

UNIVERSITY OF BAHRAIN

College of engineering

**Department of Architecture &
Interior Design**



Effects of indoor environmental quality on user's comfort in offices buildings combined with social and cultural aspects in Bahrain

A Thesis Submitted in Partial Fulfillment of the Requirements for the Master
Degree in Architecture 'Interior Architecture'

Submitted by:

Bayan Abdulhusain Mohamed Aburowais

Supervised by:

Dr. Hana Mohamed Aljawder

Assistant Professor
University of Bahrain

Kingdom of Bahrain

February, 2023

وَمَا تَوْفِيقِي إِلَّا بِاللَّهِ عَلَيْهِ تَوَكَّلْتُ وَإِلَيْهِ أُنِيبُ (88) – سورة هود

“And my success is not but through Allāh. Upon Him I have
relied, and to Him I return”

Hūd – Verse 88

I. Abstract

Numerous research studied factors influencing indoor environment quality (IEQ) aspects, but most of them were focusing on each factor separately. Thus, there is a lack of research on the factors that affect IEQ as a whole. Studying these variables while considering social and cultural issues is crucial in the Middle East and Bahrain. Therefore, this research aims to investigate the relationship between occupants' satisfaction and IEQ inside an office building in Bahrain and evaluate the social and cultural aspects of IEQ. The research focused on users' satisfaction with the overall aspects (i.e., thermal comfort, natural lighting, electrical lighting, air quality, and acoustic) and their overall work comfort within the office space itself. It assesses the connection between the variables and the hypothesis, as well as the role of personal control and determining IEQ factors in an office building.

To offer a basis for this research, a quantitative method that established an online questionnaire was distributed randomly among users of selected office buildings, sectors, and office types in Bahrain. The questionnaire was conducted over eight months, starting with a pilot study in September 2021 and ending with the final questionnaire, and data collection was done in April 2022. Effects of indoor environmental quality on user comfort in office buildings surveys had 508 participants who answered 26 questions. The estimated completion time for the survey was 8 minutes, with an estimated completion rate of 81%. The total number of individuals with complete responses was 393.

This research aimed to investigate the connections between occupants' satisfaction with IEQ criteria, contentment with the facility as a whole, and overall work performance and satisfaction in an office building. Two out of four hypotheses (H1 and H2) were confirmed, and two were not confirmed (H3, H4). The key results and implications summarize that Males show more levels of satisfaction when compared to females. The age variable has a significant impact on IEQ comfort level. The study concluded that age, years of experience, office type, and position are the factors that affect IEQ. However, clothing type, working sector, and working hours do not significantly affect a user's comfort level. Furthermore, Users with total control over indoor air quality feel more comfortable in their workplace environment. The study found that people who are not sharing the office with another gender have a higher comfort level than those who share the office with another gender.

This study's statistical data and results provide various insights. This involves evaluating design strategies that allow objective-driven decision-making, as well as emphasizing the need of cooperating across different professions. Different settings enhance the understanding of the quality and comfort of the indoor environment. While it would be great for offering a broad variety of architectural solutions to improve the overall quality of the indoor environment, this research adds to the design process by highlighting the most critical features.

II. Dedication

Dedicated to my beloved father; may he rest in peace.
And to my family.

III. Acknowledgments

First and foremost, I would like to praise Allah almighty for providing me with strength, knowledge, wisdom, and guidance along my path. I thank Allah for his countless blessings upon me, which helped me complete this work. And without Allah, I would not be able to reach what I have become.

I would like to take this opportunity to thank everyone who had a part, whether directly or indirectly, in implementing this thesis. The utmost appreciation goes to my supervisor, Dr. Hana Aljowder. I could not ask for a better supervisor. She is an exceptional woman who provided me with a wealth of information, assistance, encouragement, and inspiration. Having her as a supervisor was a privilege; she helped me with her various advice and enhanced the quality of my work. I am grateful to her for her perseverance, understanding, and patience in facing all the challenges and difficult conditions I have gone through. I am grateful to her for providing me with the necessary facilities and resources to advance my research while maintaining a positive mindset. I am grateful to her for making an effort to provide me with the time and instructive opportunities and making this research a priceless experience.

I would like to express my gratitude and appreciation to Associate Professor Dr. Kuruppu Arachichge Ranjithprema Dayaratne for showing interest in my topic and assisting me in developing the initial concept and producing the first draft. Finally, I am most grateful to my father for encouraging and pushing me to pursue a master's degree. I would also like to thank my family, especially my older siblings Abbas and Fatima Aburowais, who assisted and advised me. I will never forget the love and support I received from my best friend and sisters. Special thanks to Hawra Abdulla, Zainab Abdulla, Mona Abdulla, Zahra Abdulla, Alia Obaid, Dana Mazen, Eman Algerbal, Ebaa Jaafar, Hanan Hussain, Omar Bu Kamal, and Hameed Qarashi.

IV. List of Content

I. Abstract.....	iii
II. Dedication	iv
III. Acknowledgments	v
IV. List of Content.....	vi
V. List of Tables.....	viii
VI. List of Figures	ix
VII. List of Abbreviation	x
1. Chapter One: Introduction.....	3
1.1 Introduction.....	3
1.2 Problem Statement	4
1.3 Research Question	5
1.4 Research Methodology	5
1.5 Research Objectives.....	6
1.6 Hypotheses.....	7
1.7 Research Significance	7
1.8 Thesis Structure	9
2. Chapter Two: Literature Review.....	12
2.1 Introduction.....	12
2.2 Importance of Indoor Environmental Quality IEQ and user's comfort	13
2.3 Relationship between IEQ aspects and satisfaction in the workplace	15
2.4 Factors influencing the quality of the indoor environment in the physical Environment.....	16
2.4.1 Thermal Comfort.....	16
2.4.2 Indoor Air Quality (IAQ) and Ventilation	19
2.4.3 Lighting.....	22
2.4.4 Noise and Acoustics.....	25
2.4.5 Office Layout Impacts	28
2.4.6 Views and Biophilia.....	31
2.5 Cultural differences influencing Indoor Environment Quality	33
2.6 Personal control	34
2.7 The planned behavior theory (PBT) and The The ABC model	37
2.8 The Four dimensions.....	38
3. Chapter Three: Methodology	41

3.1	Chapter overview	41
3.2	General methodological approach	41
3.3	Research Design.....	43
3.4	Population	43
3.5	The Sampling Technique	44
3.6	Questionnaire	46
4.	Chapter Four: Data Analysis, Discussion & Findings.....	59
4.1	Introduction.....	59
4.2	Section 1: General/ Demographic	60
4.3	Section 2: The office overall	71
4.3.1	Question 9: Does the office meet your comfort needs in general? (with one being not meet at all to 5 being highly meet):.....	71
4.3.2	Question 10: How would you rank your overall comfort in these following aspects? (with 1 being very uncomfortable to 5 being very comfortable)	74
4.4	Section 3: Thermal comfort and IEQ comfort beliefs.....	81
4.4.1	Question 11: I think the following aspects influence my comfort at work: (with 1 being no influence at all to 5 being highly influenced):	81
4.4.2	Question 12: How would you describe the indoor air temperature in the summer? (with 1 being very uncomfortable to 5 being very comfortable):.....	82
4.4.3	Question 13: How would you describe the indoor air temperature in the winter? (with 1 being very uncomfortable to 5 being very comfortable):.....	83
4.5	Section 4: IEQ control.....	84
4.5.1	Question 16: How much control do you have over the following aspects of the office? (with 1 being no control at all and 5 being complete control):	84
4.5.2	Question 18: Number of people sharing the control over the following aspects:	88
4.6	Section 5: Measures of conformity intentions and social-psychological variables.....	89
4.6.1	Question 17: My coworker accepts sharing the control over the following aspects: (with one being strongly not accept to 5 being strongly accept):.....	89
4.6.2	Question 19: Are you sharing the office with another gender?.....	90
4.6.3	Question 20: I can freely speak about my indoor environment quality with my colleagues regardless the gender: (with one being strongly disagree to 5 being strongly agree):	91
4.6.4	Question 22: Setting closely to my colleague can affect my indoor environment comfort. (with one being strongly disagree to 5 being strongly agree):	92
4.6.5	Question 23: Working in a mixed environment (Including males & females) can disturb my indoor environment comfort. (with one being strongly disagree to 5 being strongly agree):	92
4.6.6	Question 24: I am able to express my feeling toward my indoor environment comfort. (with 1 being strongly disagree to 5 being strongly agree):.....	93
4.7	Comparing General/ Demographic with overall office comfort level:	94

4.7.1	Question two and question 9:.....	94
4.7.2	Question three and question 9:.....	95
4.7.3	Question four and question 9:	96
4.7.4	Question five and question 9:.....	97
4.7.5	Question six and question 9:	98
4.7.6	Question seven and question 9:.....	99
4.7.7	Question eight and question 9:.....	100
4.8	Overall statistics	101
4.9	Research Question	107
4.9.1	Testing the hypotheses	107
5.	Chapter Five: Summary, Conclusion, recommendations, and future research	112
5.1	Introduction.....	112
5.2	Summary of the study, discussion, and recommendation	112
5.3	Conclusions & Significant findings	118
5.4	Research limitations and Future Research	118
6.	References	120
7.	Appendices:.....	138
	Appendix 1:.....	138
	Appendix 2:.....	144
I.	Abstract.....	150
II.	المخلص:.....	151

V. List of Tables

Table 1: Statistical research of registered working in Bahrain published by the social insurance organization 2021.....	44
Table 2: The required sample size according to the National Education Association (Krejcie & Morgan, 1970).....	45
Table 3: Comparison between General, males, and females from section one of the questionnaire (General/ demographics):.....	69
Table 4: Comparison between General, males, and females of question 9.....	73
Table 5: Comparison between General, males, and females of question 10.....	79
Table 6: Question 16 and Question 9.....	87
Table 7: Question 18 and Question 9.....	88
Table 8: Question 19 and Question 9.....	90
Table 9: Question 19 and Question 9.....	91
Table 10: Question 2 and Question 9.....	94
Table 11: Question 3 and Question 9.....	95

Table 12: Question 4 and Question 9.....	96
Table 13: Question 5 and Question 9.....	97
Table 14: Question 6 and Question 9.....	98
Table 15: Question 7 and Question 9.....	99
Table 16: Question 8 and Question 9.....	100
Table 17: Question 10 and Question 9.....	107
Table 18: Question 16 and Question 9.....	108
Table 19: Question 18 and Question 9.....	109

VI. List of Figures

Figure 1:Thesis Structure.....	10
Figure 2. Illustration of the four dimensions to study the IEQ comfort factors.	38
Figure 3 illustrates the phases of questionnaire development.....	43
Figure 4: Equation 1.....	45
Figure 5: Question 1.....	60
Figure 6: Question 2.....	60
Figure 7: Question 2 Female only	61
Figure 8: Question 2 Male only	61
Figure 9:Question 3.....	62
Figure 10: Question 3 Female only	62
Figure 11: Question 3 male only	63
Figure 12: Question 5.....	63
Figure 13: Question 5 Female only	64
Figure 14: Question 5 Male only	64
Figure 15: Question 6.....	65
Figure 16: Question 6 Female only	65
Figure 17: Question 6 Male only	66
Figure 18: Question 7.....	66
Figure 19: Question 7 Female only	67
Figure 20: Question 7 Male only	67
Figure 21: Question 8.....	68
Figure 22: Question 8 Female only	68
Figure 23: Question 8 Male only	69
Figure 24: Question 9 Female only	71
Figure 25: Question 9 Male only	72
Figure 26: Question 10 Female only	74
Figure 27: Question 10 Male only	77
Figure 28: Question 11.....	81
Figure 29: Question 16.....	84
Figure 30: Question 17.....	89
Figure 31: Question 19.....	90
Figure 32: Question 19.....	91
Figure 33: Question 22.....	92
Figure 34: Question 22.....	92
Figure 35: Question 22.....	93
Figure 36: question 9 statistic	101

