

Office Indoor Pollution: A Questionnaire-Based Statistical Study

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Abstract

The present article reports the results of a questionnaire-based statistical study of subjective answers by inhabitants regarding thermal comfort and energy consumption in their area of residence. This study was conducted in Shahid Chamran University of Ahvaz with latitude 31°32', longitude 48°68'. The questionnaires were distributed in more than ten Faculties during a day of autumn: Weather conditions at the time the questionnaire is thus a sunny day the temperature was 28 degrees Celsius. The aim of the present study was to identify the main sources contributing to the air pollution of indoor environments of office. For that purpose questionnaires were randomly distributed among the employees and the results were analyzed with spss18. The results show that although they have felt more than 65% of the air quality problems in their workplace but they believe that the outside air more improper than the indoor.

1. Introduction

Several studies underline the role of good indoor air quality, since an average person spends more than 80% of the day in an indoor environment, either in the home or in the work place, a public building, a vehicle etc., [1]. It is a fact that the issue of indoor air contamination has gained increased attention, due to the health-related problems [2]. Sneezing, coughing and minor eye and skin irritation are some symptoms after the start of exposure to a polluted indoor environment [3, 4]. Respiratory and cardiovascular problems, even potential carcinogenicity have been reported after long-term exposure to certain indoor air contaminants [5, 6, 7]. It is known that several factors (i.e. indoor sources and activities, building's design and ventilation pattern, outdoor environment) influence the quality of the indoor air. A respectable number of studies monitoring the indoor air pollution have been conducted so far in residences, schools, hospitals, public buildings, working places, means of transport etc., [6, 8, 9, 10]. Focusing on environments associated with printing activities, there is a

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proven connection between sick building syndrome and the presence of printery equipment (printers, photocopiers) [11]. A range of pollutants is known to be emitted from printery machines: VOCs, especially from wet-process photocopiers which have been associated with occupant illness more than dry-process photocopiers, ozone, respirable particles, formaldehyde and nitrogen dioxide [11, 12, 13, 14]. Po_sniak *et al.* [15] measured VOCs in offices in Warsaw concluding that these compounds occurred in concentrations which were high enough to influence symptoms or perception of the sick building syndrome in workers, particularly in non-airconditioned buildings. Smoking seems to be an important determinant of personal exposures in such an indoor environment, as PM and VOCs levels have been found even 2 times higher among a tobacco-smoke exposed working group compared to a non-smoke exposed group [16]. Factors related to the use of printers and photocopy machines [17], to the building and constructing materials [18], to outdoor sources etc have been examined in the atmosphere of an office environment. Thermal comfort can be defined as the situation in which a person feels neither cold nor warm in a given atmosphere. Thermal comfort in a living environment is very important not only for good health but also for factors like productivity of an individual or an occupant. It depends on the subjective parameters such as age, sex, health, origin of an individual, and clothing. It has been proven that, within an environment with the same characteristics and climate, the thermal sensation and preferences for the same differs among individuals [19]. This preference always varies according to the place of study and its climatic condition. Thermal comfort is very important not only for health but also for the productivity of the occupants. In fact, thermal comfort greatly affects the efficiency of work by an individual as well as the production and social costs. Consequently, the conditions for comfort should be appropriate for the well-being, productivity, and work efficiency of the inhabitants [20]. Thermal comfort heavily depends not only on environmental factors but also on physical, physiological, and psychological aspects. Satisfaction with the thermal environment is a complex topic, and the subjective responses are extremely variable. The main purpose of a building is to offer a comfortable and healthy indoor environment to its occupants during two important seasons of this region. This condition is essential for the occupant's daily productivity [21].

2. Methodology

2.1. The Study Areas

Ahvaz with latitude 31°32', longitude 48°68' and with a population of one million persons is the capital city of Khuzestan province. Ahvaz has experienced many environmental problems such as old infrastructure, deficiencies in wastewater collection systems, increasing salinity in water distribution network as well as air pollution. Recently, dust storms over southwestern of Iran have added an anthropogenic source of air pollution to this city. Dust storm frequencies were 29, 33, 55, 45 and 17

in 2005, 2006, 2007, 2008 and 2009, respectively. In some cases, it has lasted for 48–72 h. An average man inhales almost 10 m³ of air each day. Buildings average of age is about 50 years. The questionnaires were distributed in more than ten Faculties during a day of autumn: Weather conditions at the time the questionnaire is thus a sunny day the temperature was 28 degrees Celsius.

