

Assessment of Odor Annoying Impacts on Trade and Serving Centers Close to a Vegetable Oil Manufacturing Plant

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ABSTRACT

The environmental odor pollution emitted from different sources has undesirable impacts on communities' health and welfare in a way that caused increasing public worry and complains around the world. Pars Vegetable Oil Processing Plant (PVOPP) is located near populated residential areas in Tehran; hence, many people are exposed to the plant process annoying odor daily. In order to assess the odor annoying impacts on its nearby business centers a social survey has been applied. In the field area 200 questionnaires were intended to be filled out but 180 of them have been completed by the respondents (90%). Almost 98% of the respondents have perceived the odor from the outdoor source in their working places which is known as the industry by 78% of them. Among the respondents 42% of them have defined the odor as intolerable. Considering that industry has been recognized as the most important external parameter which affect the quality of working environments, the impact of this industrial unit on decreasing the quality level of working conditions is more obvious. The duration of presence in the working place and record of service are related to disorders in working activity and emotion and thus confirm the odor pollution impacts on the employees' efficiency.

Key words: Odor pollution, questionnaire, annoyance, Vegetable Oil Manufacturing.

INTRODUCTION

The air around us contains aromatic compounds originated from citizens' daily activity in residential, trade and industrial areas which create the modern societies. Daily exposure to odor pollution is a part of modern life¹. Odor is generally defined as the feeling caused by chemical compounds which are called odorants while being perceived by stimulating the sensory receptors of smell². Odor is a combination of one or more volatile chemical compound that humans perceive by the sense of olfaction³. According to the EPA definition odorous compounds are pollutants while annoying the human or affect his health or welfare⁴.

Researches show that environmental irritants like noise and odor can have considerable impacts on the physical and moral condition of the people and their quality of life⁵⁻⁶. If this exposure is long or intensive the unpleasantness would be converted to annoyance gradually. Annoyance is described as an unpleasant feeling about a defined factor or condition which adversely affects the individuals or groups⁹. The human perception of odor is the result of a set of physiological and mental reactions which identify the odor quality⁷. Hence, the compatibility of odor perception is widely personal among individuals which their reaction is different due to their age and health status⁸. The unpleasant impacts of odor emitted from different sources have

increased the public complaints and worry all around the world, more people are sensitive to the issue and request for more control and more effective measures to decrease the odor emission by authorities⁹. Odorous compounds impress the health and welfare of communities¹¹. Since World Health Organization (WHO) defines health as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity”¹¹, in recent years health and environmental organizations have paid more attention to the odor pollution issue because of its negative impacts on the neighborhoods. Researches about odor pollution effects on human health concluded that they could be categorized to physiological and mental impacts¹².

The most common odor-related symptoms are reported burning eyes, soar throat, nose irritation, headache, nausea, cough, nose congestion and short breath¹³⁻¹⁸. Mental effects are depression^{18,20}, fatigue and sleepiness²¹⁻²⁵ mood disturbance²⁶⁻³⁰ and also decrease in the individuals working efficiency^{31, 32}.

Environmental odor can impress the evaluation of indoor and outdoor air quality and works as a warning sign. Nowadays, public awareness about the association of indoor air quality (home and office) with their health have increased which could be due to more amount of time spent indoors, aging population, decreasing air conditioning to reduce the energy consumption, increased usage of chemical compound in working and living environment and also outdoor air pollution. Millions of Americans spend two thousand hours or more per year in closed spaces and so gradually become prone to ailments related to indoor pollutant exposure such as odorous materials³³. Therefore, identifying the surrounding air combination is very significant which lead to various investigations implemented about odor pollution annoyance impact assessment on nearby residents and/or the employees working in odorous industries and facilities and odor related mental and physical health effects³⁴.

On the basis of the wide reviews, no investigation about odor annoyance effects on non-industrial workers which work in areas affected by

odor has been done yet. So, it is the first time in Iran that the nuisance impact of emitted odor from an oil processing plant on the trade and service employees around has been implemented.

