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Role of Panellists Variation in Determining Odour Hedonic Scale

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Abstract

Odour has two meanings, firstly as an impression and secondly refers to the name of chemical compound, while malodour is undesirable odour. The purposes of this study were to develop a hedonic scale of malodour, to determine the hedonic scale on selected sample places, to measure the ambient concentration of NH_3 and H_2S, and to analyse survey result of odour perception. This research was directly conducted in the field by using two methods, namely using panellist members and chemical analysis test result, in 10 (ten) suspected locations generating malodour impressions. The malodour hedonic scale used was in the range of $-4 \leq x \leq 4$ with accuracy of 1 (one) decimal number. Range of -4-0 scale indicates negative impression, while range of 0-4 indicating positive impression. The impression sorted from the smallest to highest hedonic scale by 4 (four) ethnic groups of panellists of Sunda, Batak, Minang, Java with the total score of -19.8; -18.8; -18.4; -15.1. It means that tolerance to negative smell by the Sundanese was smaller than the other three ethnics, while the highest tolerance to the biggest negative smell was by the Javanese. Hedonic scale by female's panellists showed a more negative trend than the male one.

Keywords:Ammonia, hedonic scale, hydrogen sulphide, malodour

INTRODUCTION

Odour or malodour, which refers to unpleasant smells, is nowadays considered an environmental pollution issue [1]. A number of odour pollution cases originated from such as waste treatment centres [2], paint industries, *petroleum* refineries, *chemical* plants, etc. According to Kep-50/MENLH/11/1996 [3], odour pollution is a stimulus of substance received by the sense of smell, while malodour is undesirable odour in some amount and time that can interfere human health and environmental comfort. The term of "odour" contains at least two meanings, i.e. firstly as "sense" and secondly refers to a kind of odorous chemical compound [4]. However, the real condition of volition itself is difficult to define, so there is a need for measurement of the quality and quantity of odours. Odour quality can be quantified by hedonic scale. Hedonic scale is a relative valuation category between likes or dislikes of perceived odours [4]. According to [5], emotion was considered as mental states with hedonic content that indicates satisfaction and dissatisfaction of instinctual drives. Malodour has been set within Kep-50/MENLH/11/1996 about Raw Level of Malodour and there are several parameters of malodour, i.e. ammonia (NH_3), methyl mercaptan (CH_3SH), hydrogen sulphide (H_2S), methyl sulphide $(CH_3)_2S$, and styrene ($C_6H_5CHCH_2$). Whereas, the odour source odour quantity was measured by using chemical analysis test result in accordance with SNI 19-7119.1-2005 [6] and RSNI3.7119.11:2007 [7].

Human olfactory perception differs enormously between individuals, with large reported perceptual variations in the intensity and pleasantness of a given odour [8]. Based on research done, it was also concluded that the human ability to identify the odour mix was influenced by physiology [9]. Measurement of odour quality using panellists based on age and gender has been done [10]. Pleasant or unpleasant degrees are determined by the experience and emotional connection of each panellist. Differences in emotional expression with cultural background are also thought to influence the assessment of odours. Therefore, further research is conducted using panellists from 4 (four) different ethnic groups in Indonesia.

MATERIALS AND METHOD

This research was conducted from October to December 2017. Development of malodour hedonic scale was carried out in 10 (ten) places suspected to create malodour impressions, such as poultry housing, traditional market, solid waste transfer station, catfish pond, gully, tofufactory, public toilet, meat corner in supermarket in Bogor Municipality, fish stall, and goat stall in Jakarta. The research procedure includes data collection in the form of the quantification of malodour obtained from the panellist and chemical analysis test followed by data processing. The measurement scheme is presented in Fig. 1.

