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THE STUDY OF SBS IN BUILDINGS – IMPACT ON HEALTH AND TECHNOLOGICAL SOLUTION

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ABSTRACT

Sick Building Syndrome is a condition whereby occupants of a building experience sicknesses that can be linked to the amount spent in that particular building. The end users experience unhealthy mild or sometimes severe symptoms or fall sick with such conditions as allergies as well as irritations of the throat, eyes, nose and also lethargy and sometimes dizziness Mølhave (1989). Unlike Building-related illnesses (BRI), SBS has no identifiable cause. In 1984, the World Health Organization (WHO) estimated that 30% of new and remodelled buildings worldwide may have SBS. This study will analyze the severity of SBS in North Cyprus based on different building elements and how they support the development of SBS in a building. Part of the outcome of this work is to develop a framework to test the level of SBS in a residential building by testing how occupants react to the building and demonstrating that building design elements such as orientation, roofing insulation systems, roof installations, and thermal floor masses alter the SBS effect on occupants. The goal is to develop "SBS TEST SOFTWARE" to assist professionals in assessing the SBS level in a building utilizing direct interview software, which can readily identify SBS-prone structures in Cyprus and worldwide. Cyprus' SBS difficulties can be attributed to several design flaws in building elements, improper ventilation, uneven or inadequate heat distribution, and a lack of moisture-proofing of roof decks, walls, and foundations Obi (2016).

Keywords: Sick Building Syndrome, SBS, Home Doc, Health and Safety

1. INTRODUCTION

Wargocki in his book states that SBS health issues and problems appear to be experienced when the end users occupy or spend time in a building and the malaise normally stops after they have left the building or no more occupants of the said building Wargocki et al. (2000). In response to the SBS phenomenon, extensive study systems have been geared towards mitigating it. These are either biological, psychological or climatological. Some biological studies attribute mould formations to SBS whereas psychological studies emphasize the lifestyle of occupants and domestic stress. In climatological studies, unique climatic conditions can affect indoor air quality (IAQ) thereby causing SBS. Although there are many cited causes of SBS, this study intends to pursue a purely architectural approach with reference

to the effect of the outcome of other studies. This architectural investigation is based on construction elements on residential flat buildings representing a significant number of SBS buildings in Northern Cyprus. The island's climatic conditions were considered in connection to how they affect the building elements. Therefore, the results and conclusions obtained from this study are drawn from the same climatic conditions. The orientation of the buildings was the key factor for the primary research on strategic building elements because it stands as the major architectural regulatory factor in SBS formation in Northern Cyprus residential buildings. Construction elements like windows, doors and other thermal massing elements were not deeply considered as they will lead to other subjects or scope of work that is beyond the circumference of this study. Biological causative factors were also not considered in this study as they require a biologist with a knowledgeable background in SBS especially in mould formations. However, the mould SBS was used as samples to clearly show buildings with physical evidence of SBS. The research experiments aided the development of SBS software, the Home Doc Sensor, to measure the SBS probability of any residential building in Northern Cyprus and beyond borders.

SBS causes

Many experts have distinct theories based on multiple investigations. Some believe that the temperature, humidity, or air conditioning systems are at fault; others believe that the chemicals in building materials are to blame; yet others cite fungi as the primary cause Obi (2016). As listed by the United States Environmental Protection Agency United States Protection Environmental Agency. (1991), the four causes of SBS are:

- Ventilation (Lack of Adequate Ventilation)
- Contamination with chemicals from outdoor sources
- Contamination of chemicals with indoor sources
- Biological Contaminants.

In the overall studies, however, there is a general agreement of opinion from authors that SBS is caused in part by micro-organisms termed as indoor pollutants. A building is considered "Sick" if at least 20% of its end users experience the listed health problems or SBS symptoms, but get well after leaving the building. If such a building serves as a workplace, employees may find themselves unable to produce to their full potential due to the effects of "Sick Building Syndrome," which lowers end users' efficiency and causes discomfort in what may be considered a daily normal life routine Skov et al. (1989). Despite this, complaints of symptoms may have different causes. These may include psychological variables, family lifestyle, job-related stress, and stress from family troubles. Mølhave (1989) also argues that the term "Sick Building" is often used not because buildings fall sick but that it is because it makes end users sick. He went further to say that in such cases where there is an issue of SBS, diagnosis of the building's problem should be done, and getting its remedy and its application should be normal procedure Obi (2016).

2. METHODOLOGY

This analysis was done using the "Building Case Study Experiment Method". The term "Building Case Study Experiment Method" was deduced from the logic of the term Design of experiment (DoE), which means a suitable and ideal method taken as the most ideal and unequivocal standard of testing an assumption or hypothesis Shuttleworth (2008). It involves the use of buildings and their elements as tools for different building experiments. The experiments focus on the hypothesis

that ideal building elements minimize the SBS effect on the end users and also discourage SBS formation by using different building elements to measure the level of Sick Building Syndromes in the building. In addition, this is a system whereby building element materials are tested physically to determine their physical suitability in building design and how it affects the level of SBS. This will help to deduce how they can be used in a building and how best to apply them for optimal safety and health of end users or reduce SBS factors in any given building. Against this knowledge, it's easier to identify SBS-prone residential buildings.