MATERIAL AND METHODS

This study has been done in a crowded area in southern part of Tehran. The current population of Tehran as the capital of Iran is 7,975,679[34]. In spite of the measures taken to organize the industries settlement out of the city's area, there are still some old industries working. One of these active units is Pars Vegetable Oil Processing Plant (PVOPP) which has been selected as the odor source in the area. Figure 1 illustrates the plant location and study area. It should also be mentioned that the same level of impressibility has been determined for both trade and serving centers considering their approximately equal distribution.

A questionnaire method has been applied to examine the odor annoyance for workers in the study area. The questionnaires were filled out in direct interview in summer 2011. In order to implement the research, 200 workers were selected stochastically in trade and serving area and were directly interviewed by trained questioners.

While designing the questionnaire German VDI Guideline (VDI3883 -Part II) published in 1993 and researches about Community Response to Odorous Emissions in other countries have been considered³⁵. It is necessary to mention that the guideline is used in various researches to study the community response to odor annoyance in neighborhoods. So, in this study it has been tried to design an appropriate questionnaire considering the necessary parameters for odor annoyance survey in non-industrial working environment around the odor source by keeping the general structure of the guideline recommended questionnaire or in some cases adding or changing the related questions. Questions could be categorized in four sections including a) personal characteristics (age, gender, type of job, length of working time, working place conditions, record of service,...) b) environmental issues and personal health conditions (environmental problems,

personal health problems,...) c) odor nuisance variables (type of source, intensity, frequency, quality, level of disturbance and annoyance, hedonic tone, acceptability,...) and the final part d) which is focused on individuals' daily activity and emotion. The related scales for the variables would be presented in the result chapter comprehensively.

In order to decrease the residents' sensitivity to the odor source and also minimizing the error percentage in results, other environmental

aspects of the region have been also scripted in the questionnaire. Data analysis has been done using SPSS (Version 18).

RESULT

Part 1: Social and Statistical variables Data

Among 200 questionnaires predicted for the study area, 180 have been completed by the respondents; the response rate is 90%. According to the questionnaires 174 (96.7%) of the

Table 1: Socio-statistical Data

N=180	Mean	Standard Deviation	Range
Age (year)	35.8	13	17-75
Duration of presence at work (hour)	9.8	3	1-17
Workspace area (m)	26	23	1-120
Record of service (year)	9.6	10.3	1-48

Table 2: Workers' common health problems

Health problem	Percentage
Irritation symptoms	21
Not getting enough sleep	21
Headache	19
Breathing difficulties	14
Difficulties falling asleep	17
Cough	14
Waking up during the night	12
Stomach disorders	9
Difficulties falling asleep after Waking up	8

Table 3: Odor intensity perceived by workers

Odor intensity	Percentage
Unbearably strong	14
Very strong	9
Strong	27
Distinct	23
Weak	19
Very weak	6
Not perceptible	2

Table 4: Odor hedonic tone perceived by workers

Hedonic tone	Percent
Very pleasant	3
Pleasant	
Moderately pleasant	
Mildly pleasant	
Neutral odor / No odor	
Mildly unpleasant	14
Moderately unpleasant	5
Unpleasant	36
Offensive	42

respondents were male with the mean age of 35.8 (with the range of 17 to 75 years). Considering the very few number of women participated in answering the questionnaires the related data have been removed. 64% of respondents were working in trade and 36% in serving centers.

The mean area of studied work places is about 26 m^2 and the average duration of presence at work is calculated to 9.8 ± 2.9 hr/day. Data related to socio-statistical variables are summarized in Table1.

Data related to environmental issues

showed that almost 87.7% of participants have chosen odor as the most considerable problem in their working environment while 42.2% have mentioned air pollution and 55.5% have implied noise pollution.