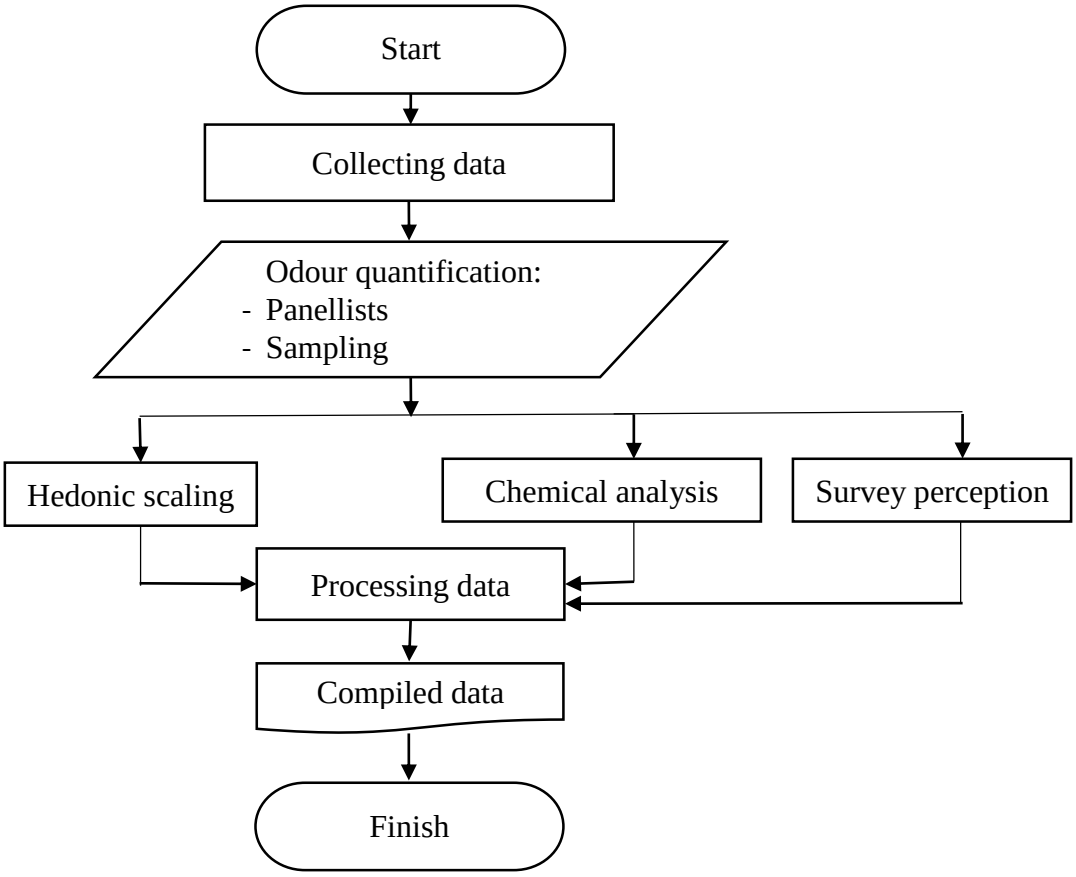

Figure 1. Flowchart of the research procedure

In developing a hedonic scale of malodour with panellists from 4 (four) different ethnic groups in Indonesia, each ethnic consists of 4 persons, a total of 16 panellists, was used stopwatch and questionnaire. The instruments used during measuring ammonia level (SNI 19-7119.1-2005) were pre-filter holder, absorbent bottle of 30 mL, steam trap, glass wool, flow meter capable of measuring flow meter of 1 litre/ minute, control valve, pump, pre-filter, 100 mL and 1000 mL flask, 0.5 mL; 1 mL; 5 mL; and 20 mL volumetric pipette, 1 mL micro pipette, 100 mL measuring cylinder, 100 mL; 500 mL; 1000 mL; and 2000 mL beaker glass, 25 mL test tube, spectrophotometer, analytical scale with 0.1 mg accuracy, 50 mL burette, 250 mL Erlenmeyer flask, watch glass, desiccator, oven, thermometer, barometer, air bath.

The materials used during measuring ammonia level (SNI 19-7119.1-2005) were adsorbent solution, sodium nitroprusside dihydrate solution ($Na_2Fe(CN)5NO.{}_2H_2O$ 2%, sodium hydroxide solution (NaOH) 6.75 M, sodium hypochlorite solution (NaOCl) 3.7%, phenol solution (C_6H_5OH) 4% v/v, buffer solution, ammonia solution of 1000 µg, ammonia solution of 10 µg, hydrogen chloride solution (HCl) 1.2 M.

