which mean 1 to seven means very low, low slightly low, moderate, slightly high, high, and very high impact respectively. The X-axis indicates the distance from the dumpsite. For each impact category, the average values of impact perception of respondents from 28 survey locations are plotted. It can be observed that the average degree of all impacts, except landfill fires, tends to decrease as the distance between the dumpsite and the survey location increases. In Figure 4e, when observing the change in landfill fire impact over distance, several survey locations exhibit a degree of perception that is unusually high and significantly deviated from the downward trend of the plots. This includes the survey locations 16, 20, 22, and 25. According to the map in Figure 2, these survey locations are in close proximity to an old dumpsite which caught fire in 2014.

Based on the in-depth interview, many respondents from these locations also express concerns about a recurrence of fire at any nearby waste sites. This suggests that the previous experience of fire serves as an additional factor affecting the attitudes and perceptions of residents toward the dumpsite. Based on the regression analysis results, the regression equations and R-square adjusted values are shown in Table 2. All the R-squared values are greater than 50%. It must be noted that quadratic regression is used for the landfill fire concern. The regression lines corresponding to all the regression equations are shown in Figure 5.

Table 2 Regression equations of the degree of impacts over the distance from the dumpsite

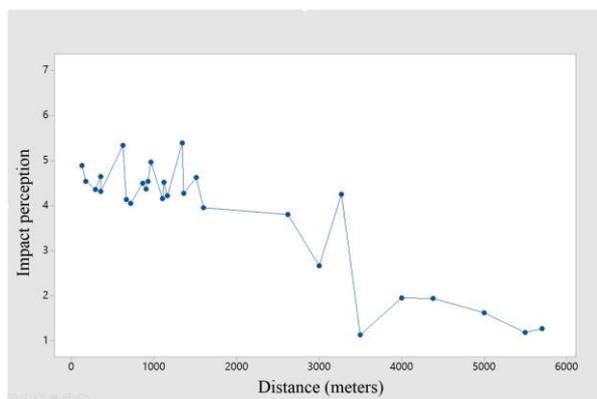| Impacts	Regression equation	R-square adjusted
Health	$4.895 - 5.84 \times 10^{-4}\,d$	69.00%
Odor	$5.830 - 8.94 \times 10^{-4}\,d$	83.20%
Air pollution	$5.087 - 6.91 \times 10^{-4}\,d$	79.40%
Scenery	$4.442 - 6.00 \times 10^{-4}\,d$	70.90%
Property values of land	$3.975 - 4.26 \times 10^{-4}\,d$	53.00%
Landfill fires	$4.015887 + 8.25 \times 10^{-4}\,d - 2.05279 \times 10^{-7} d^2$	48.90%

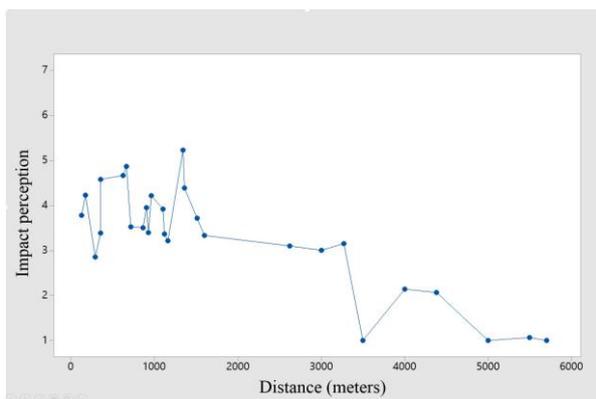Note: "d" in regression equation is distance (meters).
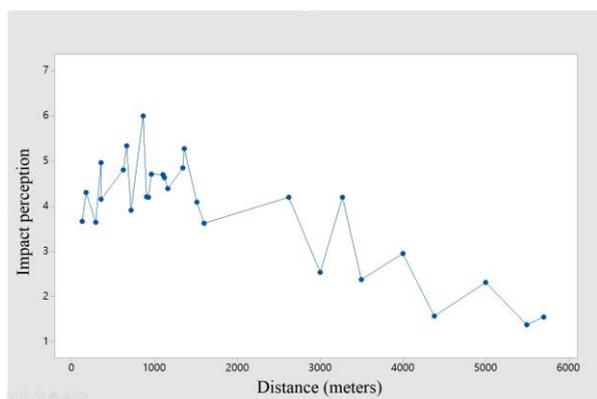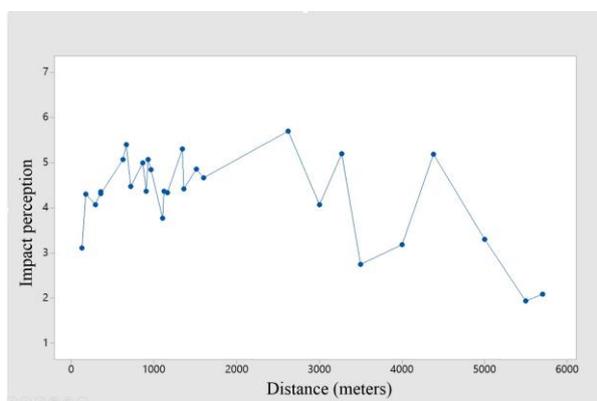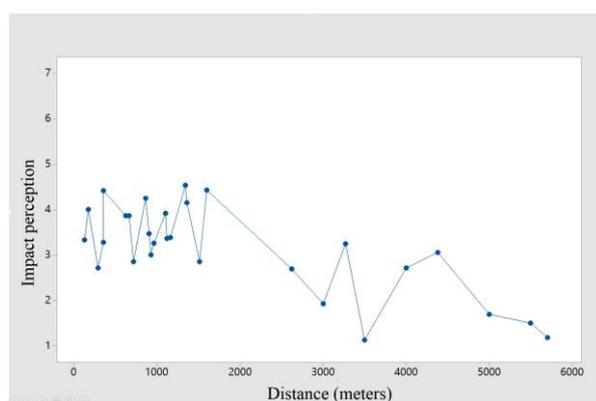
a) Health impact
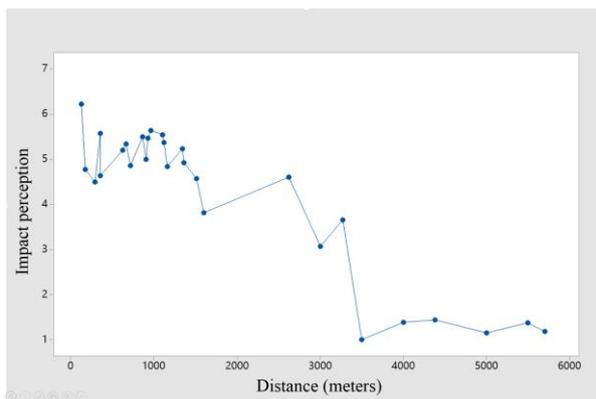
b) Odor impact