Cyprus SBS building samples and observations

Out of the 293 residential SBS buildings that were documented throughout the case study, occupants of nine (9) buildings were selected for further qualitative research and experimental reasons. This study clearly shows that there is a relationship between end users' health and SBS. The critical number of SBS-prone buildings in Cyprus is concerning. Numerous health reports concur that people should continue to anticipate an increase in SBS-related illnesses unless something is done. The main difficulty has been determining how to measure and identify buildings susceptible to SBS in advance and what can be done to mitigate such effects. Frequently, concerns are raised about how to stop SBS from developing in residential structures. Substandard building materials are one of the main contributing causes but when other factors are checked and put in place, though materials might not meet high standards, SBS can still be reduced or eliminated. SBS problems, like mould formation on walls and roofs, are frequently caused by an accumulation of moisture on wall surfaces as a result of inadequate interior space ventilation, which is a problem in many of the rooms and bathrooms. Notably, the interior spaces with the most impact are the bathrooms and bedrooms. During this research, minimal mould formation was observed in the living rooms. This indicates that contrary to what may be suggested given that all building components were constructed from the same materials, SBS issues are primarily caused by improper orientation, improper roof insulation, and improper thermal floor mass. If bathrooms and bedrooms are positioned to receive optimal ventilation and lighting, SBS is minimized or eliminated. Regarding the second SBS causative issue, the decking system of roof designs appears to be malfunctioning after some time since moisture is absorbed through the roof decks as well, which eventually contributes to the formation of mould within the building.

Table 1

Table 1 Shows Data Collected from Interviews with 2545 Respondents on their Encounters with SBS Buildings.

SBS BUILDINGS IN CYPRUS				
CITY	NUMBER OF RESPONDENTS	SEEN	LIVED	NEVER SEEN
LEFKOSA	839	352	67	420
LEFKE	275	167	47	61
GIRNE	329	112	28	189
MAGUSA	1102	278	151	673
TOTAL RESPONDENTS	2545	909	293	1343

Out of the 2545 respondents, 909 respondents acknowledged they had seen an SBS building, while 293 had lived in one at some point. 1343 reported to have never seen an SBS building Obi (2016). There have been cases of "Sick Building Syndrome" in Cyprus, however many of them have gone unreported due to unclear policies on

this issue. In my online questionnaire forum and field research study, I discovered that the number of buildings with SBS-related issues is very high because no policies are guiding the maintenance of private buildings, or that the majority of the owners, who do not live in these buildings, neglect their properties because most of them are rented out to foreigners and students. Using bootstrapping statistical methods, it is estimated that these residential buildings with extreme cases of SBS have at least 909 housing units, which include apartment buildings and bungalows Obi (2016).

Table 2

Table 2 Shows the Spread of Respondents Who Acknowledged Contact with SBS Buildings.			
SICKNESS BUILDING SYNDROME SPREAD			
		Type of Apartment	
Total Respondents	Area	Flats	Others
352	LEFKOSA	297	55
112	GIRNE	84	28
167	LEFKE	132	35
278	MAGUSA	221	57
909			

Respondents in this survey stated that they have directly experienced or seen buildings with SBS, though at varying phases of SBS occurrence. It was discovered that many people are unaware of what causes their SBS-associated symptoms and that many of the end users occupying these buildings suffer from one or more ailments that are directly related to SBS. During my field studies, I conducted direct inspections of major towns in North Cyprus. A quarter (1/4) of the SBS symptoms individuals experience are directly related to the unhealthy state of the buildings, as several of them report significant health improvements after leaving the building for a while. Some respondents did not comprehend the underlying causes of the symptoms and were indifferent about their situation, believing that the symptoms they were experiencing posed no significant threat to their lives.

3. FINDINGS AND OBSERVATIONAL STUDY REVIEW

Out of the 293 residential SBS buildings recorded during the case study, tenants of nine (9) residential buildings were selected from among the various SBS buildings recorded for more qualitative research and experimental purposes. The case study's buildings are spread over North Cyprus. These buildings were chosen using the Chi Sample selection method to ensure an adequate representation of the building elements investigated in this study.

Table 3

Table 3 Shows Sample Selected Buildings		
	LOCATION	NO OF BUILDINGS
Group 1	MAGUSA	2
Group 2	NICOSIA	3
Group 3	LEFKE	2
Group 4	GIRNE/ KARAKUM	2

The sample selection approach used in this experiment required that SBS buildings be located within the zone of other SBS-free buildings; this will aid in the comparative analysis of differences in construction elements between these

buildings. The tenants of these buildings served as respondents for the various experiments and case studies. Also, buildings with SBS concerns should be compared to other buildings to determine how the residents of these buildings react differently to SBS issues. This is to demonstrate that building elements influence the SBS effect on residents.