Figure 37: question 10 statistic	102
Figure 38: question 11 statistic	105

VII. List of Abbreviation

Abbreviation	Meaning
IEQ	Indoor Environment Quality
IEC	Indoor Environment Control
PBT	The planned behavior theory
WHO	World Health Organization
IAQ	Indoor Air Quality
AC	Air Conditioning
CBPD	Center for Building Performance and Diagnostics
CBE	Center for the Built Environment
POE	Post-occupancy evaluation
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers

Chapter One:

Introduction

1. Chapter One: Introduction

1.1 Introduction

Indoor environmental quality (IEQ) plays a vital role in ensuring the comfort of occupants at work. According to Klepeis et al. (2001), almost 85% of human time is spent indoors. The number of hours specified for office workers per day is fixed in every country (Lan et al., 2012). It is estimated that 15 billion pounds and 38 billion dollars are lost because of minimizing employees' comfort and illnesses due to inadequate fresh air supply alone in the United Kingdom and the United States, respectively (Fisk, Black, and Brunner, 2012). As a result, according to Al Horr et al. (2018), it is essential to understand the indoor office environment and its effect on occupant comfort, as it heavily impacts their comfort (Frontczak et al., 2012, Van der Voordt, 2004). IEQ is crucial in influencing workplace users' work, comfort, and well-being. Unsuitable IEQ can result in various effects, including but not limited to difficulty in focusing and headaches (Wyon, 2004), poor work performance (Varjo et al., 2015), employees' dissatisfaction with their jobs (Borisuit et al., 2015), and recognized discomfort (Bluyssen et al., 2011). In general, environmental aspects significantly impact people's comfort (Woo and Postolache, 2011). In the 1990s, researchers recognized more than one factor that caused users' annoyance and complaints about IEQ (Fransson, Västfjäll, and Skoog, 2007). Researchers acknowledged that the inadequate indoor environment quality causes workers' lower performance in their workplaces as it drastically influences business operational costs (Clements-Croome, 2015).

Furthermore, it is essential to have a comprehensive understanding of the interdependent and influential variables of IEQ, along with the influence of these various factors on the health and comfort of workers. The quality of the indoor environment often involves several different characteristics, including thermal comfort, ventilation, indoor air quality, noise and acoustics, natural lighting, and electricity. It is essential because one of the primary goals of an office building is to serve the occupants and to understand how the processes impact the level of comfort experienced by the employees. The office building environment is considered a comfortable indoor environment when eighty percent of the people who utilize the building are satisfied with how the environment is established (Ashrae, 2013), and this is a target that must be achieved in all work environments.

1.2 Problem Statement

In recent years, significant research has been carried out to comprehend how the comfort of building occupants is affected by the quality of the indoor environment (Gou, Lau, and Chen, 2012; Kim et al., 2017; Ricciardi and Buratti, 2018). Numerous studies have shown a link between user satisfaction and efficiency, as well as many indoor environmental features. However, few studies have concentrated on the total impacts of indoor environmental quality (IEQ) from the perspectives of culture, social psychology, physiology, and physicality.

Post-occupancy evaluation (POE) has been used in office buildings to investigate the effect of IEQ parameters on occupants' satisfaction and perceived work performance. Experts identified four critical factors as intertwined factors that influence worker comfort: personal, social, cultural, and environmental factors (Al Horr et al., 2016). According to Al Horr et al. (2016), indoor air quality and ventilation, thermal comfort, noise and acoustics, workplace architecture, and lighting are the main factors that influence employees' comfort. Other researchers considered a thermal quality one of the most decisive factors for user satisfaction (Putra, 2017; Akimoto et al., 2010). However, several studies concentrated on acoustics and lighting efficiency instead (Varjo et al., 2015; Synder, 2020). New building designs can become more sophisticated and dynamic with numerous office configurations, advanced sensing technology, decentralized and integrated automation systems, and interconnected indoor environmental quality. These aspects allow users to respond to the indoor atmosphere individually and with their coworkers (Chen et al., 2020).

Moreover, several approaches to occupant satisfaction evaluation show that the office building internal environment contributes more favorably or poorly to occupants' satisfaction and work performance than the building structure. In addition, research centers such as the Center for the Built Environment (CBE) at the University of California, Berkeley, and the Center for Building Performance and Diagnostics (CBPD) at Carnegie Mellon University, Pennsylvania, investigated occupants' satisfaction with specific IEQ criteria and the impact of these criteria on occupants' work performance. However, little research has been conducted on the relationship between occupants' satisfaction with specific IEQ criteria at the workstation level, their satisfaction with the overall indoor environmental aspects, and their social contribution to their overall work performance.

It is now understood that users' expectations of IEQ are affected by their mood, actions, inspiration, thermal preferences, and adaptive behaviors. The climate affects thermal comfort tolerance, but culture should also be considered because clothing type and style are influenced by cultural and religious beliefs (Zhang et al., 2017). Another aspect to consider is the ability to speak and the employees' willingness to express their discomfort (Knez and Thorsson, 2006). On the other hand, acoustic comfort can depend mainly on the worker's work region (Wilson and Nicol, 1994).

Therefore, it is essential to evaluate IEQ variables along with the social and behavioral variables. Furthermore, it is necessary to examine the intertwined variables that impact users' comfort in their indoor environment and their job efficiency by considering the built environment's physical components and users' psychological, demographical, and social factors.

1.3 Research Question

The main research question is: “What are the correlations between occupants' satisfaction and indoor environmental quality (IEQ) criteria at the workplace level, their satisfaction with the entire space, and their overall work performance, especially when combined with physical, attitudinal, and social variables?”

1.4 Research Methodology

The study employs a quantitative approach to investigate the potential elements influencing indoor environment quality (IEQ) comfort within an office building in Bahrain, merging it with social aspects. It involves the application of a structured internet-based questionnaire. In this research, a survey questionnaire was used to collect the necessary data since it is one of the most convenient methods for obtaining a large number of responses from a community. It could offer information on people's attitudes and behavior on certain issues by answering questions (Williams, 2003). The questionnaire was created to measure people's satisfaction with the quality of their workplace's indoor environment, to examine and grasp an office building's indoor environment comfort requirements, and to study the residents' perspectives in Bahrain.

A specific research questionnaire was developed to examine the research aims and answer the research question. The questionnaire has been arranged into five categories:

1. General/ Demographic
2. The office overall
3. Thermal comfort and IEQ comfort beliefs
4. IEQ control
5. Measures of conformity intentions and social-psychological variables

The first part of the questionnaire investigated demographics and included gender, age, dress code, job sector, office type, working hours, years of experience, and employee position. Then, the demographics were compared to the office IEQ satisfaction. The second part of the questionnaire was about occupants' overall satisfaction with the indoor office environment; this part was used to find the correlations. The third part discussed thermal comfort and its relation to IEQ satisfaction. The fifth part looked into IEQ control and its effect on occupant satisfaction. The last part was about social and psychological matters and their influence on user satisfaction.

1.5 Research Objectives

Based on the problem statement above and to the extent of the researcher's knowledge, no studies have been conducted in Bahrain to test IEQ aspects combined with social and cultural aspects. This study focuses on testing the quality of the indoor environment and user comfort. There seems to be little information regarding the occupants' actions, interactions with the indoor environment, and control level related to user comfort. To address these issues, this thesis aims to analyze and understand indoor environment comfort criteria inside an office building based on responses from office building workers to the questionnaires developed for this study, which can also be used for related future studies. This thesis aims to:

1. Evaluate the acceptance of the quality of the indoor environment.
2. Identify the factors that contribute to people's dissatisfaction with their indoor environment.
3. Study complex aspects of indoor environmental quality (IEQ) related to user's comfort.
4. Examine the occupants' needs and the relationship between IEQ and comfort at the workplace.

5. Look into the role of personal control over IEQ and its relationship with occupants' comfort.
6. Investigate local beliefs and social factors that play a role in users' comfort and behavior.

The interconnected factors among the building's physical, attitudinal, social, and demographic components all play a role in determining occupants' comfort at the workplace. Nevertheless, there is a lack of studies that interconnect factors among building physical, attitudinal, social, and demographic components all together. This study aims to fill this research gap by exploring the influence of these interconnected factors on occupants' IEQ-comfort belief, especially for the local region, which is described as a personal, subjective evaluation of the relationship between the impacts of IEQ aspects (i.e., the quality of indoor temperature, air, natural and electric lighting, and acoustics) and comfort.

1.6 Hypotheses

1. Users who work with average thermal levels (not too hot or too cold) are more likely to believe that indoor environment quality (IEQ) positively impacts their work comfort than those with high thermal comfort (too hot or too cold).
2. IEQ comfort belief is positively connected to the perceived ease of using IECs (Indoor Environment Control).
3. Occupants with access to IEQ controls (e.g., thermostats, blinds and shades, light switches, and windows) are more likely to feel IEQ has a favorable influence on their job comfort than their colleagues.
4. IEQ-comfort belief is linked to demographic parameters such as gender, age, dress code, job sector, office type, working hours, years of experience, and employee position.

1.7 Research Significance

According to previous research on office buildings, strategies and technologies improved the indoor office environment. In both newly constructed and redesigned buildings, such strategies and technologies allowed the design of an environment that favors occupants' comfort and efficiency (Romm and Browning, 1995). The majority of the structures that will exist in 2050 have already been constructed (Sbci, 2009). Consequently, research into the

indoor workplace environment's quality and its relationship to occupant's comfort is needed. This research aims to ascertain workplace attitudes and behaviors, social factors, and contextual factors that impact users' IEQ comfort in Bahrain's office buildings. Studying all aspects of IEQ instead of only focusing on one aspect of IEQ is essential. Therefore, this research will look at the local beliefs that play a crucial role in the comfort and behavior of users. A survey of Bahrain's society highlighted the perceived IEQ and users' comfort dependence on social and cultural aspects, combined with personal motivation in office building environments.

After considering local preferences, this study may provide a better indoor environment in an office building. This study might contribute by developing and testing a model that explains the overall complex and simultaneous link between IEQ aspects and occupants' perceptions of their indoor environment. This model can be a starting point for future studies looking at the impact of IEQ criteria on office building occupants. The findings of this study can be utilized as a reference point for determining the relationship between IEQ, user comfort, and social and cultural factors.

1.8 Thesis Structure

This thesis has been constructed to accomplish the objectives stated above. The structure of the thesis is as follows (figure 1):

Chapter 1: Introduction:

This chapter establishes the study's background, problem statement, research questions and objectives, hypotheses, and research significance.

Chapter 2: Literature Review:

The second chapter summarizes the topic's research overview and current knowledge. This chapter is divided into nine subsections and covers the fundamental ideas underlying IEQ, describes current methodologies and outlines the primary strategy implementation up to date.

Chapter 3: Methodology

The third chapter covers the research methodology utilized to attain the proposed objectives. It describes the primary techniques and tools used for data collection, including parameter measurements, questionnaires, and instruments.

Chapter 4: Data Analysis, Discussion & Findings

This chapter presents factors analysis and descriptive analysis results. The results of the factors analysis indicate variables related to the IEQ criteria. In contrast, the descriptive analysis assesses a hypothesized model that suggests a connection between work comfort and satisfaction with IEQ components, building satisfaction, overall comfort outcomes, and social-psychological aspects.

Chapter 5: Summary, Conclusion, Recommendations, and Future Research:

This chapter is based on the findings of the previous chapters of this research. These findings are examined in light of the literature review in Chapter 2 of the same research. In addition, it provides a summary of the results, discusses their limits, explores their implications in standards, and concludes with suggestions for further studies.