2.2. Instrumentation

General questions involved: age, gender, indoor air quality, satisfaction of indoor air, windows, type of conditioning, area Workspace, The number of people in one room, Ambient temperature, the dust, symptoms of the disease, duration of labor and construction activities. Finally the data obtained were analyzed with the software spss18 and considering nature of the questions test Chi-Square Mann-Whitney, Sperrman Total of determining the critical region $0.05 > p$. In this study, 370 questionnaires were randomly distributed among the employees who 127 women and 103 men answered the questionnaire.

3. Results and Discussions

3.1. The Relative Frequency

The results are evaluated in Tables (1 and 2) are shown.

Table 1. The relative frequency: The results are evaluated, question 3 to 7, 10 to 15 and 24

Questions	Percent of those who said yes	Percent of those who said no	Questions	Percent of those who said yes	Percent of those who said no
3- Are you satisfied with the overall quality of air in your work place?	50%	50%	11- Is your room window opened during the day?	34.4%	65.6%
4- Do you feel you have a problem with air quality of your work place?	66.7%	33.3%	12-Do The windows of your room suitable for ventilation?	57.3%	42.7%
5- Do you think indoor air quality is affected by the outside air?	65.6%	34.4%	13- Do you seen dust on the windows of your room have?	91.7%	8.3%
6- Is the inside air worse than the air outside?	41.7%	58.3%	15-Have you see any aunormal signs in your room that you have not seen in other environments?	19.8%	78.1%
7- Do your ativities make dust in your work place?	24%	76%	24- Have you had any construction activities (such as painting) since 6 months ago?	27.1%	72.9%
10- Does your room have a window?	84.4%	15.6%			

Table 2. The relative frequency: The results are evaluated, question 8, 9 and 14

Questions	Answers	Questions	Answers	Questions	Answers
8- How many people do you have in your room including yourself?		9-How much time do you spend at work?		14-What is the area of work space for each person in the room?	
One person	38.5%	Less than 3	2.1%	Inappropriate	27%
Two person	27.1%	3 to 5	7.3%	Partly good	29.2%
Three person	25.0%	More than 5	90.6%	Appropriate	43.8%
More than three	9.4%				

3.2. Impact on the Questions

Impact of Question 7 with content of ‘dust Production’ to Questions 3, 4, 5 and 6 with content of (indoor air quality and outdoor, compare them, and Effect of outdoor air to indoor) were evaluated in Chi-square test. The results show that isn't significant relation with question 3, In other cases (Q4 $p>0.018$, Q5 $p>0.003$ and Q6 $p>0.0$). Impact of Question 8 with content of ‘the presence of number of people in office’ to Questions 3,4,5,6 and 7 were evaluated in Mann-whitney test. The results show that isn't significant relation with questions 3, 4 and 5, in other cases (Q5 $p>0.001$ and Q7 $p>0.007$). Impact of Question 10 with content of ‘is there a window in the office’ to Questions 3,4,5,6 and 7 were evaluated in Chi-square test. The results show that isn't significant relation with all cases. Impact of Question 11 with content of ‘openness windows’ to Questions 3,4,5,6 and 7 were evaluated in Chi-square test. The results show that isn't significant relation with question 3, in other cases (Q5 $p>0.016$). Impact of Question 12 with content of ‘the suitability of the windows’ to ventilation, to Questions 3,4,5,6 and 7 were evaluated in Chi-square test. The results show that isn't significant relation with questions 4 and 7, in other cases (Q3 $p>0.0$ Q5 $p>0.003$ and Q6 $p>0.0$). Impact of Questions 13 and 14 with content of ‘there is dust on the window’ and workspace area to ventilation, to Questions 3,4,5,6 and 7 were evaluated in Chi-square test. The results show that there is significant relation with question 7, (Q7 $p>0.04$). Impact of Questions 3 to 12 to Question 15 in Chi-square test and Impact of Question 8 to Question 15 in Mann-Whitney, were evaluated. The results show that there are significant relation with questions 3, 4 and 11 (Q3 $p>0.003$ Q4 $p>0.005$ and Q11 $p>0.004$).

Impact of Question 20 with content of ‘each month, the symptoms are more evident’ to Questions 15, 16 and 17 with content of ‘unusual symptoms’ were evaluated in Chi-square test. The results show that isn't significant relation with questions 17, in other cases (Q15 $p>0.008$ Q16 $p>0.001$). Impact of Question 22 with content of ‘office temperature’ to Questions 15, 16 and 17 were evaluated in Chi-square test. The results show that isn't significant relation with questions 17, in other cases (Q15 $p>0.008$ Q16 $p>0.001$).

