

# The Effect of Sick Building Syndrome (SBS) on the Productivity of Administrative Staff

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## ABSTRACT

One of the fundamental needs for the human is to have a workplace in which they can do their work appropriately. Worldwide energy crisis necessitated the construction of official buildings with smaller space and less air ventilation. This led to the reduction in air conditioning, accumulation of the contaminants in indoor, increased exposure, health threat concerning the staff in official environments. One of these problems is Sick Building Syndrome (SBS). The focus of this study was to observe the effect of SBS on the productivity of the staff. In addition, the work related effects of psychological and mental symptoms on the productivity were studied separately.

This cross-sectional study was carried out on 105 staffs of an official building. In this study to observe the SBS a combination of questionnaires from the UK Health and Safety Organization and ESCO studies were used, and to survey the productivity, Hersey Blanchard model was utilized. To analyze the data Paired t-test, Tukey methods were used.

This study shows that there is not a significant relation between the SBS and the productivity factor ( $P=0.061$ ), not a significant relation between anxiety and distress ( $P=0.550$ ) anger ( $P=0.287$ ) forgetfulness ( $P=0.091$ ) lack of sleep ( $P=0.323$ ) and productivity. However the study shows a meaningful difference between irritability ( $P=0.034$ ) distress ( $P=0.011$ ) mental fatigue ( $P=0.029$ ) and productivity.

The mental SBS symptoms have impact on productivity. However more researches need to be done about the direct relation between SBS and the productivity level of staff.

**KEYWORDS:** *Productivity, Sick Building Syndrome, Psychological and mental symptoms, Official building*

## INTRODUCTION

One of the fundamental needs for the human is to have a workplace in which they can perform their work optimally under comfortable conditions. Because the buildings and ventilation systems are planned having a certain level of comfort in mind, the crucial question "What is the impact of comfort level on the productivity of the employees in official environments?" [1] comes into mind. The past studies concentrated more on the indoor

contamination and air quality and their effect on performance. According to WHO report, in developing countries, 5000 [2] individuals suffer from adhesive health problems caused by polluted indoor environments of the buildings every day and may die due to these factors. In the last decades, the air quality of the outdoor environment (open space) in the cities in industrial countries has improved largely. In the same period, the air quality inside the buildings has been deteriorated in indoor environment due to energy saving, reduced ventilation and the use of many

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substances and the contaminants. These developments and the fact that people in industrial countries spend ninety percent of their lifetime inside the buildings, makes the air quality indoor an important environmental issue with a wide variety of concepts for human health [2]. The worldwide energy crisis in 1937 caused the new residential and official building to be built with smaller indoor space and ventilation that is more limited. Supply of fresh air per person was 20 to 30 [3] cubic feet which was decreased by 5 cubic feet per minute [3] to save energy and reducing the air entering and leaving the place. This has caused the reduction in air ventilation in indoor environment and increasing range of exposure and health threats for humans [3].

The range of exposure to the contaminants indoors is 100 times more than the range of exposure to the contaminants outdoors and the concentration of the contaminants in indoor environment is usually two to four times more than outdoor environment [4]. The United States Environmental Protection Agency has classified the contamination and improper conditions of air indoors as one of the four most serious environmental hazards that demands care and management [4].

SBS syndrome that was first defined by WHO in 1983 includes such typical symptoms as eye, nose, throat, ear irritation, coughs, mental fatigue, headache, nausea, dizziness and itchy skin. These symptoms seem to be related to the workplaces. SBS can also include the complaints about taste and smell [5]. The term SBS refers to the condition in which the people in one building, depending on the number of hours they spend there, experience disorders similar to sickness. No symptom of sickness can be diagnosed about these people after they are examined by the doctors [6]. The real cause of this syndrome has not been discovered, but they disappear as the subject leaves the building [7]. There are solid evidences about the relation between Indoor Air Quality (IAQ) and lung cancer, allergies and other health impacts and comfort including SBS [8-9].

Most of the studies [10-15] in the last decade have attributed SBS among the employees in the building directly to the problems with the ventilation, and the Indoor Air Quality (IAQ) has been studied as the cause of the symptoms of SBS [10-15].

Olsen carried out a research on the relation between IAQ and the performance of the individuals [2]. This research reflected the results of the impacts IAQ had on the workers' health, comfort and performance. He confirmed that on average 20% to 60% [2] of the office workers suffer from SBS symptoms such as headache, fatigue and irritation of mucous membrane. This research studied the impact of environment, job satisfaction and job stress on self-report basis. The result suggested that limiting contamination sources, improving air quality through air purification and increasing ventilation rate could enhance the performance of the employees 5% to 10%; and reducing energy consumption by reducing indoor air quality is inadequate investment [2].