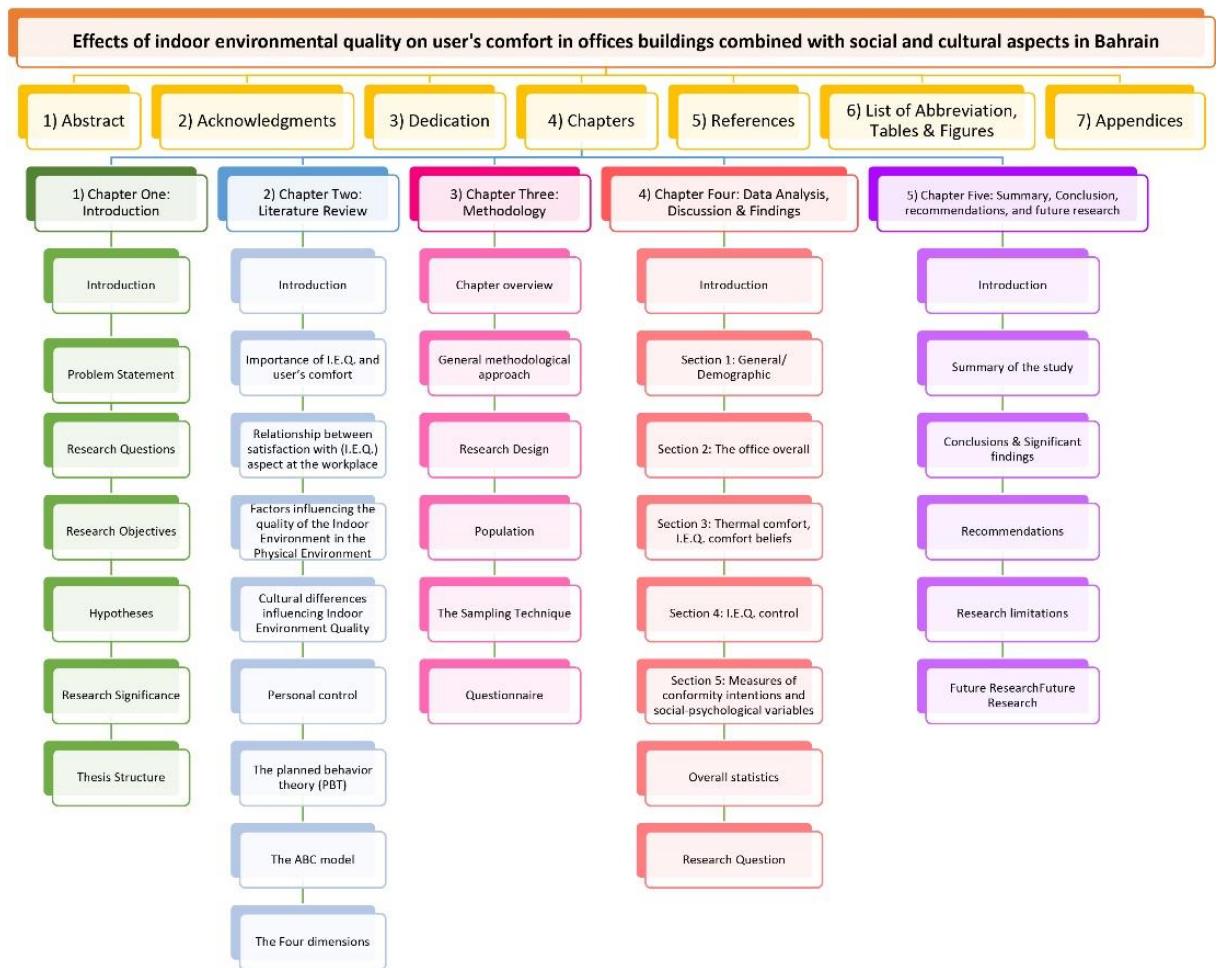


Figure 1:Thesis Structure

Chapter Two:

Literature Review

2. Chapter Two: Literature Review

The purpose of this chapter is to examine the theory behind indoor environmental quality (IEQ) aspects and personal control within buildings, specific workplaces. This chapter examines the underlying concepts of IEQ, offers a summary of existing techniques, and provides an overview of the principal strategy implemented nowadays. It provides the context and overview of the research and investigations conducted, as well as the evolution of personal control of indoor environments. The chapter consists of nine subsections. First a literature review on the importance of IEQ and user comfort. Second, discussion of IEQ satisfaction in the workplace. Third, factors affect the quality of the indoor environment in the physical environment. Fourth, views and biophilia. Fifth, the effect of cultural variations on IEQ. Sixth, personal control of the indoor environment. Finally, a description of the ideas and methods will be further explored in the methodology section.

2.1 Introduction

The relationship between indoor environmental quality (IEQ) and occupant's comfort has become a critical study area throughout the building life cycle. The relationship's significance is highlighted as IEQ has a strong effect on changing people's actions by nature, especially in places like an office building where the occupants' comfort is of high importance. Therefore, this chapter uses the literature review as the basis to provide a rational understanding of the connection between IEQ and occupants' comfort in an office building. The literature highlights the relationship between IEQ factors and cultural, social, and physical perspectives.

The majority of the world's population lives in cities and works in offices, so humans spend most of their time indoors (ASHRAE, 2013). It is accepted that urban life has led us to live more than 80% of our time in closed spaces. Therefore, the idea of ideal interior environments and what is wanted, expected, demanded, and accepted by the users about the places in which they spend a considerable portion of their lifetime. Al Horr et al. 2016 argued that it became vital to understand the indoor office environment and its effect on occupants' comfort. Indoor environments have far-reaching consequences on people's health, general well-being, and efficiency. Several studies have looked at how building occupants view the indoor environment and what defines a comfortable environment. Various physical and chemical parameters that affect building occupants' comfort have been identified in indoor environments. There are acceptable ranges of IEQ standards, and criteria dealing with IEQ

have been established. Despite the fact that these criteria were implemented in the indoor environment of a building, not all building occupants are satisfied with the indoor environment (Frontczak et al., 2012).

Adding to that, the concept of IEQ is not static; it evolves along with countries' technological and economic development and becomes increasingly demanding as societies evolve. Various subjective responses to the same indoor conditions can occur as not everyone is pleased with the same set of circumstances. Another reason could be that satisfaction with indoor environments is affected by influences other than physical conditions, such as cultural, social-psychological, physiological, and physical perspectives (Frontczak et al., 2012).

2.2 Importance of Indoor Environmental Quality IEQ and user's comfort

IEQ could be defined as “the assessment of important factors impacting occupant comfort and wellbeing” (Garnys, 2007) and “an element to offer a physically and psychologically healthy environment for its occupants” (Bonda & Sosnowchik, 2007). Because workers are the most significant expense in the workplace, creating an interior environment that improves worker comfort, health, and well-being could impact business investments by improving worker satisfaction and comfort (Fisk, 2000). A reduction in workers' performance could be caused by low IEQ and result in a significant financial impact on the company (Garnys, 2007). As a result, businesses have looked into IEQ to improve the quality of life for their employees as a form of cost savings (Kats, 2013). Thus, providing a high IEQ that supports workers' quality of life can be considered the primary objective of an office building. In other words, office buildings are intended to create a pleasant indoor environment for workers (Meir et al., 2009).

Direct and indirect effects of IEQ on occupants' comfort studies can be traced back to the 1920s when Maslow and Vernon, and Bedford published their work on the workplace environment and its needs (Maslow, 1943; Vernon and Bedford, 1926). Early researchers such as Herzberg (1966) and Heschong (1979) demonstrated the importance of IEQ on the comfort of its occupants in the workplace. Rather than providing buildings suitable for survival, the built environment sector has a fundamental obligation to provide a built environment that is beneficial to its occupants and promotes their health and well-being (Construction, 2014).

Concerning the work environment, more progress has been made in the integral concept of the indoor environment, at least from the theoretical point of view. The

requirements of an indoor environment contribute significantly to improving the health conditions of the working population (WHO, 2004).

The quality of the indoor environment affects the user's comfort. Personal, social, organizational, and environmental factors are the significant factors that influence human comfort in the workplace. But it is unclear how significant these individual variables are and how they interact (Clements-Croome, 2006). When 80% of office occupants are comfortable with the environmental settings, it is called a healthy indoor environment (ASHRAE Standard, 2004). The comfort that occupants feel inside the environment is directly related to their happiness in the indoor environment (Frontczak et al., 2012, Choi et al., 2009). Employees' perception of their working environment substantially affects their job satisfaction, which significantly influences their performance.

Comfort is contextual and differs from one person to another. It is identified as reducing uncomfortable feelings, which positively affects one's overall wellbeing. In an office environment, there are various forms of comfort, including physical comfort (air quality, temperature, and noise), functional comfort (disruptions, interruptions, distance from work, and resources), and psychological comfort (privacy, territoriality) (Feige et al., 2013). Physiological, social, and physical environmental factors may also influence workplace comfort (Oseland, 1999). Oseland divided the physical environmental conditions into four categories. These categories are physical conditions (temperature, light, noise, and air quality), space (plan, configuration, and privacy), usability (workstation and controls), and aesthetics (color and quality). According to researchers, the behavioral environment, which includes several behavioral and social aspects in the workplace, affects the overall occupant's comfort (Haynes, 2007; Fleming, 2004). Privacy, collaboration, interaction, and distraction are subjective behavioral and social factors that affect an occupant's comfort (Brenner and Cornell, 1994, Fleming, 2004).

According to Haynes, the behavioral environment is an interconnected feature of an office environment that influences occupant behavior and the social environment that the office workers build and develop. Haynes (2007) suggested a theoretical theory in which workplace occupants and work behaviors affect the physical and behavioral elements that constitute the office environment, and both affect office efficiency. He believes that the physical environment includes office layout and comfort, while the behavioral environment includes distraction and interaction (Haynes, 2007; Haynes, 2008). While the literature on

these factors focuses on the IEQ, there is a lack of attention to occupant's comfort. As a result, the impact of these factors on occupants' comfort should be reevaluated. The following section contains a review of the literature on IEQ. Factors.

2.3 Relationship between IEQ aspects and satisfaction in the workplace

The majority of the attraction of an office design stems from the possibility of improving the overall IEQ for the employees. Air quality, temperature conditions, lighting, ventilation, and occupant's level or type of personal control over environmental circumstances are all essential factors that influence occupants' comfort (Heerwagen, 2003). Over the last decade, researchers have consistently discovered a link between the IEQ of work environments and occupants' happiness and performance. For example, Clements-Croome and Baizhan (2000) investigated the relationship between workplace performance and the indoor environment. They discovered that when overall dissatisfaction with the indoor environment was high, users' self-assessed performance suffered.

As the green building movement progressed, the emphasis shifted to the relationship between IEQ and the health and comfort of building inhabitants. IEQ refers to the ability of a building to provide its residents with an interior environment that satisfies the requirements for maintaining their health, happiness, and productivity (Liang et al., 2014). In the past years, extensive research has been conducted on the effects of acoustic quality (Kaarlela-Tuomaala et al., 2009), lighting (Abdou, 1997), thermal comfort (Mahbob et al., 2013), indoor air quality (IAQ) (Wyon, 2004), and overall indoor environmental quality (IEQ) (Fisk et al., 2011) on the safety and productivity of building occupants. The most significant economic advantage of a green building for its occupants is the enhancement of productivity and labor efficiency (Kats et al., 2003). Green office buildings are related to improved productivity, reduced absenteeism, cheaper health insurance cost, and a lower incidence of workers' compensation claims (Singh et al., 2010; Thatcher and Milner, 2012). During the certification of green buildings in Taiwan, the IEQ was assessed based on the building's acoustics, lighting, ventilation, and interior construction materials to provide inhabitants with a healthy and pleasant indoor environment. However, thermal comfort was not considered an essential aspect of IEQ assessment. Chiang and Lai (2002) created a scoring system comprised of nine criteria for use in Taiwan. In this approach, a building satisfies the overall IEQ criteria if the sum of the points granted for each criterion, after weighting, is at least 60. However, thermal

comfort is not included as a criterion in this system, as achieving thermal comfort inside a building in Taiwan during hot summer days frequently requires extensive air-conditioning (AC) and is viewed as a departure from the energy-saving aspect of the green building initiative.