4. Conclusions

Indoor air quality has a huge impact on employee health and performance. Since most people working in offices are indoors in a controllable environment for most of the day, it makes good business sense to evaluate and where necessary, improve indoor air quality. Improved air quality can not only increase employee satisfaction, it can also result in higher performance and reduce the number of days lost to staff sickness.

Many factors contribute to decreased air quality in the workplace. Formaldehyde, volatile organic compounds (VOCs), cigarette smoke, and ozone all contribute to degraded air quality. Poor indoor air quality can result in flu like symptoms including headaches, sore throats, itchy eyes, or in limited scenarios, chronic illnesses such as cancer. Sources of air pollution in offices include off gassing from furniture, carpets, cleaning products, and photocopy equipment.

High humidity can lead to moisture, and mold, as well as discomfort and decreased comfort, productivity, etc. With respect to, day to day growth of the air pollutant concentrations followed by creating different problems and threatening human health, identification and control of pollutant concentrations in closed environment is discussed as an essential issue. The results of this study showed that based on the reported researches, the sort of activity in closed environment, e.g. the natural ventilation or with fan and etc.. the design of building such as the position of doors and windows and the materials used in them, the quality of outside air and of course the type of pollutant sources all are effective in the amount of pollutants in closed environment. Without a doubt employing any of the above standards can be effective in decrease of pollutant in closed environments. In this study majority of the people that answered the questionnaire were among young people, so it can be considered that they had suitable physical condition. However 65% of them felt problems in their air quality, inside of their workplace, they claimed the outside weather was worse. More than 65 % of the participants believe that indoor air is influenced by the outdoors. And with respect to the existence of floating dust in Ahvaz weather, most people tend to stay in closed environments and not using outside weather for their workhouse ventilation. While less than one third of people, had activities that produced dust, but even this amount has made its impact on the indoor air quality, and also the impact of outdoor air on the indoor air. Also these people stated their lack of satisfaction about the area of their workplace and also the exciting dust on their windows.

Researches show that an increasing number of people in a workplace, increases the amount of dust in the workplace, but it has no relation to their opinion about the satisfaction of the workplace. More than three fourths of the offices had window, and two thirds of people avoid opening the windows, the bad quality of Ahvaz weather can be known as its reason, nevertheless the employees

observed unnatural signs that they wouldn't observe in open environment. Symptoms are mostly like headaches, respiratory problems and feeling sleepy in last months of summer and first months of autumn. Employees state their office temperature as too cold or too warm. Ahvaz city even with huge amount of dusts, have some days that the weather quality is suitable, but due to lack of public announcement, citizens still don't tend to open their windows.

Appendix A. Synthesis of the questionnaire

1 – Sex Man Woman	15- Have you see any aunormal signs in your room that you have not seen in other environments? Yes No
2 - The Age Less than 25 25 to 34 35 to 44 45 to 54 More than 55	16- Which of the following symptoms have you seen in your (room only)? Burning eyes Skin irritation Respiratory problems Headache Sleepy There are other cases
3- Are you satisfied with the overall quality of air in your workplace? Yes No	17-Which of the following symptoms in colleagues (room only) have you seen? Burning eyes Skin irritation Respiratory problems Headache Sleepy There are other cases
4- Do you feel you have a problem with air quality of your workplace? Yes No	18- When during the day problems of Q17 do usually occur for you? Morning Noon Evening
5- Do you think indoor air quality is affected by the outside air? Yes No	19- Which day of the week Q17 problems usually occur for you? Saturday Sunday Monday Tuesday Wednesday
6- Is the inside air worse than the air outside? Yes No	20-Which month of the year Q17 problems usually occur for you? April May June Jun August September Stamp November December
7- Do your activities make dust in your workplace? Yes No	21-Whether the signs of Q17 is permanent or temporary? permanent temporary
8- How many people do you have in your room including yourself? 1 2 3 More than 3	22-What is your room temperature? Cool Proportional Very Hot
9- How much time do you spend at work? Less than 3 3 to 5 More than 5	23-Which kind of conditioner do you have in your room? Air Conditioning Split Fan Other
10- Does your room have a window? Yes No	24-have you had any construction activities (such as painting) since 6 months ago? Yes No
11- Is your room window opened during the day? Yes No	
12- Do The windows of your room suitable for ventilation? Yes No	
13- Do you seen dust on the windows of your room have? Yes No	
14- What is the area of work space for each person in the room? Appropriate Inappropriate Partly good	

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