A study shows the results of staff evaluation in 6 restored historical buildings in Malaysia as per a questionnaire-based survey [16]. This study shows the impact of indoor environment quality on the employees' perception of their performance, reflected in their satisfaction with the indoor environment of the building, and its significance range based on the questions answered by them. One of the results of this study is that sustainable development not only leads to the preservation of the resources, but it also improves the productivity and welfare of the residents of the buildings. It was further clarified that factors such as temperature, health, ventilation and thermal control has an important role in performance of the workers [16].

Musaa and et al. [17] carried out a research in 2011 to observe the role of Indoor Environment Quality of a studio building on the understanding level of the students studying architecture. The methodology used in this research had two parts; measurement and questionnaire. This research showed that there were two parameters to determine the temperature comfort for the studio environment and the temperature and moisture comfort were important parameters for 70% of the students. The temperature inside the building was not standard, and this condition for a teaching-learning environment could be acceptable for a short time, but on the long run left negative health effects on the students [17].

The direct relation between SBS symptoms and the productivity of the employees has been referred to in a limited number of sources. Therefore, the focus of this study was to observe the SBS symptoms on

the productivity of the staff.

## MATERIALS AND METHODS

This study was carried out in an official building named Nargan. This building is located on Taleghani Street, near Sepahbod Gharani intersection in Tehran in Iran built in 1352. It has two underground levels, ground floor and 6 other levels as different engineering departments (piping, civil, structure and architecture). There are 160 people working as staff members in this building. The working hour during the day is 8.5 hours. The windows of the north wing were double-glazed UPVC and the other windows were single glazed windows with aluminum frames. The heating and cooling systems were fan coils. The light sources were fluorescent lights.

The study was carried out in a condition in which the individuals had equal chance of participating in the research. Moreover, people participating the research were chosen from those who were not addicted to tobacco use and did not show any symptoms similar to SBS. The people lacking these qualities were disqualified and every participant was qualified according to the above-mentioned parameters. In this study to observe the SBS a combination of the UK Health and Safety Agency questionnaires and previous studies [18-19] were utilized. To measure the productivity of the staff members, achieve model of Mr. Blanchard [20] was used. The standardized questionnaires included the information as follows:

The first part of the questionnaire of SBS includes the demographic data concerning the people with questions such as age, height, weight, smoking, equipment like computer, printer, etc.

The second part of the questionnaire includes questions concerning SBS (general and psychological symptoms).

The third part of the questionnaire concerned the questions about sickness history like asthma, eczema and cold that could be regarded as interfering factors. In this study, the psychological and mental SBS symptoms and the general symptoms were observed separately and their relation with productivity was observed separately.

The second questionnaire consisted of questions relating the individual productivity in the company. This questionnaire had 17 questions.

To measure the variables important in the research and gathering data, interpretation and localization of the questionnaires, the validity and reliability of the questionnaires were indicated.

**Validity:** Lawshe method was used to validate the questionnaire. This method is a quantitative method to validate the data. In this study, some of the experts were asked to decide about the importance, relevance, necessity and irrelevance of the questions in the questionnaire. Then the content validity index was calculated for each question. The acceptable content validity index rate was different for every question with the presence of 10 experts was considered 0.62 three questions from SBS questionnaire and 1 from productivity questionnaire were omitted.

**Reliability:** After the questionnaires were compiled and validated, they were sent to 30 staff members to carry out the pilot study and at the end of the work day, the questionnaires were collected.

After the questionnaires were filled out, the coefficient correlation  $\alpha$  was calculated using Spss15 program. The  $\alpha$  rate calculated for the SBS questionnaire was 0.949 and for the productivity questionnaire 0.882 which is more than 75% which is meaningful.

After the validity and reliability factors were considered, the questionnaires were answered by 105 residents out of 160 residents of the building. Fifty-five of the staff members could not participate the survey because of vacation, the professional missions and personal lack of interest.

Therefore, the numbers of participants were reduced to 105. The results obtained from the questionnaires were analyzed by Spss15 and Excel 2007 programs.