2.4 Factors influencing the quality of the indoor environment in the physical Environment

2.4.1 Thermal Comfort

2.4.1.1 Definition and importance of thermal comfort

Thermal comfort is described as "a state of mind that reflects satisfaction with the thermal environment" (ASHRAE, 2004). Workers' satisfaction with the temperature in their offices, when compared to the other parameters, demonstrates a strong link to their overall indoor air quality situations (Wagner et al., 2007). Clothing, shifting motion, changing attitude, window position, and mood are all highly independent and complex variables that affect comfort (ASHRAE, 2005). It is a personal condition that differs from one individual to another; comfort evaluation is a perceptual mechanism affecting physical, physiological, and psychological factors (Lin and Deng, 2008). Overall thermal comfort in a building is challenging since it results from various physical conditions, creating a thermal environment, and understanding a set of subjective human responses to that thermal state. Individual and geographical thermal comfort varies due to various factors such as age, sex, metabolism rate, and time of year (Quang et al., 2014). The number of complaints about discomfort in a workplace is used to measure thermal comfort. The human response to thermal comfort is described in the literature using terms like thermal sensation, thermal acceptability, and thermal preference (Langevin, Wen, and Gurian, 2013). Human thermal comfort is a psychological feeling, while thermal sensation is an objective state (Hensen, 1991). The direction and magnitude of one's sensory experience of the local thermal environment are known as thermal sensations (ASHRAE, 2010).

Thermal comfort is affected by air temperature, air density, relative humidity, mean radiant temperature, clothing insulation, and metabolic rate (Goldman, 1999; Lin and Deng, 2008). The degree to which an occupant accepts the environment is referred to as thermal acceptability. In terms of the Environment, thermal preference is ideal (Langevin, Wen, and Gurian, 2013). When an environment changes from an appropriate to a desired thermal condition, occupant satisfaction improves. According to the literature, females express more

discomfort in a thermal environment than males, as they are more sensitive to deviations from an optimal thermal environment and are less satisfied than males in more excellent conditions (Karjalainen, 2012, Kim et al., 2013).

For decades, researchers have studied thermal comfort, and numerous thermal comfort standards and measurement methods have been established (Olesen and Parsons, 2002; ASHRAE, 2005). These standards are set for models and studies that mainly focus on North America and Northern Europe (Ogbonna and Harris, 2008). They are suitable for static and uniform thermal environments but do not consider individual variables such as age, gender, or regional behavior and expectations (Zhai et al., 2015). As a result, these standards may not be entirely accurate for all types of indoor activities and different regional climates. Many research studies in various regions of the globe questioned and proved incorrect expectations and predictions of thermal comfort, as they were done based on a "rational approach" that ignored age, gender, and race and suggested a narrow, well-defined thermal comfort spectrum (Ogbonna and Harris, 2008; Nicol, 2004).

The importance of thermal comfort in occupants' efficiency cannot be overlooked, as the lack of efficiency could be caused by dissatisfaction with thermal comfort (Roelofsen, 2016). While ambient temperature significantly affects occupants' thermal comfort, local thermal ventilation or work conditioning may also impact their comfort. Local thermal ventilation and personal control are beneficial in an office where worker teams are seated in various zones. It may also be used in offices where workers must perform various tasks that require varying degrees of physical activity. While employee thermal control is linked to increased comfort and satisfaction, it also raises concerns about occupant control behavior. Acceptance of a thermal environment is subjective and strictly related to the occupant's expectations. Individual variations occur in user comfort expectations and preferences of the environment (Moezzi, 2009). In addition, inefficient use of the thermal control system could result in energy waste (Shahzad et al., 2016). An inefficient thermal control system in workplaces wastes energy due to occupants' lack of understanding of the system operation and general thermal comfort disagreements. Energy awareness could contribute to a shift in behavior toward more energy-conscious activities, resulting in energy savings and increased occupant satisfaction and comfort (Tetlow et al., 2012).

2.4.1.2 Thermal conditions and occupants' satisfaction and work performance

According to ANSI/ASHRAE Standard 55, if 80% of occupants are happy with a building's thermal environment at any particular minute, the building's thermal environment is rated as relatively pleasant. The furniture materials in office buildings, such as mesh back chairs and seats, can help workers feel more comfortable in warmer environments by minimizing heat build-up. The colors of interior surfaces can influence employees' feelings of coolness or warmth (BuildingGreen, 2004). The interaction of these elements and others has an impact on occupants' thermal comfort. According to the CBE occupant survey findings, happiness with workplace temperature (as one aspect of thermal conditions) contributes considerably to workspace satisfaction and is closely associated with overall building satisfaction (Frontczak et al., 2012).

Temperature dissatisfaction can directly impact employees' physical and mental job performance (Fisk, 2000; Wyon, 1996). For example, changes in temperature between 18°C and 30°C can significantly impact employees' writing, working, and learning performance, as well as their reading speed and word memory (Wyon, 1996). According to Seppanen and Fisk (2006), the increase in room air temperature between 20.0-23.0°C increases job performance. Previous research found that occupants' satisfaction with workstation thermal conditions is related to their satisfaction with the overall institution and job performance.

The thermal quality level in workplaces directly impacts the level of comfort and well-being experienced by employees. According to Wargocki and Frontczak (2011), the thermal environment is often considered the most critical factor in achieving high levels of IEQ. According to Oz and Ergonül (2015), the quality of the thermal environment affects not only the health and well-being of employees but also their productivity. According to them, the ability to control and adjust the temperature is a crucial factor in influencing the degree to which employees are satisfied with their level of thermal comfort. A study performed by Huizenga et al. (2006) at the Center for the Built Environment showed that 76% of all tenants who had access to a thermostat were satisfied with the temperature at their place of employment.

2.4.2 Indoor Air Quality (IAQ) and Ventilation

2.4.2.1 *Definition and Importance of Indoor Air Quality*

Indoor air quality (IAQ) refers to "the environmental qualities within buildings that may impact human health, comfort, or job performance" (IAQ-SFRB, 2010). The ANSI/ASHRAE 62.1 Standard (2010) defines acceptable perceived IAQ as "air in which there are no known pollutants in dangerous amounts as assessed by appropriate authorities, and a significant majority (80 percent or more) of those exposed do not show dissatisfaction."

IAQ is a crucial aspect that affects occupants' well-being and comfort (Wargocki, 2002). There is no doubt that all indoor environments aspire to have fresh air free of pollutants, and that depends on the quality of the outdoor ambient air and how it is used to meet the needs inside factories, buildings, and homes. Various studies indicated that pollutants in indoor air might be in greater quantity than those in outdoor air. This could be reasoned through the following: 1) pollutant concentrations are not significantly reduced when outdoor air enters buildings, 2) people spend approximately 90% of their time indoors, 3) hundreds of products that are used inside buildings are considered new sources of air pollution (Environmental Protection Agency, 1998).

Langer and Bekö (2013) found that a workplace with good air quality has better job efficiency in terms of office tasks such as text editing, proofreading, and mathematical tasks. IAQ is a difficult principle to measure as it comprises various time-dependent physical and chemical parameters (such as humidity levels, temperature, and the number of air contaminants). IAQ parameters are impacted by outdoor environments (climate), building conditions (material, layout, and construction), HVAC systems (Heating, Ventilation, and Air-conditioning systems), indoor space configurations (furnishing, decor, and equipment), and occupant efficiency habits. These variables are highly interdependent and dynamically influenced by various adjustments and interactions (Szczurek et al., 2015). IAQ can be improved by either rising ventilation or decreasing pollutant levels in the air. Ventilation systems in indoor environments condition the air, control thermal loads, and maintain pressure differences. Ventilation could reduce the concentration of pollutants by diluting them. However, at the same time, it can pollute spaces that were freed of pollutants, a situation that has been specially studied with tobacco smoke. Most common ventilation systems do not have filters for respirable particles (Spengler JD, 1999).

The type of pollutants in an indoor environment does not differ from pollutants in an outdoor environment. These pollutants are classified as chemical (including carcinogens), biological, physical, and ergonomic pollutants. Chemical pollutants are generally further classified based on their toxicity and relative concentration between indoor and outdoor environments. Biological, physical, and ergonomic pollutants do not reference the outdoor environment. However, these pollutants are highly influenced by the concept of hygiene and comfort conditions which are related to economic development and culture.

According to the researchers (Wargocki, Wyon, and Fanger, 2000), improved occupant satisfaction resulting from improved IAQ would benefit both the occupants and the building as a whole. In today's Western world, maintaining optimal indoor environmental conditions is primarily achieved at the expense of increased energy consumption, a situation that is very evident in indoor air management.

Studying the quantitative effects of improved air ventilation rates in workplaces around the United States supports this argument. On a national scale, it was predicted that raising minimum ventilation rates from 8 to 10 l/s per person will save US\$13 billion per year, and increasing ventilation rates from 8 to 15 l/s per person will save US\$38 billion per year (Fisk et al., 2012). These advantages reflect a recognition of improved occupant performance and comfort as a result of improved air quality. Reports also showed that air quality and movement have a significant impact on indoor environment comfort and satisfaction. A case study in California on a municipal office building identified that air movement affects thermal comfort (Zagreus et al., 2004). The users of the building reported that improved air movement would significantly enhance their comfort.

An online survey in 215 buildings imposed the effect of air quality on sensed productivity. Cleanliness, stuffy air, and smell were identified as factors that significantly impact air quality. (Huizenga et al., 2006). According to the analysis, occupants without access to windows were less satisfied than occupants with access. A linear relationship between air quality and perceived productivity was yielded as an assessment of satisfaction. Moreover, Pawel Wargocki, David P Wyon, and P Ole Fanger studied air quality effects on workers' performance of tasks like typing and proofreading. (Wargocki, Wyon, and Fanger, 2000). The analysis outcome points out a strong correlation between air quality and performance and satisfaction. The study showed that works that are more satisfied with the

air quality tend to perform better. Thus, these studies concluded that doubling the workplace's ventilation rate increases the workers' performance and comfort.

The outcome of more recent studies approved the relationship between air quality and occupant comfort and satisfaction. Contrary to other indoor environmental factors, air quality considerably affects the occupant's health, general wellbeing, and satisfaction. (Sadick and Issa, 2017).

2.4.2.2 Indoor Air Quality conditions and occupants' satisfaction and work performance

Biological pollutants and chemicals in the interior space, including pollutants from materials and furnishings, are linked to IAQ in building settings. Furthermore, the rate of ventilation, which is affected by external environmental conditions and human activities such as cigarette smoking, has an impact on the IAQ of building settings (IAQ-SFRB. 2010). Issues in IAQ can have a negative impact on the health, comfort, and performance of building users (Antikainen et al., 2008).

Research performed by the Indoor Environment Department (IED) of Lawrence Berkeley National Laboratory (LBNL) indicated that the increase in workers' satisfaction with IAQ is related to improved job performance. According to this study, a reduction in occupants' dissatisfaction with IAQ by 10% can result in a boost in their job performance by 1% (I.E.D.,-2010; Wargocki et al., 2000).