The instruments used during measuring hydrogen sulphide level (RSNI3.7119.11:2007) were absorbent bottle of 30 mL, steam trap, vapour absorber (glass wool or silica gel), flow meter capable of measuring flow rate of 2 litre / min, control valve, suction pump, 25 mL; 100 mL; And 1000 mL flask, volumetric pipette, dropper, 100 mL measuring cylinder, 100 mL; 500 mL; and 2000 mL beaker glass, 25 mL test tube, spectrophotometer with civet, analytical scale with 4 decimal precision, 50 mL burette, 250 mL Erlenmeyer flask, watch glass, desiccator, oven, thermometer, barometer.

The materials used during measuring hydrogen sulphide level (H_2S) (RSNI3.7119.11:2007) were adsorbent solution, H_2SO_4 50 % (v/v) solution, N, N-dimethyl-p-phenylenediamine dihydrochloride (p-aminodimethylaniline dihydrochloride), iron(III) chloride solution 3.7 M, ammonium phosphate solution 40% b/v, sodium thiosulphate solution 0.1 N, H_2SO_4 solution (1:5), KIO_3crystalline, iodine solution, starch solution, hydrochloric acid (HCl) solution 1 M, hydrochloric acid (HCl) solution (1+10), sodium thiosulphate solution ($Na_2S_2O_3$) 0.1 N, H_2S solution (µL H_2S/mL).

RESULTS AND DISCUSSIONS

a. Odour Hedonic Scale

The malodour of hedonic scale indicates an indication of being very like or very dislike of odour. The malodour hedonic scale used a range of $-4 \leq x \leq 4$ that represents negative and positive impressions with accuracy of 1 (one) decimal number. Range of -4-0 scale indicates negative impression, while range of 0-4 indicating positive impression. Selection of scale $-4 \leq x \leq 4$ refers to the literature [4, 11] shown by Table 1.

Table 1: Hedonic Scale of Malodour [4, 11]

Scale	Impression	Scale	Impression	Scale	Impression
-4	sting	-1	a bit unpleasant	2	quite pleasant
-3	unpleasant	0	odourless	3	Pleasant
-2	quite unpleasant	1	moderate	4	very fragrant

b. Determination of Odour Sources

The determination of the location of odour source research was conducted based on the consideration of interview result to 80 respondents. Respondents were asked to name 3 places that produce unpleasant odours. Top ten source of odours according to respondent's perception is presented in Fig 2.

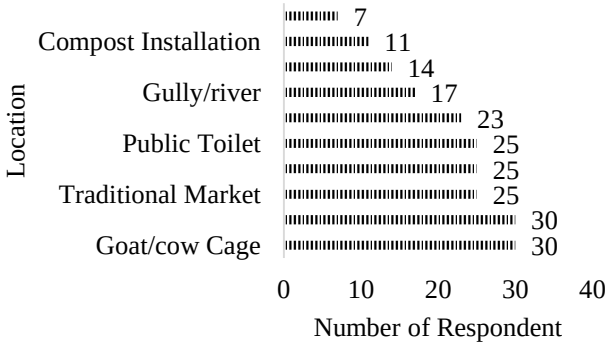

Figure 2. Source of Odours According to Respondent's Perception

Based on the interview's result, the development of malodour hedonic scale was carried out in 10 (ten) places suspected to create malodour impressions, such as poultry housing in Dramaga area, Dramaga Traditional Market, solid waste transfer station in Dramaga Traditional Market, catfish pond in Dramaga area, gully in Dramaga Area, tofu factory in Dramaga area, public toilet in Dramaga Area, meat stall in supermarket, fish stall in Koja Traditional Market, and goat cage in Tanjung Priok area.

c. Determination of Calibration Curve

Calibration curves are used to understand the instrumental response to an analyte, and to predict the concentration of analyte in a sample. The calibration curve is made three times with the aim of obtaining an appropriate curve. The NH_3 and H_2S gases are foul gases. From result of calibration curve processing of ammonia (NH_3), got data R^2 = 0.9733. This calibration curve is used for calculation of subsequent causes of odour pollution. The NH_3 gas calibration curve is shown in Fig. 3.

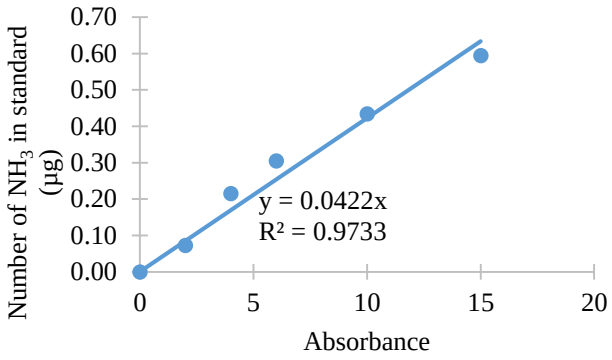

Figure 3. Calibration curve of NH_3 gas

Figure 4 shows the results of hydrogen sulphide (H_2S) calibration curve and R^2 = 0.9407.