## RESULTS

**Demographic features of the research community:** The demographic features are provided in Table 1 as follows:

**Table 1.** Demographic features

Gender of the participants	Men				Women			
		62.9%				37.1%		
Percentages of age group	25-18	26-35	36-45	45-55	55 years old and more			
	0.95%	53.33%	25.71%	15.24%	4.76%			
Percentages of occupancy period	More than four years	3 to 4 years	1 to 2 years	6 months to 1 year		3 to 6 months		
	45.71%	20%	17.14%	9.52%	7.62%			
Percentages of working hours	More than 9 hours		8 to 9 hours		7 to 8 hours			
	7.62%		61.90%		27.62%			
Percentages of computers used hours	More than 8 hours		5 to 8 hours		3 to 5 hours		1 to 3 hours	
	38.10%		57.14%		3.81%		0.95%	
Complained during the last month before the test	Noise	Poor light	Bright light	Too cold weather	Too hot weather	Too dry weather	Too humid weather	Unpleasant odors
	70.48%	18.10%	12.38%	27.62%	71.43%	37.14%	13.33%	76.19%

The number of participants who answered the SBS symptoms questions reduced from 105 to 68 people, and 37 participants in the SBS symptoms research who had spring cold (14 people), asthma (2 people), eczema (6 people) and smoked (19.05%) were omitted from the study due to self-explanation, reviewing of the medical records and the doctor's diagnosis. At this time, there were 54.4% men and 45.6%

women.

**SBS General Symptoms:** According to the results represented in Fig. 1, the highest percentage of the general symptoms among men and women is sore eyes with 77.42% of women and 67.57% of men suffering from it. The lowest prevalence of the symptoms among women and men is for scratchy throat (6.45%) and nausea (13.51%).

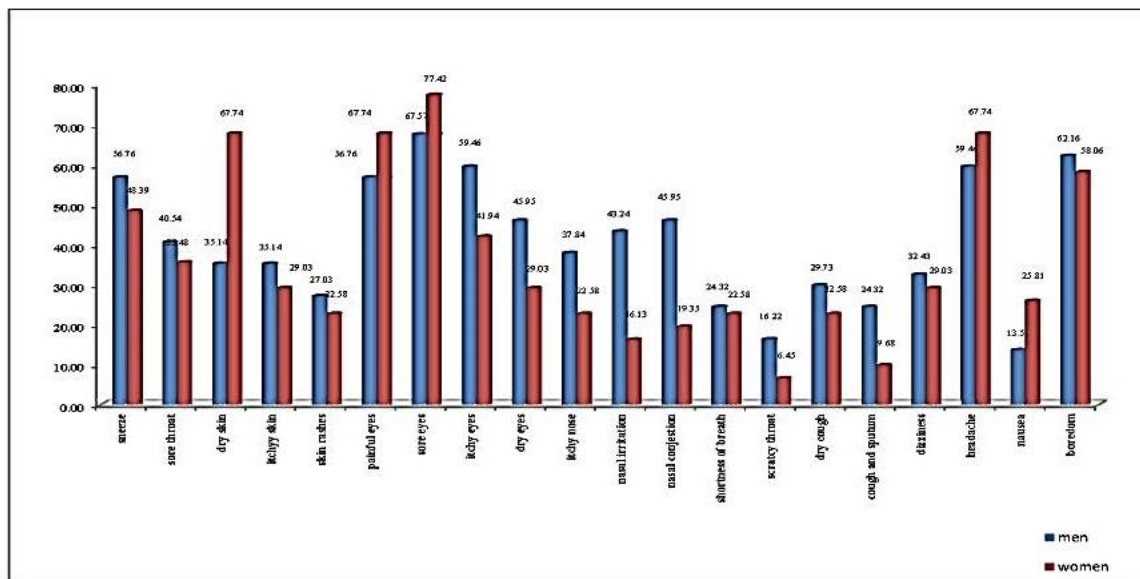


Fig1. Percentage of SBS general symptoms

**Productivity Results:** After *t*-test analysis, the results of the observation about 7 key parameters in productivity evaluation in work environments are reported as follows:

The comparison of working ability between men and women shows a meaningful difference and men benefit from a better condition ( $P = 0.031$ ). The analysis of the clearness in role specification in organizational activities a meaningful difference was not noticed ( $P=0.628$ ). Average organizational support, management and departmental support and cooperation showed better results among men and men benefited better individual, vocational and leadership condition ( $P=0.030$ ). In fact, both groups showed poor quality regarding this factor and they are required to improve this factor. Regarding environment factor (indoor and outdoor) which includes rewards, organizational rivalries, management strategies, job planning...both men and women experience the same conditions at work. Both groups show a low level of this factor ( $P=0.483$ ). The results of the analysis for average feedback factor did not show a meaningful difference ( $P=0.351$ ). The results of the analysis for evaluation factor between men and women showed the average of this factor is the same in both groups ( $P=0.542$ ) and both groups benefit from medium level standards. The analysis of average motivation factor between men and women showed a meaningful difference. Although men are in a better

condition than women, but both groups are at the medium level of risk factor and there is an evident need for the improvement of this factor. ( $P=0.027$ )

