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A STUDY ON AIR QUALITY NEAR SOLID WASTE TREATMENT PLANTS AMONG UNIVERSITY POPULATION: ADANA CASE

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ABSTRACT

In the city of Adana, which constitutes the field of this study, rapid urbanization with rapid population growth causes increasing waste consumption. This uneven increase has brought along the problem of urban waste collection and disposal. The fact that the Sofulu solid waste disposal facility in Adana is located within the residential areas causes the health and social life of the city to be negatively affected. Even if measures are taken for sanitary landfills, it is likely to adversely affect public health as they create various sources of air pollutants such as chemicals, odor, and volatile organic compounds. The aim of this study; Alparslan Türkeş Science and Technology University, located near the Adana Sofulu solid waste disposal facility and host many individuals daily, to investigate the impact of a solid waste disposal facility on the user with a user-oriented survey. Statistical techniques were used to examine the relationships between residents' responses to the layout of the landfill. The research was carried out among 100 participants, 50 were university students, and another 50 were academic and administrative staff working at the university. The difference between these two groups was observed statistically with the cross-classification analysis. In addition, research on environmental awareness towards solid waste disposal facilities.

Keywords: Solid waste landfill, air quality, environmental awareness, survey.

1. INTRODUCTION

The changing socio-economic structure in the process of getting difficult living conditions and urbanization requires re-questioning and rearranging the life we live. Cities today are rated primarily for the quality of life. Quality of life, on the other hand, is a phenomenon that contains many concepts together. In this context, increasing air pollution because of technological developments and changing lifestyles is one of the factors that make up the whole of this concept. While creating the concept framework, boundaries are determined by today's living conditions and technology. Today, this framework has surrounded almost every area of our lives with its different shapes and appearances. Along with the increase in population, the production volume of municipal solid waste facilities increases because of urbanization, industrialization, and technological developments.

The National Waste Management and Action Plan have been prepared within the sustainability principal framework in the past years. However, new sanitary landfills are also in need with the increase in waste. The selection of these alternative landfills is very important [1].

Rapid population growth and rapid urbanization in the city of Adana, which constitutes the field of this study, have led to increasing waste consumption, and this irregular increase has brought along the problem of urban waste collection and disposal. The fact that the existing solid waste disposal facility in Adana is located within the residential areas causes the health and social life of the city to be negatively affected [1].

In general, the amount of solid waste is directly proportional to the economic development and urbanization rate. Globally, the amount of waste is increasing rapidly all over the world. Solid waste