Indoor air quality (IAQ) refers to "the environmental qualities within buildings that may impact human health, comfort, or job performance" (IAQ-SFRB, 2010). The ANSI/ASHRAE 62.1 Standard (2010) defines acceptable perceived IAQ as "air in which there are no known pollutants in dangerous amounts as assessed by appropriate authorities, and a significant majority (80 percent or more) of those exposed do not show dissatisfaction."

Improved IAQ at workstations can increase job performance, according to Fisk and Seppanen (2007). According to their research, indoor pollutants sources, such as off-gassing of toxins from surface materials, equipment, and furnishings, can impact employees' work performance, including text proofreading, text typing, speed, and accuracy (Fisk and Seppanen, 2007). Removal of a carpet that caused complaints about its negative impact on air quality improved typing and reading performance by about 4%. While, typing errors were reduced by 16% by removing computers with CRT monitors that produced pollutant sources

(Bako-Biro et al., 2004). Adding to that, text typing speed and accuracy were improved by removing pollutant sources such as linoleum flooring and shelves (Wargocki et al., 2002; Bako-Biro, 2004).

The International Center for Indoor Environment and Energy (ICEE) at the Technical University of Denmark has conducted several studies on the impact of IAQ on human performance. Research findings showed that exposure to a pollutant source, such as a 20-year-old carpet, has a significant negative impact on occupants' performance (Fanger, 2008; Wargocki, 2008).

2.4.3 Lighting

2.4.3.1 Definition and Importance of Lighting

When discussing architecture, one must inevitably bring up the topic of light, and most notably, natural light. Lightening is more than the physical means that enables people to see the exterior and interior material forms of buildings. Instead, it provides architecture with its primary energy component, which is required for the existence of a rich integrated duality of matter and energy. This generates an aesthetic sensation in the users that goes beyond merely being useful (ul Haq et al., 2014).

Therefore, excellent design is always related to natural illumination generated within the structure. From the categorical eloquence of the Pantheon's single opening to the magical richness of the Germanic baroque to the progressively intricate Gothic cathedrals, natural light has been a determining factor that influences the quality of space. Despite this, the importance of light in architectural aesthetics is sometimes overlooked when analyzing great works with solely stylistic and geometrical criteria. When we visit a building, the aesthetic force of light distinguishes architecture from simple construction in the narrower meaning of architectural excellence. This is how the best architecture critics, from Vitruvius to Bruno Zeni, have defined light when speaking with the enthusiasm that only art can generate (ul Haq et al., 2014).

The lighting of a room must be in line with the activity that takes place in it. For example, dim lighting is sufficed for watching television, while lighting must be much more intense for reading. Moreover, the lighting should not be used as an aggressive element that ends up tiring the occupants. An office that is comfortable from all the points of view listed

with walls painted in bright red would be uncomfortable for the occupants (Augustin, Frankel, and Coleman, 2009).

Daylight is essential for humans' biological clock to work correctly and get the energy for mental and physical performance during the day. Throughout the year, daylight affects humans' day-to-day tasks. The biological clock, also termed the internal clock, is regulated by daylight and has been set for millions of years in response to the sun's rising and the darkness of night. Thus, light is needed to regulate human physiology and performance (Aries, 2005). The majority of people's time is spent indoors, which makes it essential to understand the space and distribute its light accordingly (Leech et al., 2002). Exposure to daylight has a positive impact. Overall, it affects people and makes them happier and more relaxed (Li, 2010). Since office workers spend most of their time indoors, they rely on indoor lighting or any available natural lighting to accomplish their assignments. Daylight is the best light source because of its superior color rendering and its ability to produce the best light for human visual comfort. It brings a sense of joy and happiness to people and positively affects them (Li, 2010). Organizations that support natural lighting obtain higher occupant efficiency and comfort in their workplaces (Yang and Nam, 2010). The lighting of workplaces must allow workers to have adequate visibility conditions to circulate and carry out their activities without any risk to their safety and health. Natural light is preferably recommended, which, if it is not enough, will be complemented by general artificial light, and it will also be complemented by localized light when high illumination levels are required in specific areas. When the lighting is not adequate, it could result in visual and ocular and an increase in fatigue, and as a consequence, more errors and accidents could occur along with a decrease in performance (Yang and Nam, 2010).

Daylight is preferred by building users over electrical lighting (Elzeyadi, 2011). Physical, behavioral, and psychological factors also play a role in occupant choice. Physically, there is not much of a difference since, for a rate, electrical lamps will cover the spectrum and color rendering of daytime. However, according to the literature, physiological and psychological factors affect humans' sensory and hormonal processes (Rea, Figueiro, and Bullough, 2002). Visual size, luminance intensity, color difference, retinal image efficiency, and retinal lighting are all factors that influence how much a person performs any task (Boyce, 1997). Daylight levels are several times larger than those of typical electrical lighting. They affect melatonin, a hormone that controls the body's internal clock, as well as these light levels (Rea, Figueiro, and Bullough, 2002). It has to do with the assumption that

daylight improves consciousness during office hours while doing monotonous work (Boyce, 1997, Nagy, Yasunaga, and Kose, 1995). Several studies indicated that daylight is necessary for the human body to function correctly in everyday activities. According to a study of office staff focused on the value of windows and their advantages, almost all of them agree that workplaces should have windows, and 86% believe that natural lighting is the best source of illumination for office activities (Cuttle, 1983). Windows can offer views of various visual details such as the atmosphere, nature, and nearby events. These views can be appealing to the eye and positively affect the occupants' efficiency (Heerwagen and Heerwagen, 1986). Thus, the literature validates occupants' preference for windows. On the other hand, the window scale's acceptability depends on factors such as the amount of indoor and outdoor light, sun angle, and sky luminance (Ne'Eman, 1970).

According to a study, only 43% of respondents prefer large windows in an office setting, and different spaces require different lighting levels (Butler and Biner, 1989). An investigation into high-rise office buildings found that just 56% of those who responded considered window access to be important. According to 86% of the personnel, the size of the window did not matter as long as the lighting conditions were appropriate (Wotton, 1982). Due to solar radiation and wind speed, the window's orientation causes markedly different control responses (Zhang and Barrett, 2012). The use of more blinds on the southern side of a glazed building than on the northern side indicates that the occupants dislike direct sunlight (Rubin, Collins, and Tibbott, 1978). Blind use in windows is heavily influenced by solar altitude and solar radiation, suggesting discomfort caused by direct sunlight. The exterior air temperature, the year's season, the time of day, and the office's occupancy pattern are closely associated with window control (Zhang and Barrett, 2012). The scale, place, and form of the glass façade are all determined by the geographical area, local environment, and immediate surroundings. However, owner dissatisfaction is increased by the usage of blinds and the misuse of glass facades in Dubai's skyscrapers due to inadequate construction and lack of knowledge about orientation and solar attitude (Aboulmaga, 2006). Blinds results in the usage of electrical lighting and wasting of the available sunlight, which increases CO₂ pollution. Also, in hot and heavy solar radiation zones, exterior architecture elements in the façade can be used to prevent glare issues (Lim et al., 2012).

In hot climates, designers use a double façade to minimize heat gain and glare issues caused by direct sunlight. The usage of a typical mashrabiya' screen as a second skin in the Masdar City project in Abu Dhabi, as well as the screen pattern on the Doha Tower in Abu

Dhabi, are excellent examples of reducing heat gain and glare from direct sunlight in hot climates (Boake et al., 2014). For a building's natural lighting strategy to work, it needs to take into account local weather conditions, the building's orientation, and solar altitude, as well as its near surroundings.

2.4.3.2 Lighting conditions and occupants' satisfaction and work performance

Electrical lighting and natural lighting are two examples of lighting settings. For an individual's wellbeing, interior lighting quality must meet human demands such as vision, activity, communication, mood, comfort, health and safety, and aesthetic judgment (NRCC, 2009). Poor lighting at workplaces may cause discomfort (Boyce, 1998).

In-office buildings, natural lighting has often been seen as a valuable source of energy savings and a way to improve occupant visual comfort. According to Jones (2008), natural lighting is a "technique of bringing natural light into interior areas to minimize the use of electrical lighting."

However, glare from faraway light fittings blocked by high partitions and insufficient light levels on task surfaces can cause visual discomfort, leading to dissatisfaction (NRCC, 2009a), lower job accuracy, and extended task completion time (NRCC, 2009b). High-quality lighting settings may decrease distractions and discomfort by providing employees with appropriate working circumstances and aesthetic aspects for psychological comfort.

According to previous research, occupants' happiness with lighting conditions at their workstations is connected to their overall facility satisfaction and job performance (Choi, 2011).

2.4.4 Noise and Acoustics

2.4.4.1 Definition and Importance of Acoustics

Hearing is one of the five basic human senses. World Health Organization (WHO) defines unwanted sounds as noise. According to Frontczak et al. (2012), noise has a psychological influence on people, such as nervousness and a decreased ability to concentrate. Excessive noise is undoubtedly a cause of annoyance. The total permissible noise level measured in decibels must be limited. However, some nuances must also be considered, such as the noise being permanent or intermittent. It is also necessary to take into account the noise intervals and those of silence. Another important aspect is the sound

spectrum; broadband spectrum noises (multi-frequency) are much more tolerable than those with pure tones and their harmonics, "beep" type noises to understand us; these, in addition to being more annoying, if the exposure to them is very prolonged, they end up causing deafness at the frequency of the beep (Banbury and Berry, 2005).

Consequently, there should be suitable acoustic comfort inside the buildings. In an office building, noise is a significant factor but not very much in residential buildings. Acoustic efficiency becomes more critical in office design because most office activities need some noise control for occupants to function efficiently (Ayrer et al., 2003). The noise levels usually found in buildings in the service sector are below 80 dBA, a level from which action must be taken to prevent the risk of hearing loss for workers. However, the noise originating in these buildings could annoy workers and affect their execution of the work. Noise interferes with verbal communication, acts as a distracting element, hinders concentration and attention, and reduces performance (Ayrer et al., 2003).

Poor acoustic and noise efficiency can contribute to employee frustration and negatively impact performance and comfort (Frontczak et al., 2012). There are two kinds of noise sources in an office: external and internal. External noises include cars, crowds, automobiles, and machinery. Work colleague conversations, one-minute inquiries, and computer sounds such as telephones and other office devices are examples of internal noises. (Banbury et al., 2005). According to research, occupants exposed to constant transportation and traffic noises have elevated blood pressure and stress hormone levels (Evans et al., 1998). Internal types of equipment such as fax machines, telephones, and air conditioning units may also be a source of discomfort and tension (Ayrer et al., 2003). Voice and workplace noises have a significant impact on office tasks. Researchers found that the score in 'memory for prose' tasks dropped by 66% when people were exposed to different background noises. Office noises, such as unanswered calls and background voices, hinder the focus of nearly all of the survey respondents in an experiment (Banbury and Berry, 2005). Both internal and external noises impact occupants' efficiency, causing stress, anxiety, and potential long-term health problems.

Vibrations can also cause various effects, ranging from simple annoyance to profound health alterations and interference with human activities (in the execution of specific tasks such as reading, in the loss of precision when executing movements, in the performance loss due to fatigue, etc.).

Vibrations in the vicinity of a typical service sector workstation due to construction sites, road traffic, or proximity to elevators can significantly disturb the occupants of the building. The main symptoms produced by these vibrations are dizziness and irritability.

The most common criticism against offices with an open floor plan is the presence of ambient noise. This should not come as a surprise, given that the concept of open-office planning always invites some level of acoustic compromise. This is because of the contradictory requirements of good speech communication and good speech privacy to co-exist in a single physical environment. Therefore, there is a danger of interruption and distraction from background noise wherever there is effective communication, both formally and informally, as in most open-plan workplaces (Banbury and Berry, 2005).