**Psychological-Mental SBS Symptoms Results:** The correlation and impact of SBS psychological symptoms (anxiety and distress, irritability, anger, depression, mental fatigue, forgetfulness, lack of sleep and concentration) and productivity were studied separately. Number of participants in the study of work-related psychological symptoms was 105 people. Based on the analysis performed, no impact of sicknesses like cold, asthma and eczema and even smoking cigarette on work-related mental and psychological symptoms was observed. For this reason, all the participants were taken into account. The highest prevalence of psychological and mental SBS symptoms between men and women is due to mental fatigue for women (56.41%) and men (59.9%). The lowest prevalence of symptoms for women is forgetfulness symptoms (5.13%) and for men, forgetfulness symptoms (13.64%) and lack of sleep and concentration (13.64%).

#### Data Analysis:

**The relation between SBS general symptoms and productivity:** Based on the results of *t*-test analysis, there is no meaningful relation between productivity and SBS

symptoms. It means that the average productivity of staff members with SBS symptoms is equal to average productivity of the individuals without the SBS symptoms. However regarding the figures ( $P=0.061$ ) this theory is marginally acceptable.

- The relation between work-related psychological-mental symptoms and productivity

The analysis reports of each of the psychological-mental SBS symptoms with productivity based on the Anova test result and tukey are provided in Table 2.

**Table 2.** Psychological-mental SBS symptoms

SBS psychological symptoms	<i>P</i> (relation with productivity)	Results
Anxiety and distress	$P=0.550$	There is no meaningful relation between productivity and anxiety and distress symptoms.
Irritability	$P=0.034$	There is a meaningful relation between the productivity and the irritability symptoms caused by the work environment.
Anger	$P=0.287$	There is no meaningful relation between productivity and anger symptom.
Depression	$P=0.011$	There is a meaningful relation between productivity and depression symptom.
Mental fatigue	$P=0.028$	There is meaningful relation between productivity and the mental fatigue symbol caused at work environments.
Forgetfulness	$P=0.091$	There is no meaningful relation between productivity and forgetfulness symptom in work environment.
Lack of sleep and concentration	$P=0.323$	There is no meaningful difference between productivity and lack of sleep and concentration symptoms.

Based on the results of the analysis tabulated in this table, there is no meaningful relation between productivity and anxiety and distress, anger, forgetfulness, lack of sleep and concentration symptoms; and the average productivity of individuals with these symptoms is equal to individuals without these symptoms or the productivity of individuals with these symptoms but with roots unrelated to work. These analyses show that about irritability symptoms there is a meaningful difference ( $P=0.034$ ) between the average productivity of the individuals with irritability symptoms caused by work environment, the average productivity of the individuals with irritability symptoms caused by sources other than the work environment, and the average productivity of individuals without these symptoms.

To show the average with difference Post Hoc test was performed. According to

Tukey test results there is a meaningful difference between average productivity of individuals with irritability symptoms caused in work environment and the average productivity of individuals without such symptoms ( $P=0.026$ ) and the average productivity of individuals without the irritability symptoms is more than the average productivity of individuals with irritability symptoms caused by work environments; However, there is no difference between the average productivity of individuals with irritability symptoms caused by a source other than work environment and the average productivity of individuals without such symptoms ( $P=0.026$ ). Considering depression, the results show that there is a meaningful difference ( $P=0.011$ ) with 95% of certainty between the average productivity of individuals having depression symptoms caused by work environment and the average

productivity of individuals without such symptoms ( $P=0.008$ ). There is no meaningful difference between the average productivity of an individual having the depression symptoms caused by sources other than work environment and average productivity of individuals without such symptoms ( $P=0.730$ ). About mental fatigue, there is a meaningful difference with %95 of certainty between average productivity of fatigue symptoms caused in work environment and average productivity of individuals without these symptoms ( $P=0.029$ ); However no meaningful difference between the average productivity of the individuals with fatigue symptoms caused by sources other than work environment and the average productivity of individuals without those symptoms ( $P=0.954$ ).