4. RESULTS AND RESPONSES FROM INITIAL CASE STUDIES

Thirty-five respondents living within these acute SBS buildings were drawn and interviewed to measure how they respond to SBS malaise in their buildings. Below are the results:

Table 4

Table 4 Shows the Respondents' View on the SBS Symptoms and their Experience During Summer

		Frequency Response				
ITEM	**CONDITIONS**	**ALWAYS**	**OFTEN**	**SOMETIMES**	**NEVER**	**MORE COMMON AT NOON**
A	Dry or sore throat	11	7	17	-	26
B	Heat rash	27	3	5	-	35
C	Headache	-	6	14	15	30
D	Drowsiness	2	4	7	24	23

During summer, end users experience an upsurge in SBS symptoms. Thirty-five (35) respondents were selected from four major cities with extreme building cases of SBS using a qualitative research technique. These experienced heat rash, twenty (20) respondents experienced headaches associated with SBS syndrome, and thirteen (13) experienced drowsiness.

Table 5

Table 5 Shows Respondents' View on the SBS Symptoms and their Experience in Winter.

		FREQUENCY RESPONSES				
ITEMS	**CONDITIONS**	**ALWAYS**	**OFTEN**	**SOMETIMES**	**NEVER**	**MORE COMMON AT NIGHT**
A	Cold and Catarrhal	31	3	1	-	33
B	Dry and Sore Throat	17	10	4	4	25
C	Headache	16	5	9	5	16
D	Drowsiness	2	4	3	27	17

Thirty-five (35) individuals reported experiencing colds and catarrhal during every cold season. Thirty-one (31) respondents experienced dry and painful throats, as well as headaches. Only nine (9) respondents reported feeling drowsy in winter. These findings from the initial research study reveal the effect of SBS on building occupants and indicate that this sickness exists.

5. CONCLUSION

5.1. HOME DOC SENSOR

Health reports in Cyprus have placed a lot of illness and health issues on the state of the environment or the living conditions of the end users Harrison & Kessels

(2004). Investigation report of Kato Lakatamia in Cyprus by the Ministry of Health Leonidou Associates Ltd. (2005) stated that reported cases of cancer clusters have been on the increase over the last two decades and the threat is growing in number because of environmental factors Obi (2016). The number of sick buildings in Cyprus is disturbing. Indoor air quality (IAQ) is essential as people are spending more time indoors and in buildings. The accumulation of gaseous contaminants in indoor air, such as volatile organic compounds (VOCs), can dangerously impact occupant's health and productivity.

Remedying SBS is too costly therefore, preventive measures are more advisable and they should begin right from the initial design stage and considerations. Due to the high cost of "curing" SBS in many buildings in Cyprus, SBS buildings have remained in that state. The main logic behind these SBS buildings in Cyprus is that they are very old and were designed on outdated health and safety principles. The fairly new ones didn't consider the appropriate use of updated SBS-free building designs. An additional study was conducted to develop an SBS software ideal for building designs to minimize the SBS effect on occupants. The significance of this innovation is to positively impact the overall health status of the Cyprus community and beyond. Improving indoor air quality is one way of combating sick building syndrome. Home Doc Sensor is an innovative device designed to monitor, detect and alert users in real time once they step into an unhealthy building. Users can keep a watchful eye by monitoring environmental conditions that could trigger an attack or the metamorphosis of a healthy building into a sick one.

Figure 1

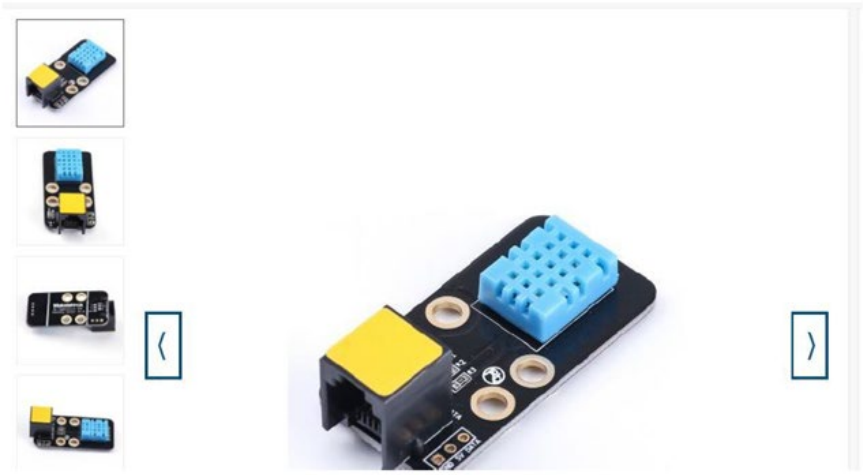

Figure 1 Home Doc Sensor

Easy to use and control from mobile devices via Bluetooth or an internet connection, the Home Doc Sensor minimizes the occurrence of inhabitants experiencing ill health due to building-related causes thus reducing the severity of SBS.

CONFLICT OF INTERESTS

None.

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