c) Air pollution impact

d) Poor scenery impact

e) Landfill fires impact

f) Property value loss impact

Figure 4 Scatter plots between the distance from the dumpsite and level of impact based on 7-point Likert scale
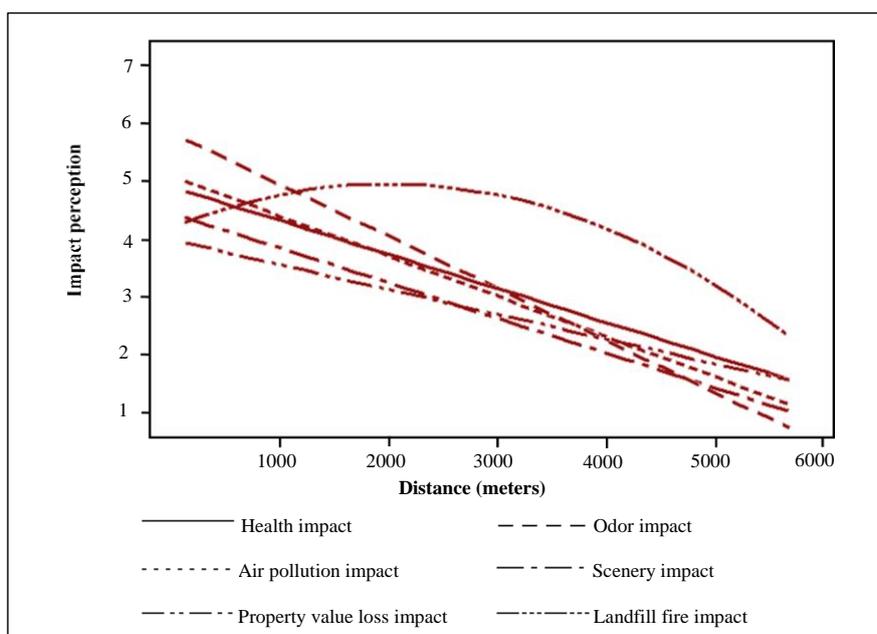
Figure 5 Relative comparison of perception levels for impact categories

The use of regression analysis helps to visualize the relationships among the residential proximity to waste sites and the public perceptions of the impacts of MSWM. The relative importance of impacts over different spatial scales can be observed. The extent to which each of the impacts is perceived by residents can also be examined. Based on the analysis results, within a radius of about 1 km around the dumpsite, the public perception of odor impact is the highest, followed by that of air pollution and health impacts. The perception of the effects of dumpsite on the values of properties is the lowest. Based on both the scatter plots and the regression lines, at a distance of about 3.5 km away from the dumpsite, the perception levels of all impact categories are significantly reduced and become fairly close to each other.