## DISCUSSION

The fact that people spend most of their time in buildings raised the importance of the analysis of the indoor quality inspection to become an important issue in health and productivity of the workers.

This study focuses on the analysis of SBS symptoms and its impact on the productivity of staff members. The research findings suggest that general SBS symptoms among men are more than those of women (54.42% and 45.58%). In the SBS studies carried out in countries like England, Denmark, Finland and the Netherlands the results suggested the SBS symptoms among women were more than those of men [21].

Among the reasons for the reverse findings in the building in this study is the more hours men spend in the building compared with those buildings or the difference of the impacts of risk factors such as work stress, job specification, free time and lifestyle between men and women.

Another reason for the higher prevalence of SBS symptoms among men here compared with other countries can be attributed to the geographical difference.

This study shows that there is no meaningful relation between productivity and general SBS symptoms ( $P=0.061$ ). However, the research proves that mental, psychological symptoms like irritability, depression, and mental fatigue caused in work environment has an impact on productivity. Therefore, one of the important results of the research is the fact that SBS psychological symptoms are

more effective than general and physiological symptoms on productivity.

Unfortunately, no books or researches about the mental SBS symptoms were available. There were only limited references to the direct relation between SBS symptoms and productivity of the staff.

Mr. Raw in his study of the Great Britain Environment Agency shows there is a reduction in the performance level of the staff members showing more than two SBS symptoms, and there is correlation between SBS and productivity the participants had estimated [22]. Based on his data Fisk and Rosenfeld reported 2% reduction in self-estimated productivity [23]. It was further proved that mucosal and work related symptoms can also affect the self-reported productivity [24].

However, there is no more validity about the accuracy and correctness of the self-reports on the reduction of productivity in other quantitative researches. The data analyzed in one study shows a relation between SBS symptoms and staff performance [25].

For the first time Warcoki and others showed that, the low quality of air perceived by the workers can affect their performance negatively. 47 staff members participated in computer assisted neurobehavioral tests at their workplace as a part of a three-week long study on SBS. The employees with more SBS symptoms performed 7% longer in an executive task and in digit symbol substitution test showed 30% more error range.

This study proved that by improving perceived air quality, SBS symptoms decrease and the performance level regarding the official tasks improve [26]. These findings were later approved in other separate researches in Denmark using different quantities for ventilation, [27] [28] and in Sweden [29] using different types of contaminants and other parameters.

Ten participants out of 68 participants in the SBS symptoms analysis in this building did not have any of the symptoms and the other participants reported at least two of these symptoms. Therefore, it could be concluded that the prevalence of the SBS symptoms among the employees was high, and this causes the employees to take absences because of the sickness.

Economic consequences of SBS

symptoms related to the reduction or increase in productivity caused by the workplace, labor cost and supply costs of the workplace. This factor is highly different throughout the country and in different environments.

Ray analyzed the yearly SBS costs in a big official building with 2500 workers could be estimated with reference to the analysis of the contract, one day of absence a year attributed to SBS symptoms and an hour of complaint each month about the indoor environments in workplaces. In 1990, the cost of the organization was 400 pounds. Unfortunately measuring productivity through self-report and the workers' impression is very difficult task. However, the research suggests that by increasing the ventilation rate by three times from 10 to 30 liters per second for each person, the typing speed of the workers also increased [27]. Absence caused by sickness is considered an alternative for productivity in some of the epidemiologic studies; however, absence with sickness as a cause can have many reasons other than the workers' health.

The studies carried out by the British Environment Office consisted of asking question from the employees who believed the office environment could affect their productivity. (On nine-point scale from -40% to +40%) it was interesting that some of the workers believed that the office environment increases their productivity. There is a linear relation between the number of work-related SBS symptoms and self-reported productivity that shows productivity decline is due to these symptoms [30].

In one research the improvements in self-reported productivity and absence with sickness as a cause was studied. The results showed an improvement of productivity when the rooms of one level were equipped with two carbon filters and HEPA in each workstation. This level was compared with other levels. The results showed 61% reduction in absences with sickness as a cause.

This figure equals a 3.1% increase in the productivity of each worker compared with the same time in the previous year [31].

## CONCLUSION

The prevalence of SBS symptoms among the workers in this building has been high. However, there was not a meaningful difference between the productivity of individuals with SBS symptoms and those

without any symptoms. However, the mental SBS symptoms like irritability, depression, mental fatigue have impact on productivity.

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The authors declare that there is no conflict of interests.

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