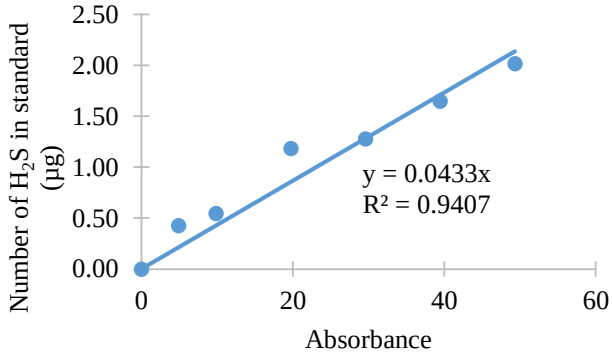

Figure 4. Calibration curve of H_2S gas

d. Analysis of Hedonic Scale

Odour is referred to as properties or quality of source which effects, stimulates, or conceivable by the sense in the form of aroma, fragrance, and offensive smell [12, 13]. The compilation of various compounds and the smell of the odour generated has been done [1]. There have been many studies on mitigation of the odour by the researchers in foreign countries [14]. The 10 (ten) places that allegedly give rise to the negative odour impression sorted according to panellist ethnics (Fig. 5).

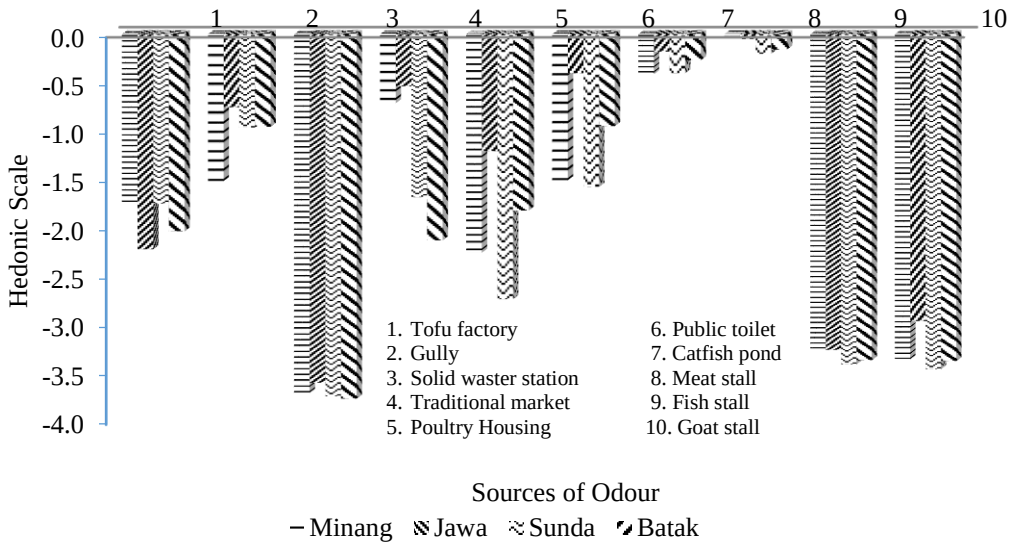

Figure 5. Hedonic scale of odour sources

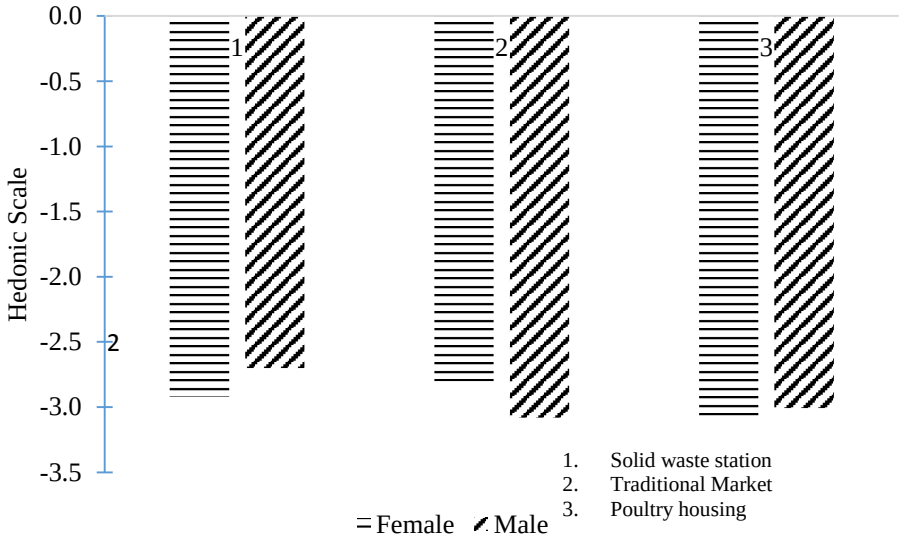

Figure 6. The comparison of hedonic scale between male and female panellists

Obtained hedonic scales in 10 (ten) places suspected to create malodour impressions is negative impressions below 0. It means every panellist gives negative impression to the 10 (ten) places suspected to create unpleasant smell. The impression sorted from the smallest to highest hedonic scale in a row by ethnic of panellists in a row is Sunda, Batak, Minang, Java with the total score of -19.8; -18.8; -18.4; -15.1. It means the tolerance to negative smell by the Sundanese is smaller than the other three ethnics. While the highest tolerance to the biggest negative smell by the Javanese. Measurement of hedonism scales is also conducted in 3 (three) places suspected to negative impressions by using 5 male panellists and 5 female panellists. Fig. 6 shows the comparison of hedonic scale between male and female panellists.

The result of hedonic scale by female's panellists shows a more negative trend than male. This is indicated by the of hedonism scale 2 of the 3 lowest places by female.

e. The effect of NH_3 and H_2S gasses on health

NH_3 gas is a colourless gas with a characteristic pungent smell composed of nitrogen and hydrogen [15]. This gas is one of the smelly and in certain amounts of waste can be harmful on health [16, 17]. The effect of NH_3 gas is shown in Table 2 [18].

Table 2. The effect of NH_3 gas on healthy [18]

Concentration and Exposure Time	Effect