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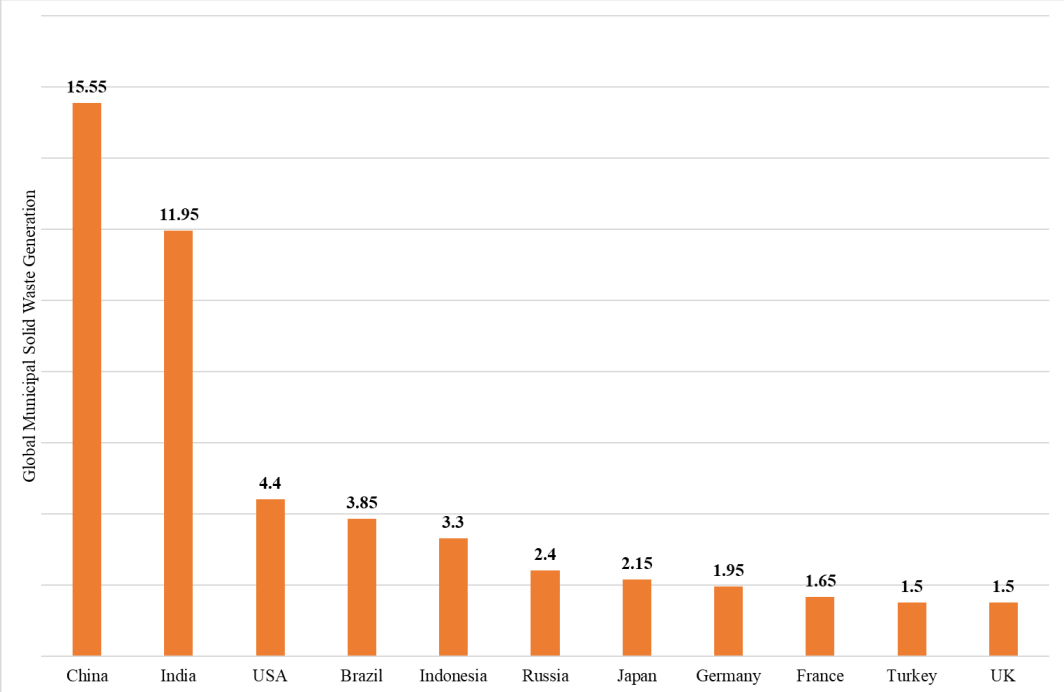
growth rates appear to be rapidly increasing in China, other parts of East Asia and parts of Eastern Europe, and the Middle East and Pacific Region, as are urbanization rates and GDP [2]. There is a strong relationship between urban solid waste generation rates and greenhouse gas emissions. The increase in solid waste, greenhouse gas emissions and ozone-depleting substances is due to pollution and urbanization. Most landfills are open dumps and pose serious environmental and social threats [3]. Figure 1 shows the global municipal solid waste generation percentages in selected countries in 2018. While production is mostly seen in China and India, Turkey is in the top ten with 1.5% [4].

Figure 1. Global municipal solid waste generation [4].



According to statistical data between 1990 and 2017 about the global distribution of deaths from outdoor air pollution, most of the deaths due to outdoor air pollution occur in India, and Turkey ranked 2. with 36%, China is 3rd, with a 30% increase [5].

Also, indoor air quality is affected by the presence of various microorganisms and allergens such as particulate matter (PM), carbon monoxide (CO), carbon dioxide (CO_2), temperature, relative humidity, and formaldehyde (HCHO) etc. Several studies have documented the relationship between indoor air quality and students' school performance [3]. These studies show that classroom ventilation rates are directly related to student's academic achievement.

To control the IAQ related to COVID-19, [6] analyzed the design strategies in post-pandemic architecture. By offering methods to understand the health and environmental problems of COVID-19, this research aims to show architects the increased risk of disease transmission. To improve IAQ, this paper offers a conceptual model based on this problem and explores the integration of engineering controls, design strategies, and air sanitization approaches. Buildings contain a comprehensive IAQ management approach for human-centered designs requiring sufficient ventilation systems, air filtration, humidity regulation, and temperature control [7], [8].

In Çanakkale, Turkey, [9] surveyed 121 households and gathered data over 12 months. Air contaminants, including CO2, VOCs, temperature, and humidity, were observed. Additionally, several infections were common, and the SBS symptoms changed seasonally. There is a correlation between the frequency of SBS symptoms, the calculated IAQ parameters, and personal factors (p 0.05).

[10] proposed an analytical model and its variables of IAQ related to thermal comfort and health. According to this research, factors such as outdoor/indoor temperature, wind velocity, outdoor/indoor relative humidity, physical features of the room, natural/mechanical ventilation, the number of occupants, and air exchange rate were determined to define health, IAQ, and thermal comfort [7].