Part 2: Personal Health Status Data

In this part data illustrated that eye irritation (21%) and not getting enough sleep (21%) were equally more common in respondents comparing

with other health problems. Data related to this part are briefed in Table2.

Generally 69% of the respondents had at least on of the problems mentioned in the above table. 69% showed no allergy symptoms. 39% of the allergic people had to take medicine. Only 19% of the participants were regular smokers.

Part 3: Odor characteristics

Table 5: Relationship between odor-related variables with odor source and mutual comparison of variables

Test Variable	Odor source ($\alpha=.05$)	Post Hoc ($\alpha=.033$)
Odor intensity	.010	Vehicle < Industry P=.006
negative impacts of activity and emotion	.001	Waste water < Industry P<.001 Vehicle < Industry
Unpleasantness	.032	P=.009
Odor disturbance	>.001 *	Waste water < Industry P<.001
Annoyance	.004	Waste water < Industry P=.001

Table 6: Relationship between odor-related variables with odor quality and Mutual comparison of variables

Test Variable	Odor source ($\alpha=.05$)	Post Hoc ($\alpha=.033$)
Odor intensity	.072	-
negative impacts on activity and emotion	.001	Waste water < Burning P<.001 Waste water < Sulfur P=.001
Unpleasantness	.017	Burning < Sulfur P=.006
Odor disturbance	.001 >	Burning < Sulfur P<.013 Waste water < Sulfur P<.001
Annoyance	.001	Waste water < Burning P=.013 Waste water < Sulfur P<.001

Sensitivity to odor

Data resulted from this item showed that 98% of the individuals have perceived the odor from the outdoor source in their working places which is known as the industry (Vegetable Oil Manufacturing plant) by 78% of them. Figures 1 and 2 illustrate the odor source and quality. Sulfuric, burning, sweet and wastewater are the options for determining odor quality.

6 categories from 1 for once or less monthly to 6 for frequently in a day have been offered for this variable, the last item frequently in a day has been chosen by 91% of the respondents.

Odor intensity

7 classes from 0 for not perceptible to 6 for unbearably strong have been chosen for determining the intensity of odor, 23% of the workers have mentioned it as distinct and totally 73% have

Odor frequency



Fig. 1: Map of Pars Vegetable Oil Processing Plant Location and Study Area

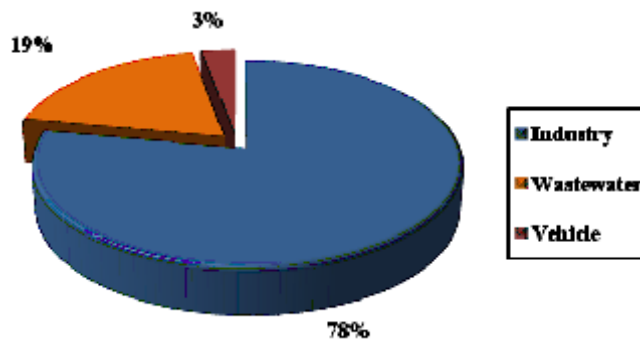


Fig. 2: Proportion of odor sources

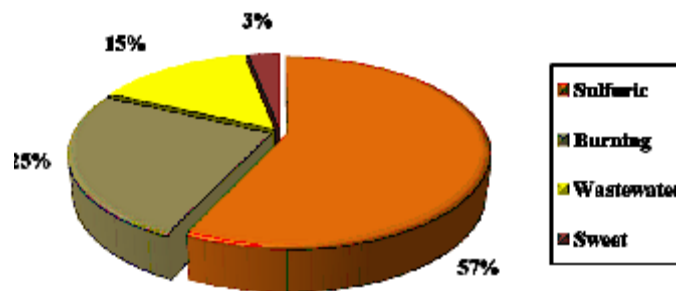


Fig. 3: Proportion of odor quality

chosen distinct to unbearable options. Results are shown in Table3.

This variable has been divided to 9 classes from -4 for offensive to +4 for very pleasant.