Utilizing a variety of questionnaire-based approaches, the great bulk of research undertaken up to date has focused on the last element, irritation. For instance, Langdon (1966) discovered that the most common complaint about workplace surroundings was noise, particularly background conversations. Boyce (1974) investigated an open-plan workplace and found that among 200 employees, 67% of them were bothered by ringing telephones, 55% by individuals conversing, and around 50% by air conditioning and office types of equipment.

Moreover, 519 employees were examined in 15 European workplaces by Nemecek and Grandjean (1973), and a third of these employees complained about office noise, especially background talks (although the mean ambient sound levels were unrelated to these complaints). In addition, Keighley (1970) evaluated the acceptability of noise in 40 workplaces and measured the ambient and peak sound levels above the background. The research revealed that acceptability was unrelated to the ambient sound level but substantially negatively linked with peak levels above ambient, indicating that unique or conspicuous sounds were the least acceptable. 54% of nearly 2000 participants surveyed by Sundstrom et al. (1994) said that they were often irritated by noise, mainly caused by people chatting and telephones ringing. Interestingly, this noise disruption was associated with work and environmental unhappiness but not with self- or supervisor-rated performance. In conclusion, these studies indicated that disruption reported by office workers was unrelated to the ambient noise level. It also showed that distinctive or salient sounds, such as peaks of office noise, are highly unacceptable. Finally, background speech was reported to be the most bothersome noise source in the office environment.

Although the physical qualities of the sound may be comparable, background noise in the actual world may contain extra meaning, which complicates the application of the findings of a laboratory study to the real world. Laboratory participants are trained to disregard background noise, but office employees may pay attention to workplace noises. The individuals in these trials were exposed to irrelevant sounds for the first time, while office employees spent a significant amount of time in their workplaces. Consequently, the degree to which habituation happens is theoretically and practically significant. The habituation research within the context of the irrelevant sound paradigm is incomplete and inconsistent. Banbury and Berry (1997) discovered substantial habituation effects after 20 minutes of continuous exposure. Using a different technique, Tremblay and Jones (1998) found no indication of habituation. One possible reason for this discrepancy is that the process of habituation is attention-dependent. In the research conducted by Banbury and Berry, individuals paid attention to the irrelevant sound, but in the study conducted by Tremblay and Jones, exposure was accidental (i.e., unattended). The observation might explain the disparity in the findings that a brief period of silence repaired the interference caused by irrelevant sound (Banbury and Berry 1997).

Office noise was identified as a potential source of dissatisfaction within the work environment in previous research in terms of motivational deficits (e.g., Evans and Johnson, 2000), performance decrements (e.g., Veitch, 1990, Banbury and Berry, 1997), and annoyance. Previous research has found that office noise is a potential source of dissatisfaction within the work environment (e.g., Sundstrom et al. 1994).

2.4.5 Office Layout Impacts

According to the social connections approach, the lack of interior walls and barriers in open-plan offices promotes the development of social contact and relationships among workers, which positively affect employee motivation and satisfaction (Bach, 1965). Meanwhile, sociotechnical theorists contend that the lack of physical boundaries in a workplace generates possibilities and experiences for workers that are significantly different from those they would face if they were working in an area confined by walls and/or partitions (Muzaffar, Noor, and Mahmud, 2020). Advocates of the open-plan layout assert that it fosters an interactive and collaborative work atmosphere and dominates the workplace in various professional fields. Recent research has shown that, despite the structure's many

well-known advantages, the open-plan office layout could be challenging for executives to promote collaborative contact and staff productivity (Thalin, 2017). As individuals demand greater privacy, open space workplaces tend to impede their privacy as they are visible to other workers and might make them feel uneasy. Employees felt their privacy was violated since their activities and comments were audible to others in the workplace. Employees' views of open plan offices included a lack of privacy, overhearing coworker chat, and heating conditions (Tanabe, Nishihara & Haneda, 2015). The results revealed that workers were dissatisfied with their work environment since the above conditions impeded their ability to accomplish their duties.

(Stillman, 2018) The ability of employees to concentrate on their work is hindered by open office design. The lack of employees' ability to focus due to distraction could result in the drainage of their cognitive and emotional resources. Moreover, it could be discouraged employees' face-to-face interactions and cause social withdrawal between coworkers as they tend to communicate through emails and instant chats rather than in person (Stillman, 2018). The occupants with open plan layouts were unsatisfied with the amount of sound privacy they had more than half of the time.

On the other hand, a closed office is a workplace where workers have separate working areas that are segregated by walls, cubicles, or panels. This type of working area is also known as a private office. Many people believe that an employee's ability to concentrate on their task is increased when they have a private cubicle to work in, which in return leads to increased productivity (Muzaffar, Noor, and Mahmud, 2020). While this is true to a certain degree, it is evident that for some people, being confined to a cubicle for many hours daily seems suffocating. This is the case, especially if the cubicle is small (Fanger, 2011). In addition, closed offices provide a greater degree of privacy, which not only lends a sense of safety but also plays a significant part in decision-making. A more distinct understanding of hierarchy and increased productivity because of a reduction in distractions are two further advantages.

Moreover, the disadvantages of closed offices include more significant expense, minimal supervision, and restricted possibilities for social connection and cooperation among staff members. These factors all contribute to a higher likelihood of burnout. However, closed offices introduce less number of distractions to the workers, which enables them to work more effectively and create higher-quality outcomes. Companies with occupations that

demand focus and quiet working locations, such as law firms, accounting agencies, and other organizations in the financial industry, are more suited to use closed offices than other types of enterprises (Fanger, 2011).

To save space, energy, and money, there is an increase in designing an open-plan office layout (Al Horr et al., 2016). Satisfaction of users' comfort largely depends on the office layout compared to IEQ and personal control factors (Bluyssen et al., 2011). It influences workers' productivity, well-being, and satisfaction (Chen et al., 2020; Lee, 2010). Many scholars argue that making open-plan offices, like removing walls and boundaries, encourages social interaction and cooperation between coworkers (Festinger, Schachter, and Back, 1950). Contrarily, others insist that the absence of walls and boundaries impacts social interaction and cooperation because of the distractions and overload of surroundings (Ireland and Garnier, 2018). According to the latest studies, face-to-face interaction has decreased by approximately 70% in open-plan offices (Bernstein and Turban, 2018).

Open-plan offices are inadequate due to their disadvantages. These disadvantages include low job satisfaction (Veitch et al., 2007), distraction (Varjo et al., 2015; Brill, Michael, and Weidemann, 2001), cognitive overload (De Croon et al., 2005), and concentration problems (Kang, Ou and Mak, 2017). Also, poor air quality and unacceptable thermal conditions can cause occupants discomfort in open-plan offices (Haapakangas et al., 2014; Pejtersen et al., 2006). Research papers showed that workers' thermal comfort is higher in office spaces with fewer desks than in open spaces or environments with many desks (Castaldo et al., 2018).

Occupants' dissatisfaction with noise in open-plan offices is high due to the poor acoustic conditions. The noise and lack of privacy while speaking can cause disturbances (Varjo et al., 2015; Kang, Ou, and Mak, 2017). When the size of open-plan offices increases, the dissatisfaction with noise and lack of privacy increases (Al Horr et al., 2016). In correlation, privacy satisfaction in open-plan offices directly impacts the users' satisfaction with other IEQ factors, like lights and ventilation (Veitch et al., 2007). Moreover, the satisfaction of workers in terms of their open-plan offices reflects positively on their satisfaction with the indoor environment and their jobs. This concludes that it is essential to consider IEQ physical and well-being factors in office layouts (Veitch et al., 2007).

2.4.6 Views and Biophilia

Biophilic design is one of the most modern methods used to enhance the interactions and ties between humans and nature in a built environment (Parsaee et al., 2018). The concept of biophilic design stems from the biophilia philosophy. The term biophilia is a Greek word that means love of life (Ramzy, 2015). Wilson was the first to propose the biophilia notion (Wilson, 1984). This notion is based on humans' innate attraction for life and natural processes and patterns. The creation of the biophilia theory is supported by biological research and human needs. Humans are part of nature in a biological sense and synchronize with environmental circumstances (Pfeffer, Korf, and Wicht, 2018). The biophilia hypothesis supports this viewpoint. It compares humans to other organisms that have gradually adapted to nature via evolution (Kellert, 2008). The biophilia idea stresses human psychological, emotional, and spiritual wellbeing through natural human-nature connections (Soderlund and Newman, 2015).

The biophilic design method aims to reestablish and maintain human-nature connections and ultimately manifest this intrinsic bond in human life (Soderlund and Newman, 2015). Biophilic design asserts that this connection with nature is essential for human health (Gillis and Gatersleben, 2015). Architecture could represent people's physiological characteristics and psychological characteristics, and disposition toward nature (Soderlund and Newman, 2015). This architectural strategy could produce shapes and places corresponding to the design—challenges characterized by varying surroundings (Alexander, 2002).

Biophilic design is an instinctual language of architectural environments, assuming natural shapes and patterns as vocabularies and compositional grammar (Ramzy, 2015). The ideal biophilic design incorporates nature into the built environment in a restorative and inspiring manner without interfering with the space's function (Ryan et al., 2014). Therefore, designers can create pleasurable, functionally productive, and regenerative structures provided they have a thorough knowledge of the relationships between realistic patterns and human needs (John, Clements-Croome, and Jeronimidis, 2005).

Large windows in office buildings allow daylight for indoor environments and provide occupants with direct visual contact with the outside view (Tzempelikos, 2008). Being near a window could be good psychologically and physically, mainly if the view includes natural elements (Heerwagen & Orans, 1986). Employees' stress levels decreased,

and their quality of life improved by giving them restorative experiences through visual contact with nature through windows (Kaplan,1993). In other terms, offering access to appealing outside views and connections to nature may make buildings more effective and productive places to work (WBDG, 2008). This feature has contributed to better performance and work-life quality through psychological aspects (Kroner et al., 1992). In contemporary office buildings with translucent facades, glare prevention is crucial, and a view and natural light supply are essential (Tzempelikos, 2008). The majority of previous studies of Venetian blinds refer to the calculation of their optical properties and control issues (Lee et al., 1998) by utilizing experimental techniques (Aleo and Viadana, 1994; Tzempelikos and Athienitis, 2003), analytical models (Kuhn, 2006), semi-analytical and numerical methods (Simmler and Binder, 2008), and ray-tracing simulation (Andersen et al., 2005).

According to Wilson (1984), biophilia is the bond that exists between humans and nature. Humans have an intrinsic attraction to all living things and are extremely sensitive to the shapes, processes, and patterns seen in nature (Nabhan et al., 1993). These psychological mechanisms date back to when human contacts with other living species (plants and creatures) were more direct, active, and frequent than they are now (Krmáová, 2009). A study showed that people in the natural environment have a better degree of pleasure and wellbeing than those who aren't (MacKerron and Mourato, 2013). Since ancient times, living routines and environments have been subjected to substantial changes. Nowadays, cities limit humans' engagement with other creatures, which results in a decrease in human pleasure and well-being.

Incorporating a natural environment or vegetation into a workplace has a significant impact on users' comfort (Kellert et al., 2011). Greenery in workplaces positively impacts workers as it enhances their comfort levels and decreases their stress. In addition, indoor plants can assist in improving indoor air quality. (Lohr et al., 1996). Passive observation of natural stimuli through windows can relieve stress and improve users' moods (Heerwagen, 2003). According to field research, employees with a window view of nature felt less irritated and more satisfied than those with a view of merely the built area (Kaplan and Kaplan, 1989). Even while outside the building, plants and nature can assist in reducing tension, anxiety, and stress and increasing the comfort and well-being of users (Chang and Chen, 2005). Windows with outside world views are one of the significant needs of office occupants to attain pleasure in an office environment (Parsaei et al., 2019). Therefore, Biophilia and the presence of views should be part of the fundamental design concept of a workplace. The

primary goal is to provide the most practical and conducive design for the users, and including Biophilic design elements increases user wellness and comfort.