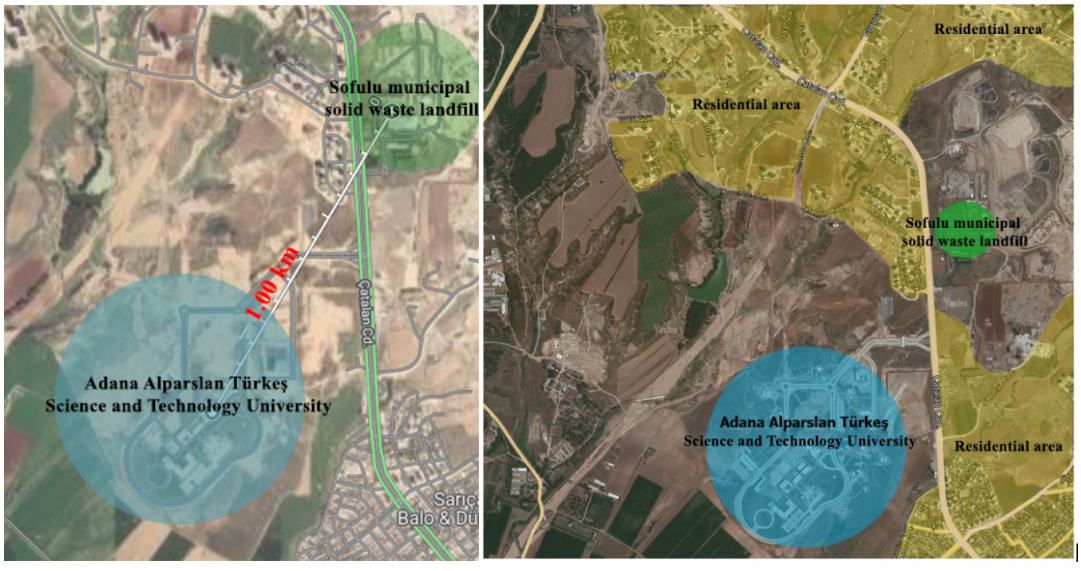
This research covers the surveys and evaluations about the indoor environmental quality that will be made with the user population within the boundaries of the Adana Alparslan Türkeş Science and Technology University campus, which is located near the Sofulu solid waste disposal facility. This study is planned to investigate the effect of air pollutant emissions from landfills on indoor air quality and thermal comfort on users at ATU near Adana Sofulu solid waste disposal facility. For this purpose, conducting a user-oriented survey at the university, which hosts many individuals daily, is part of the study. A separate survey was conducted between 08:00 and 17:00 in the morning for a year between the administrative and academic staff working at the university and the students in the university education period. Thus, this study includes research on air pollutant emissions from landfills, including quality of life.

2. METHODOLOGY

The methodology followed in the study includes designing survey questions to determine the study's objectives, conducting surveys across campus, processing the survey data, and ultimately evaluating the results of the surveys, along with a series of research that includes a review of the relevant literature. The surveys were made to the Adana Alparslan Türkeş Science and Technology University campus staff and students working there. First, ethics committee approval was obtained for the study, the participants were informed about the subject and answers were received.

In this study, Sarıçam district, where ATU and Sofulu landfill, located on a total area of 1,431,673.82 m² in Balcalı District, 202 blocks, 52 parcels, is located, is the region that hosts approximately 10% of the total population with rapid development transformation and urbanization will be discussed (Figure 1). The university campus, which is approximately 1.00 km from the Sofulu municipal solid waste landfill, has been determined as the study area.

Figure 1. Location of the university campus and municipal solid waste landfill



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A simple and understandable questionnaire was designed, and criteria related to the thermal comfort of offices/classrooms, indoor air quality and the impact of storage space were evaluated to collect data on the campus public. Using a Likert-type scale, it was expected to be evaluated with multiple options between the two extremes. Likert-type questions contain a statement that includes an attitude or opinion about the subject under investigation and options that indicate the level of agreement with this statement. These options are ranked "highest to lowest" or "best to worst." The questionnaire, which consists of 10 questions in total, includes four questions about indoor air quality and thermal comfort, five about solid waste treatment plant and its effect, and one about indoor air pollutants. Table 1 shows the criteria used in the survey.