Hedonic tone

Annoyance

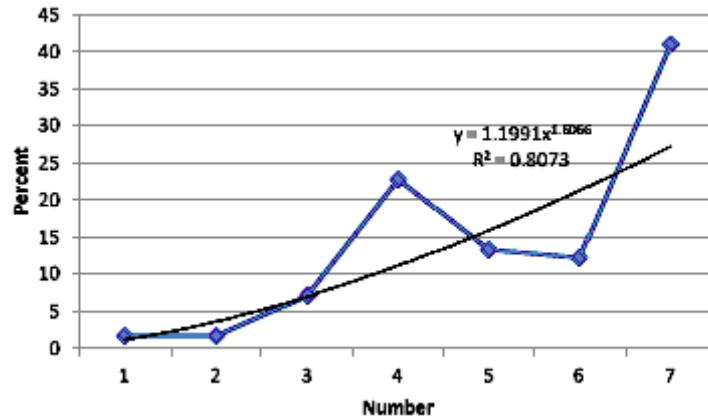


Fig. 4: Odor annoyance perceived by workers

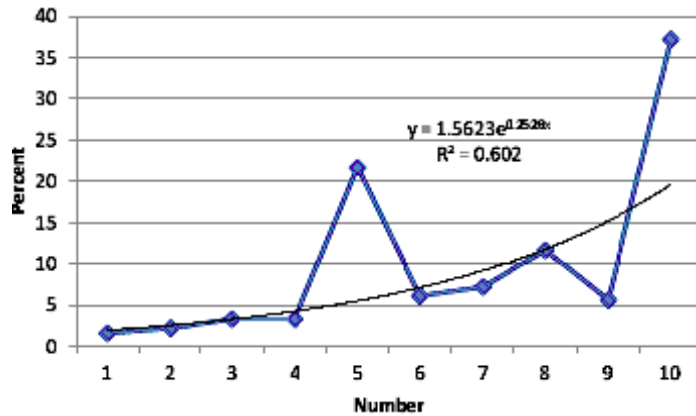


Fig. 5: Odor disturbance perceived by workers

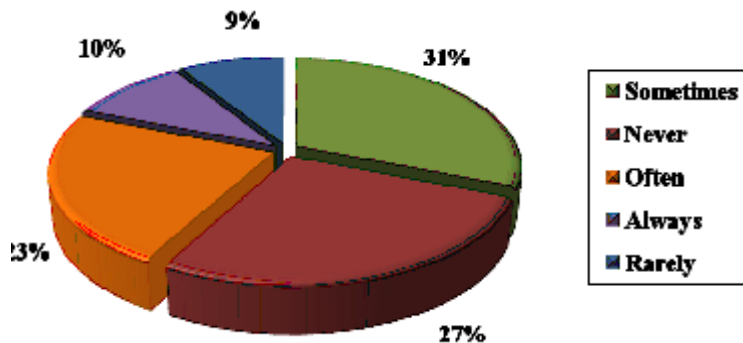


Fig. 6: Odor negative impact on workers' activity and emotion

7 scales have been offered in the questionnaire for this variable from 0 for no annoyance to 6 for maximum annoyance, 41% of the respondents have chosen the maximum annoyance item. Nearly 66.6% of the people have answered 4 to 6. The sample annoyance mean has been 4.64 (\pm 1.58). The confidence interval for odor annoyance level which has been calculated by non-parametric percentile bootstrapping was 4.6 and 4.2. Figure 3 illustrates the related results.

Disturbance

In order to determine the disturbance level it has been divided to 11 categories from 0 for no disturbance to 10 for maximum disturbance. 37.2% of the respondents have selected number 10 which means maximum disturbance. The mean odor disturbance degree was 7.4 (\pm 4.6). The confidence interval for odor disturbance has been calculated by non-parametric percentile bootstrapping which was 7.0 and 7.8. Figure 4 shows the related results.