20-25 ppm (-)	Mild discomfort, depending on whether an individual is accustomed to smelling ammonia
50-80 ppm (2 hours)	Perceptible eye and throat irritation
100 ppm (2 hours)	Nuisance eye and throat irritation
140 ppm (2 hours)	Severe irritation, need to leave exposure area
134 ppm (5 minutes)	Tearing of the eyes, eye irritation, nasal irritation, throat irritation, chest irritation
500 ppm (30 minutes)	Upper respiratory tract irritation, tearing of the eyes
700-1700 ppm (-)	Incapacitation from tearing of the eyes and coughing
5000-10000 (-)	Rapidly fatal
10000 (-)	Promptly lethal

H_2S gas is a colourless *gas* with the characteristic odour of rotten eggs composed with hydrogen and sulphur [19]. The effect of H_2S gas is shown in Table 3 [20].

Table 3: The effect of H_2S gas on healthy [20]

Exposure Limits (ppm)	Health Effects
0.008-0.2	Olfactory threshold -"rotten eggs" smell detectable
20	Sense of smell to gas lost. Concentrations tolerated for some hours without harm
20-50	Eye irritation
50	Prolonged exposure may cause pharyngitis and bronchitis
60	Prolonged exposure may cause conjunctivitis and eye pain
150+*	Irritation of upper respiratory tract. Sense of smell lost
250	Pulmonary oedema with risk of death
500	Very dangerous, evacuation should occur well below this level
1000	Loss of consciousness occurs
1000-2000	Acute intoxication: symptoms include rapid breathing, distress, nausea and vomiting. May be rapidly followed by loss of consciousness, coma and cessation of breathing.
2000+**	Immediate loss of consciousness and high probability of death

Notes:

* More than 150 ppm

** More than 2000 ppm

f. Chemical Analysis of NH_3 and H_2S

The quality standard of is regulated in Kep-50/MENLH/11/1996. The NH_3 gas limit is 2.0 ppm, while H_2S is 0.02 ppm. In Figure 7 and Figure 8 is shown the results of the tenth chemical test analysis of the odour source site. Detected levels of NH_3 and H_2S gases are below the regulated limit, except the H_2S level in the tofu factory is 0.202 ppm. Based on the literature (Table 2 and 3), the detected levels of NH_3 and H_2S are not to have a negative impact on health. The detected level of NH_3 and H_2S from 10 (ten) selected sources was presented in Fig 7 & 8.