Table 1. Landfill site survey questions

	Survey Questions
1	Rate of fresh air in classroom/office
2	Feel about the air quality in classroom/office
3	Satisfaction of indoor temperature of classroom/office
4	Feel about the indoor temperature in the classroom/office
5	Principle of municipal solid waste landfill
6	Impact of the municipal solid waste landfill on the university campus
7	Odor period from municipal solid waste landfill
8	Impact of the municipal solid waste landfill on classroom/office air quality
9	Health impact of municipal solid waste landfill
10	Indoor air pollutants

2. ANALYSIS OF SURVEY DATA

100 completed questionnaires were processed to analyze the air quality impact of the landfill's proximity to the campus. The analysis includes responses to questions about indoor air quality to campus users near a landfill. Responses were analyzed with 10 questions describing participants' knowledge of the impacts of landfills and their concerns about office/classroom air quality and health concerns. These answers were taken within the questions of the rate of fresh air, the satisfaction of indoor temperature and fresh air, the principle of municipal solid waste and information about indoor air pollutants. In the analysis phase, these options were coded by assigning a numerical value according to their degree, and the qualitative data were converted into quantitative data and analyzed. The data obtained from the questionnaires were coded and analyzed with the SPSS statistical program. Table 2 includes the analysis of the answers given by the staff and students as mean.

Table 2. Mean of the statistical analysis of survey for student and staff

		Student	**Personal**
1	Rate of fresh air in classroom/office	**2.4**	**2.5**
2	Feel about the air quality in classroom/office	**2.4**	**2.5**
3	Satisfaction of indoor temperature of classroom/office	**2.7**	**3.7**
4	Feel about the indoor temperature in the classroom/office	**3.5**	**3.0**
5	Principle of municipal solid waste landfill	**1.6**	**1.6**
6	Impact of the municipal solid waste landfill on the university campus	**4.1**	**3.8**
7	Odor period from municipal solid waste landfill	**1.3**	**1.3**
8	Impact of the municipal solid waste landfill on classroom/office air quality	**4**	**3.5**
9	Health impact of municipal solid waste landfill	**1**	**1.1**

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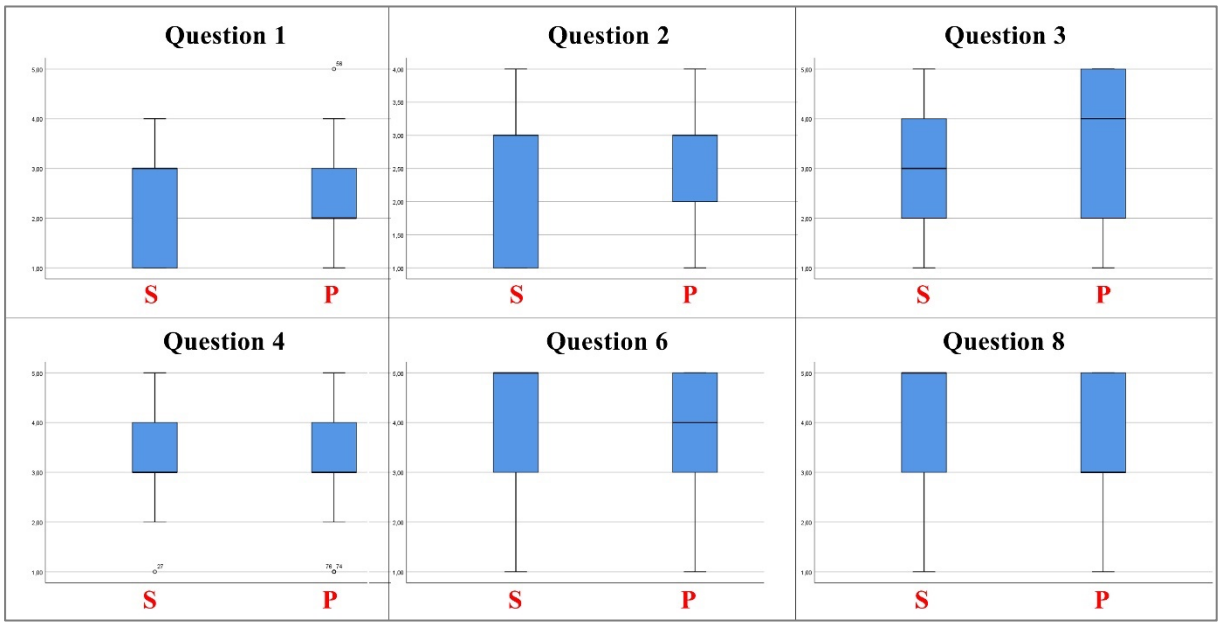
A box whisker plot is a diagram showing the data's minimum, maximum, and three quartiles, with a vertical box and two lines coming out of that box [11]. The length of the box section of the graph is the quartile difference Q3-Q1. The line in the middle of the box shows us the median value of Q2. It is possible to see the smallest value in the data set, the first, second and third quartiles of the data and the largest value in the data set with the box-whisker plot [12]. The fact that it is located right in the middle shows that the data are normally distributed [13]. Figure 2 shows the box whisker diagrams for all questions. In this figure, "S" represents the students and "P" represents the personnel/staff. If the median line of one boxplot is outside the box of another boxplot, a difference is likely between the two groups. The longer the box, the more scattered the data. The smaller the box, the less dispersed the data will be.