2.5 Cultural differences influencing Indoor Environment Quality

Cultural differences in routines, attitudes, thermal preferences, motives, and adaptive behaviors can all impact occupants' perceptions of IEQ. For example, thermal comfort tolerance is mainly determined by climate, but it is also influenced by cultural factors such as clothing choices (Zhang et al., 2017). As a result, indoor thermal comfort has gotten much attention lately, along with increased living quality. In addition, the occupants' country of origin impacts acoustic comfort (Wilson and Nicol, 1994).

According to researchers, European and North American cities have a higher indoor temperature, whereas Chinese cities have the lowest (Zhang et al., 2017). A study showed that Chinese residents have a high acceptable percentage in terms of comfort, which was likely due to their wearing clothes with the most significant and considerable diversity in terms of types and materials. Another research found that Slovenian residents were more outspoken about controlling electric lights, blinds, and thermostatic values than Italian residents (d'Oca et al., 2019). Thus, daily cultural and environmental attitudes impact certain aspects of IEQ (Mansour, 2014).

Clothing insulation has a considerable effect on the heat perception of occupants. Asia has a greater average level of garment insulation than Europe and North America, which might be attributed to the difference in indoor temperature as I have a lower indoor operational temperature. On the principle of thermal balance, lower indoor temperatures result in more heat loss from the human body, causing the Chinese to wear more clothing to stay warm. In addition, several studies have shown that Chinese and Asians have a lower baseline metabolic rate than whites and Westerners (WoutersAdriaens and Westerterp, 2008; Qi et al., 2014). According to the PMV function, individuals with a lower metabolic rate must wear more clothing to maintain a neutral body temperature in the same thermal environment. Chinese garment insulation is the highest and most diverse. European and North American clothing has a comparable amount of insulation, which is lower than that of the Chinese. Individuals feel warmer while wearing more clothing at the same temperature. (Zhang et al., 2017).

It appears appropriate to examine the behavior of building occupants from a multidisciplinary standpoint. The contextual (rather than just environmental) variables that influence human-building interaction are now widely acknowledged by researchers (O'Brien and Gunay, 2014). Researchers in the area of architecture have contributed substantially to developing an interdisciplinary approach to understanding how occupant behavior, comfort, and satisfaction influence the accomplishment of high-performance buildings (Day and Gunderson, 2015). Day and Gunderson, 2015 presented a framework that integrates academic views and research methods from interior design, building science, data science, and social science. The architects supported the hypothesis that occupants who received appropriate instructions on utilizing building technology and energy systems were more likely to be happy with their working environment—focusing on the social-psychological aspects of energy concerns that influence the intents of workers in the workplace. A previous study (D'Oca et al., 2016) highlighted the need for additional knowledge on individual adaptive behavioral patterns and motivational drivers in the office environment. The interactions with building control devices to establish an individual's comfort conditions are negotiated in social networks, where monetary incentives for engaging in pro-environmental behaviors are negligible compared to residential spaces. Staddon et al. (2016) revealed that workplace social norms and group dynamics are vital factors that affect workers' desire to engage with building control systems. They demonstrated how information on workers' desire to save energy and the effect of subjective norms might be used to develop intervention programs for energy consumption in office settings.

2.6 Personal control

Personal control significantly influences the user's experience and level of satisfaction in relation to the indoor environment. Building service system designers currently appear skeptical about the advantages of having personal control over the temperature and humidity of an indoor environment. As a result, designers frequently eliminate opportunities for control, like operable windows and adjustable thermostats. They are likely unaware of the comfort, health, and productivity benefits offered by indoor control options, or they might not give the user's experience a significant amount of consideration throughout the process of designing the building (van Hoof et al., 2010). Consequently, buildings are managed from a centralized location rather than by individual occupants. This is especially true with impermeable structures dependent on HVAC systems managed from a centralized location.

This section will provide an overview of personal control and its significance, as well as a review of relevant research on the influence of personal control on the indoor environment. Nevertheless, few recognized the following factors of personal control: available adaptive opportunities, purposes for not practicing adaptive opportunities, office type, season, users' aspirations, as well as the psychological problem of both the belief of having access to the adaptive opportunities and the effectiveness of having this access (Gossauer and Wagner, 2006, Hellwig 2015).

Paciuk (1990) divided personal control into three categories: accessible, performed, and perceived control. Accessible control refers to the types of control options available to office occupants, such as opening and closing windows, interior and exterior doors, blinds, personal fans, heaters, and thermostats. It might also contain the worker's dress code and other variables impacting how the occupants interact with the building.

Performed control refers to how frequently building occupants participate in indoor environmental adaptation behaviors to achieve the desired comfort level. Occupants can maintain control by modifying the control options accessible to them.

Finally, perceived control is the degree to which building occupants think they can influence desired changes in the indoor environment. Hellwig (2015) defined personal control as *'the ability to change occupants' indoor environment according to their requirements and preferences,'* which is similar to perceived control.

Occupants who are aware of their capacity to modify the surrounding indoor environment based on prior experience are more confident in feeling comfortable in their offices when discomfort arises. Personal control corresponds to the behavior of adaptation, specifically technological or environmental adaptation. Occupants modify their surroundings through available control opportunities, such as opening and closing windows, doors, or shades, turning on fans or heaters, or adjusting thermostats (Al-Atrash, 2018).

In ASHRAE Standard 55, the adaptive model defined two levels of acceptability, 90%, and 80%. According to Fange (2002), personal control is one of the most critical success criteria for reasonable personal control. "Of course, 100% happiness with indoor climate may be reached; all it takes is effective personal management exactly where people are," he added. In addition, Brager and Olesen wrote: "Even if the standard specifies circumstances that would please 80% of the users, 20% of them may still be unsatisfied. The

greatest approach to improve upon this level of acceptance is to offer occupants personal control over their thermal environment, enabling them to adjust for inter- and intra-individual variations in preference” (Olesen and Brager, 2004).

According to Aronoff and Kaplan (1995), it is critical to offer office occupants personal control over the indoor environment. “Because the thermal settings that individuals feel pleasant are so diverse,” they said, “the optimum approach would be to allow everyone to select their conditions.” As a consequence, personal control allows people to modify their individual preferences and makes them feel more in control of their surroundings, making them happier. Personal control also improves the quality of the work environment.

Based on a review of several personal control studies, Heerwagen (2000) identified numerous benefits of personal control. Including increased perceived productivity, fewer symptoms of illness, lower absenteeism, improved work performance, comfort and acceptability, shorter time to achieve comfort, very few coping behaviors, and fewer problems for building managers.

Previous research on the influence of indoor system controllability has shown a correlation between higher occupant satisfaction and work performance (Aronoff and Kaplan, 1995; Olesen and Brager, 2004. Fisher, 1990) defined personal control as "individuals with control can act to change or reverse situations which are disliked."

According to the findings of a study based on data generated by the PROBE research project, occupants' perceived work performance was higher in buildings where occupants had more control over their environments, such as temperature and ventilation. This was the case in buildings where occupants had more control over their environments (Leaman & Bordass, 2001). Research showed that a user's sense of personal control over their workstation systems is favorably related to their satisfaction with their entire working environment (Lee & Brand, 2005). The findings from the CBE (Center for the Built Environment) survey indicated that a more significant proportion of occupants are dissatisfied (42%) with overall thermal comfort at the workstation level than those who are satisfied (39%). On the other hand, occupants with some control over their thermal environment, such as a thermostat, operable window, portable heater, or portable fan, are satisfied with the temperature in their workplace (Huizenga, Abbaszadeh, Zagreus, & Arens, 2006).

2.7 The planned behavior theory (PBT) and The The ABC model

Researchers have lately discovered that combining both the physical and social sciences is the only way to gain complete knowledge of occupant behavior and the possibilities for building efficiency. (Xu, 2017). Previous theories, particularly Ajzen's theory of planned behavior (Ajzen, I., 1991) and Stern and his colleagues' attitude-behavior-context model (Stern et al., 1999; Guagnano et al., 1995), have been effective at predicting behaviors in certain areas. According to (Chen et al., 2020), all models have limits in understanding behavior in different domains or contexts. To further understand the interconnected connections between occupant behaviors and IEQ, merging existing theories is a promising approach. These two theories are the planned behavior theory and the ABC model. The planned behavior theory (PBT) is a model for determining the impact of social-psychological elements on workplace behavior. The PBT is a logical decision-making theory that explains how social-psychological aspects impact actual behavior and behavioral intention (Chen et al., 2020). The TPB claims that evaluating attitudes, subjective standards, and perceived behavioral control (PBT) helps develop an intention (Ajzen, 1991). When a person's behavioral intention is strong enough to be followed up with a subsequent action, he or she will carry out the behavior.

The ABC model is used to investigate how factors at the organizational/external, individual/internal, and their linkages affect office occupants' IEQ comfort beliefs (Guagnano et al., 1995). Guagnano argued that according to the ABC model, the link between attitude (A), internal variables, and conduct (B) is influenced by the context (C), also referred to as the external condition. When an action is difficult or unpleasant, a person's mood does not always determine performance. In most ABC model implementations, the C factor is a single variable that represents the complexity of implementing the desired behavior. In certain circumstances, contextual considerations might include economic incentives and costs, physical capabilities and restrictions, institutional and regulatory elements, interpersonal impacts (e.g., social norms), and more significant social context elements (Stern et al., 1999). Therefore, the ABC approach is mainly a promising approach for researching occupants' IEQ interaction, where both a coworker and institutional effects are present. Based on these two theories Chen et al. 2020 proposed the four dimensions to have a better and clearer understanding of the influence of IEQ belief on the occupants inside the building.

2.8 The Four dimensions

According to Chen et al.2020 and based on previous empirical investigations of the PBT and ABC models, there are four aspects for understanding the effects of IEQ-belief on comfort (Figure 2).