Based on 2-sample t-test analysis which used to compute the difference between two groups, sets of data from questionnaire depending on public perception levels in each impact within 5.7 kilometer from the dumpsite are divided into 2 sets. The first data set is public perception level before 3.5 kilometer and the second data set is public perception level after 3.5 kilometer. The results show that there are differences in the perception level between two sets of data with a p-value lower than the significant level of 0.05. Data within 3.5 kilometers has obviously high level in perception in all impacts compare with data outside 3.5 kilometers. It must be noted that the high perception level of landfill fire impact is associated with the experience of a previous fire incident at the old dumpsite. This problem has to be resolved through further discussion and clarification of safety measures, and policies need to be put in place for communities around the old dumpsite. To improve the overall public perception toward the dumpsite, it is important to prioritize the problem-solving strategies based on the degree of impacts perceived by people in the high impact areas. Based on the results of this study, the high impact area covers the distance of about 1.5 km in all directions away from the dumpsite. At this distance, the average level of perception for all impacts is about 4, which is described as "moderately affected" in the questionnaire.

5. Conclusion and discussion

This study aims to improve the local public perceptions of Praeksa Mai dumpsite. A series of in-depth interviews and questionnaire-based interviews were conducted around Praeksa Mai dumpsite, to understand the current environmental and health concerns associated with the dumpsite. There is a sufficiently large number of respondents distributed across distance intervals. The in-depth interviews reveal important health, environmental, and economic impacts caused by the dumpsite. This information serves as a basis for developing the questionnaire that was used to measure the degrees of impact perception. By using ordinal logistic regression analysis, the demographic, geographical, and socio-economic factors that influence the public perception related to health, environmental, and economic impacts, are identified. Some important conclusions can be made:

- Younger respondents are more concerned about the impacts than older respondents.
- There is a stronger perception of the dumpsite impacts among respondents with higher education.
- The living duration significantly influences the degree to which respondents are affected by the dumpsite odor.

- Respondents who live or work closer to the dumpsite perceive greater impacts from the dumpsite than those who are farther away.

The determination of spatial distribution of public perception and the spatial extent to which each of the impacts contributes to the negative public perceptions of the dumpsite is the main technical contribution of this paper. Questionnaire and statistical analysis techniques are demonstrated to be a viable method to accomplish this research goal. In most of the previous studies in the field of MSWM, survey and statistical analysis tools allow management to determine if any factor or impact category significantly affects public perceptions at a specific distance, but do not reveal the change in the perception level over distance intervals. In this study, the findings of the public perceptions are based on the average levels of perception concerning each impact category across 28 survey locations. Linear and quadratic regression techniques are used to model the relationships among the levels of perception and distance from the dumpsite. By applying the regression analysis, a comparison of the perceptions among different impact categories over different distance zones is possible. This enables management to understand the relative importance of impacts over different distances from the dumpsite. Based on the regression analysis results, the odor is the most significant issue faced by the group of residents living within 1 km around the dumpsite. At this distance, air pollution is the second most common concern, followed by health, scenery, and property value. The area under the regression lines can also be estimated, to serve as a guide in prioritizing and specifying what improvement efforts will most benefit local communities in each geographical area. Another important finding in this study is that, at about 3.5 km away from the dumpsite, the respondents feel that they are only slightly affected by the dumpsite in most impact categories. Outside this distance, the respondents feel that none of the impacts, except a landfill fire, is more significant than the other impacts. This distance is determined to be the impact distance of the Praeksa Mai dumpsite. A landfill fire is the only impact that led to concerns among the respondents who live nearby the old dumpsite, located about 4 km southwest of the Praeksa Mai dumpsite. These findings help determine the minimum distance for a waste site of similar quality and communities. This distance is needed in order to avoid significant negative public perceptions.

The results and discussion presented in this paper are expected to be of value to the local governments around the Praeksa Mai dumpsite and all the stakeholders. The findings are essential for the successful development of effective strategies and approaches for improving the public perceptions of Praeksa Mai or any dumpsite with similar characteristics and conditions. Public perception improving efforts can be more relevant in the context of target groups and can be communicated in a more appropriate and assessable way. The strategic network design of MSWM can also be made in light of a more precise estimation of the number of affected residents [20]. The proposed public perception evaluation methodology can be used for any waste processing site with significant localized negative externalities. It must be noted that, prior to the step of questionnaire survey, a detailed review of current issues in the area and a preliminary field survey are needed to identify relevant impact area and suitable survey approach. In this study, the questionnaires were administered by interview in response to the concerns for the relatively limited number of respondents and their limited literacy abilities. For cases without these complications, the use of self-administered questionnaire can be considered as a less costly alternative.

Several future research tasks must be addressed to obtain a more complete understanding of public perception issues. This includes the investigation of the odor issue by considering exposure factors such as seasonal wind direction and other climate factors. Also, the effects of the garbage collection route on the living conditions of residents should be studied. Based on our in-depth interview results, the garbage truck issues have a clear effect on the negative perceptions of the dumpsite. Lastly, a quantitative analysis tool suitable for estimating the equivalent number of residents affected by the negative externalities of a waste site should also be developed. This will be useful for a future landfill site selection process, to minimize the number of affected people and public opposition to landfill siting.

6. Acknowledgments

7. References

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