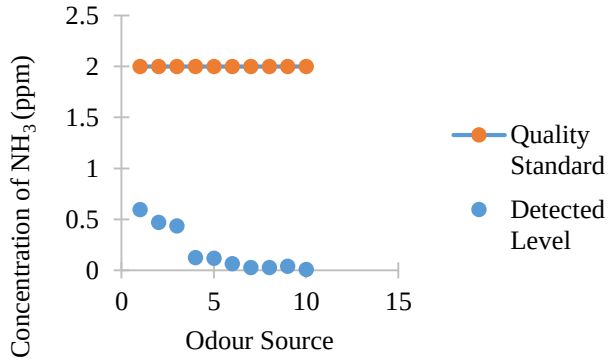

Figure 7. The chemical analysis of NH_3 detected level

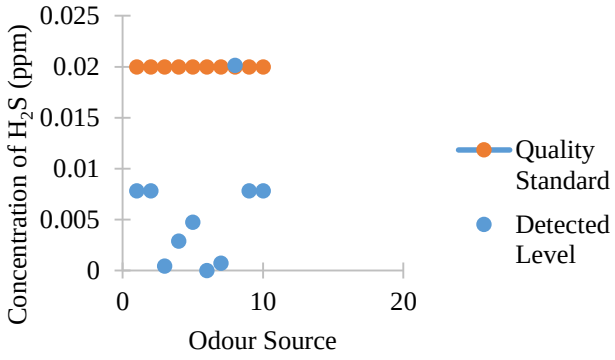

Figure 8. The chemical analysis of H_2S detected level

g. Survey of Odour Perception

Survey was conducted on 73 respondents who visited solid waste station in Jakarta. The question was listed on points below.

1. Do you smell malodour from a garbage truck that passes by?
2. Do you smell malodour from solid waste station 5 meters away?
3. Do you feel disturbed by the smell arising from the solid waste station?
4. Is malodour environmental issue?

There were also surveys of 10 heads of family living around the solid waste stations. The question was listed on points below.

1. Are you getting used with the odour from the solid waste station?
2. Do you / family ever experience health problems?

The result of the survey was presented on Fig 9.

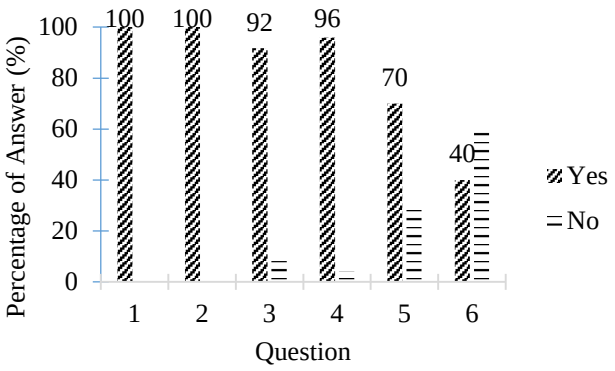

Figure 9. The result of the survey

CONCLUSIONS

The conclusions that can be drawn from the research are as follows:

1. The malodour hedonic scale used a range of $-4 \leq x \leq 4$ that represents negative and positive impressions with accuracy of 1 (one) decimal number.
2. The impression sorted from the smallest to highest hedonic scale in a row by ethnic of panellists in a row is Sunda, Batak, Minang Java with the total score of -19.8; -18.8; -18.4; -15.1. It means the tolerance to negative smell by the Sundanese is smaller than the other three ethnics. Also, the result of hedonic scale by female's panellists shows a more negative trend than male. This is indicated by the hedonic scale 2 of the 3 lowest places by female.
3. Detected levels of NH_3 and H_2S gases are below the regulated limit, except the H_2S level in the tofu factory is 0.202 ppm. Based on the literature (Table 2 and 3), the detected levels of NH_3 and H_2S are not to have a negative impact on health.
4. Based on survey of odour perception, all the respondents smell malodour from the garbage truck and solid waste station 5 meters away. But, only 92% feel disturbed by the smell.

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