Odor acceptability

2 scales have been defined in this part (0 for acceptable and 1 for unacceptable). The results show that 82% of the respondents have known the odor unacceptable, 33% of which have complained to the related authorities.

The statistical relationship between the respondents' adaptability to odor and complaining to the local governors has been calculated by Fisher's Exact 2-sided Test which was significant ($p < 0.002$).

Part 4: Odor negative impacts on workers' activity and emotion

Results related to this topic showed that 10% of the respondents have always felt the odor negative effects on their activity and emotion. Figure 5 illustrates the result of this section.

There is a significant relationship between the duration of time spent at work with the evidences these effects. (Spearman $r = +0.26$ $p < 0.001$). The relationship between record of service and showing these impacts is significant additionally. (Spearman $r = +0.34$ $p < 0.001$). Record of service has also significant relationship with odor

disturbance and annoyance but no relationship were found with odor intensity.

Spearman correlation coefficients between odor perception intensity, negative impacts on activity and emotion, hedonic tone, disturbance and annoyance show significant relationship among them ($p < 0.001$). The coefficient values are +0.40 to +0.83.

The effect of odor source on its intensity, negative impacts on activity and emotion, unpleasantness, disturbance and annoyance have been studied by Kruskal-Wallis test at first, then different sources have been compared by repeating Mann-Whitney U test and applying Bonferroni correction in order to adjust type 1 error while comparing multiple variables.

According to the results, this industrial source odor and its unpleasantness are significantly more than other sources which were defined in this study.

The role of odor type on the related properties including negative impacts on activity and emotion, unpleasantness, disturbance and annoyance have been also investigated by Kruskal-Wallis test at first, then different sources have been compared by repeating Mann-Whitney U test and applying Bonferroni correction in order to adjust type 1 error while comparing multiple variables.

Odor intensity is not significantly different in defined odor types but sulfur type is more unpleasant, annoying and disturbing than others.

DISCUSSION

The main objective of this research has been assessment of industrial source odor related parameters on non-industrial workers in the region. In many countries investigations about odor pollution have been considered and the impacts of this environmental problem on nearby residents or the employees working in the place which is known as odor source have been studied. Unfortunately there is no research about odor related effects on other workers close by. This group of people is not exposed to odor as long as near residents and also

is not intensely in contact with odorous materials like industrial workers, but the result of this study shows that odor pollution is unbearable for 82% of the respondents.

Considering that industry has been recognized as the most important external parameter which affect the quality of working environments, the impact of this plant on decreasing the quality level of working conditions is more obvious.

The duration of presence in the working place and record of service are related to disorders in working activity and emotion and thus confirm the odor pollution impacts on the employees' efficiency. The results achieved by Ludvigson *et al.* (1989) and Wilkinson (2002) have also mentioned this.

According to Winneke and Steinheider in 1993³⁸ and also Thuerauf *et al.* in 2009³⁹ gender affects the intensity of odor perception and females feel more level of annoyance. In this study, also average values women have given to annoyance and disturbance levels are more than men (Although due to the insufficient number of women the test is not strong enough).

In this research there is an adverse relationship between age increase with annoyance, the level of which is less in older workers than younger ones. This conclusion is confirmed by the results from Konstantinidis *et al.* (2006), Larsson *et al.* (2009), Pierre M. Cavalini and RAJESH KUMAR SINGH researches³⁸⁻⁴¹.

On the basis of results of this study, more comprehensive investigations about odor pollution management in different fields is recommended. Moreover, effective measures to decrease and control the odor related impacts and providing the citizens' health is emphasized. It should also be mentioned that compliance with the regulations related to industrial positioning and keeping the possible maximum distance from residential area are effective ways of reducing air pollution such as odor and increasing the residents' quality of life.

Considering the lack of comprehensive management systems to decrease the odor pollution and also absence of necessary related regulations in Iran, it is expected that the results of such researches would be an effective factor in making the authorities more sensitive and a motivation to develop comprehensive studies about odor pollution management plan.

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