Figure 2. Boxplot diagrams for some questions



It is necessary to use different analysis tools to understand whether there is a statistical difference between them. Therefore, a t-test analysis was performed in this study after the box plot. Whether there is a mean difference between the two sample groups was examined with this analysis.

When the answers given by the students and staff were examined, it was found that the results were different from each other after the t-test (Table 3) for satisfaction with the office/class indoors. And the 8th question about the impact of the municipal solid waste landfill on classroom/office air quality results differs. Accordingly, it has been observed that the satisfaction of the staff with the indoor air quality and ambient temperature in the office is higher than the satisfaction of the students with their classrooms. Also, according to the survey, a significant difference is observed in the answers between the students and the staff for odor annoyance. It has been concluded that the odor emitted from the solid waste treatment plant is more effective in classrooms.

Table 3. t-test table

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
Sig. (2-tailed)	0.780	0.588	0.002	0.136	0.909	0.226	0.949	0.054	2.000

The last question of the survey was asked to measure information in general, and the analysis result for the question, which is all indoor air pollutants, and some options include toxic gases, is given in Table 4. As can be seen in the table, the question of which options are indoor air pollutants from particulate matter (PM), carbon dioxide (CO_2), methane (CH_4), hydrogen sulfide (H_2S), and carbon monoxide (CO) and formaldehyde (HCHO) were asked. While 60% of the students said that CO_2 is not an indoor air pollutant, 17.1% of the staff did not. In addition, 68% of the participants said they did not know whether formaldehyde is an indoor air pollutant. While 64% of the participants do not know about hydrogen sulfide, 53% do not know about particulate matter.

Table 4. Multiple response analysis

	PM	CO_2	CH_4	H_2S	CO	HCHO
Student	54.0%	40.0%	80.0%	44.0%	60.0%	8.0%
Staff	35.5%	83.9%	71.0%	22.6%	58.1%	6.5%
Total	46.9%	75.3%	76.5%	35.8%	59.3%	32.1%

3. RESULTS

This study, in which the opinions of campus users are determined, includes questions about classroom/office use and indoor air quality of indoor areas. This study shows the importance of raising awareness and choosing the right land. In addition, this situation, which affects the quality of life of those residing around the landfill, is expected to raise awareness among managers.
A summary of the research findings is as follows;
• 44.4% of users say that solid waste integrated facility impacts indoor air quality. Also, 90 out of 100 samples think it's affecting their health.
• Decentralized heating and cooling systems are used in offices and classrooms where ventilation can only be done naturally. While 25% of users were unsatisfied, 42% gave an average rating. There were only 2 examples that claimed to have a clean air indoor environment.
• 60% stated that they do not know the system's working principle. For this reason, it is important to increase the general knowledge and awareness of those living near this landfill area.

In addition, managers must involve the public and institutions in their immediate vicinity when implementing waste management programs and making landfill site decisions. Public support is essential for the success of such decisions.

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