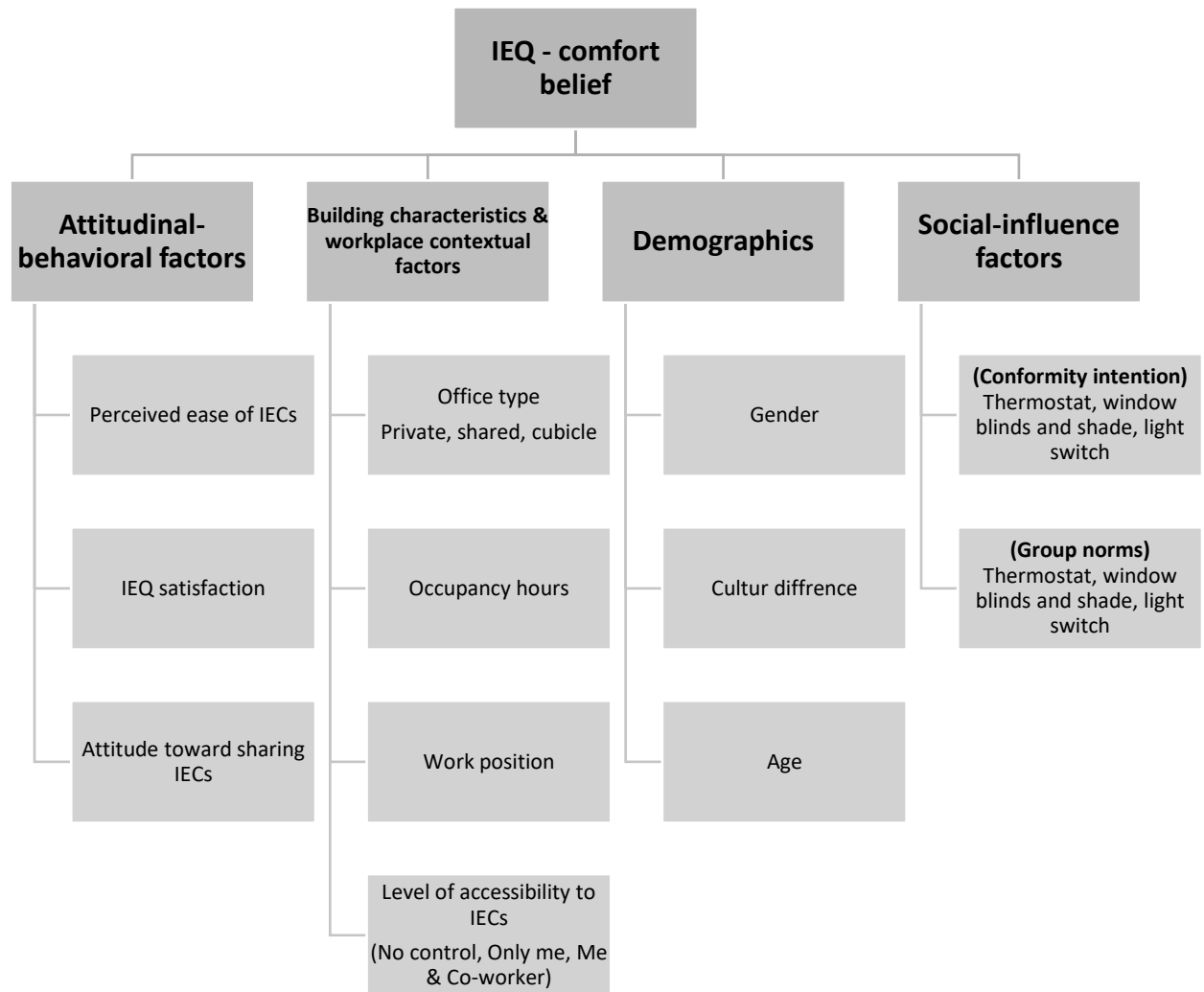


Figure 2. Illustration of the four dimensions to study the IEQ comfort factors.

The first dimension is attitudinal-behavioral factors or IEQ satisfaction, which are attitudes toward sharing IECs and perceived ease of control over IECs. They are defined as a set of positive and negative evaluations toward a particular object and action, such as IEQ satisfaction, perceived ease of control over IECs, and attitudes toward sharing IECs. The second dimension is building characteristics and work-contextual factors. It includes office types (open-plan, private, and cubical), IEC (Indoor Environment Control) accessibility, number of persons sharing IECs, occupancy hours (hours spent at work), and work positions.

Demographics such as regional differences and gender are considered the third dimension. Finally, social and organizational elements, as well as two interactive elements. The practice of sharing IECs is a sign that interacting social elements constrain personal behaviors (i.e., others' expectations and acceptance of one's actions). User intends to adhere to group norms of sharing IECs is the second aspect. Scholars discovered that users' conformance to the norms of sharing environmental control elements in buildings is favorably connected to group norms (Chen et al., 2020). Furthermore, creating a multi-dimensional framework can assess results and lead building designers to consider all essential factors so they can develop and run a better-built environment.

The purpose of this section was to evaluate the existing literature by highlighting the indoor environment quality (IEQ) components available in the literature and thought to influence occupants' comfort in an office setting. IEQ factors and their physical properties were discussed in this section. In this study, a quantitative approach is applied to investigate the potential factors that affect the IEQ comfort level within an office building in Bahrain. This approach is combined with consideration of the social components of the building. The next chapter will discuss the methodologies and approaches used to conduct the study.

Chapter Three:

Methodology

3. Chapter Three: Methodology

3.1 Chapter overview

The techniques for collecting occupant data to test the hypotheses are described in this chapter. The settings, samples, instruments, and techniques used for data collection are all explained. The methods for collecting indoor environmental quality (IEQ) factors and testing hypotheses about connections among variables in this study are described.

This chapter discusses the survey approach used in this research to evaluate the effects of IEQ in Bahrain office buildings. The survey was conducted in phases. First, there was a pilot study to examine the validity of the survey. Next, a survey was developed based on the pilot study to match the criteria needed to help achieve the thesis aims and objectives. The final stage was summarizing the pilot study's analysis and establishing the complete survey questions. The questionnaire stages will be discussed in the following subsections in detail. The survey development stages included defining the survey's objectives, establishing the demographic and sample size, creating, pre-testing, and launching the survey, and then evaluating and discussing the findings. The sections below reflect the survey's aims and processes.

3.2 General methodological approach

Scientists have lately discovered that combining the physical and social sciences is the only way to gain a complete understanding of occupants' behavior and the potential for indoor environment quality (Xu et al., 2017; D'Oca et al., 2017). Beyond technological concerns, more concentration on social-psychological issues associated with occupant behavior might provide valuable insights into IEQ (Castaldo et al., 2018).

A survey questionnaire was employed to gather the needed data in this study since it is one of the most convenient approaches for obtaining a large number of responses from a community. It can give information on people's thoughts and behavior related to specific subjects by answering the questions (Williams, 2003).

The questionnaire was done to determine people's satisfaction with the quality of their office's indoor environment, analyze and comprehend the indoor environment comfort standards of an office building, and investigate the residents' perspectives in Bahrain on the following:

1. Acceptance of the quality of the indoor environment.
2. The factors that contribute to people's dissatisfaction with their indoor environment.
3. Studying the complex aspects of IEQ related to user comfort.
4. Occupants' needs and the relationship between IEQ and comfort at work.
5. The role of personal control over the IEQ and its relationship with occupants' comfort.
6. Local beliefs and social factors play a role in users' comfort and behavior.

The questionnaire was constructed, and there were phases of questionnaire development (Figure 3). The first stage of the questionnaire was the questionnaire preparation stage. This phase includes establishing the questionnaire's objectives and identifying the demographic target. The demographic target was used to determine the sample size required. Next, determine how the questionnaire will be distributed. The second phase was the design phase, in which the layout was created for the questions based on the objectives. The third phase was the testing and evaluation stage. It is concerned with consulting specialists and statisticians to assess the questionnaire's content validity. The pilot study determined the dependability and understandability of the questions. Modify all comments from the participants on the content and answer any unclear queries. The fourth phase was the stage of approval, and it was about obtaining approval regarding the questionnaire's content. The fifth stage was the implementation stage which included visiting several office buildings to distribute the questionnaire. The questionnaire was distributed online to many office buildings, and results were gathered online. The final stage was questionnaire analysis, and it was done using SPSS software. A descriptive analysis was done.

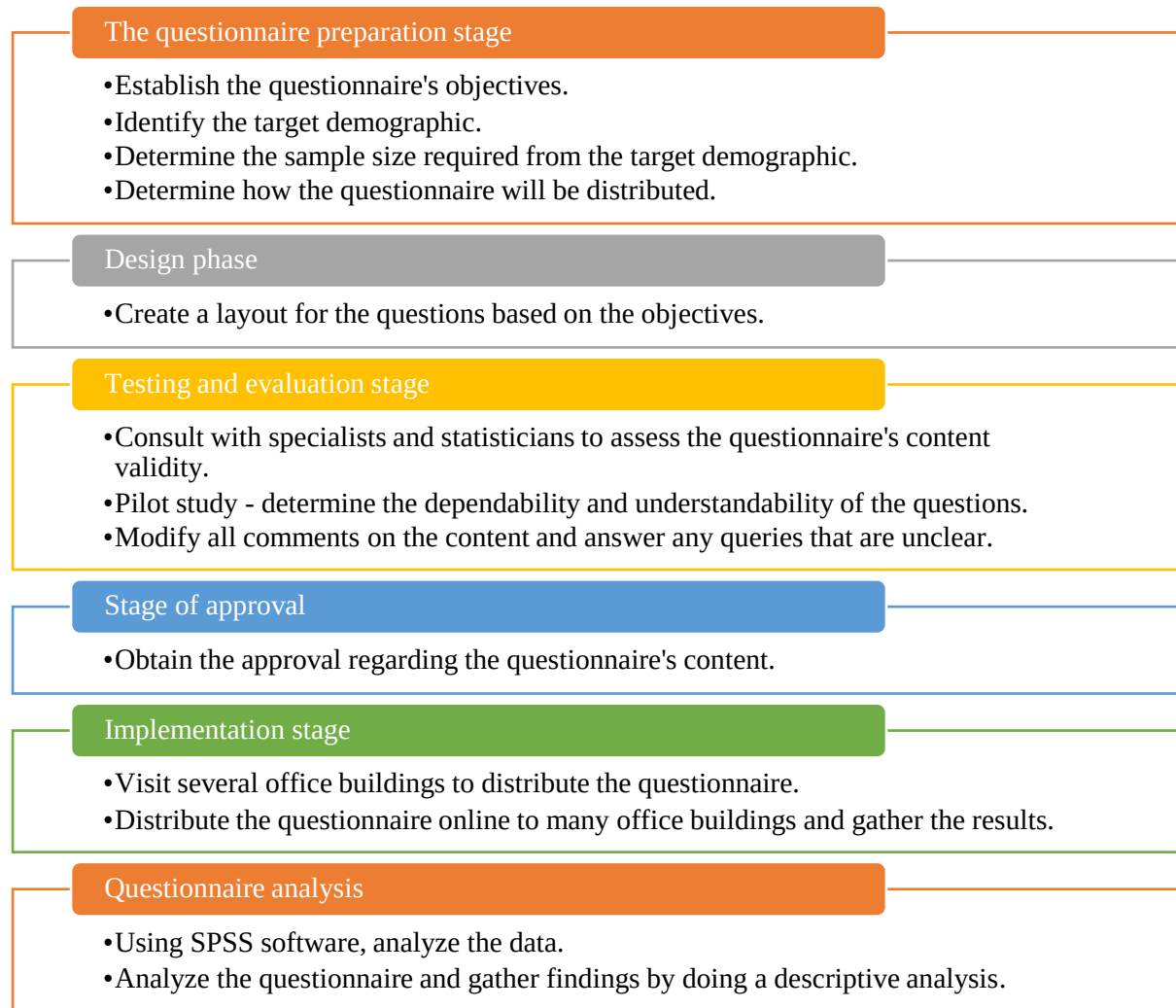


Figure 3 illustrates the phases of questionnaire development.

3.3 Research Design

The research uses a quantitative method that investigates the possible factors that affect the indoor environment quality (IEQ) comfort inside an office building in Bahrain, combining it with social aspects. It employs an internet-based structured questionnaire. The questionnaire has been adapted from the Chen et al.2020 questionnaire developed based on the planned behavioral theory (PBT) and the ABC model. Additional questions were added to fit the contextual case, and some questions were rephrased to be more understandable.

3.4 Population

The population of this study is the workers who work inside an office building in Bahrain during the sampling timeframe. The questionnaire was distributed randomly to

Bahrain residents to assess the various criteria for IEQ in their workplaces. The survey's target population included people of both genders aged 18 and older.

3.5 The Sampling Technique

After establishing the goals, objectives, and study needs, the researcher investigated random Bahrain office buildings. For this quantitative research, the sample was taken from the workers who work inside an office building in Bahrain. According to the most recent statistical research published by the social insurance organization (SIO) in Bahrain (Table 1; social insurance organization, 2021), the total number of workers is 552,068, including Bahrainis and non-Bahrainis, in the third quarter 3 of 2021 statistical report.

Table 1: Statistical research of registered working in Bahrain published by the social insurance organization 2021

Item	المجموع Total	القطاع الخاص Private Sector	القطاع العام Public Sector	البيان
1. Number of Contributors	552,068	503,778	48,290	1. عدد المشتركين
1.1 Bahraini	143,909	95,619	48,290	1.1 بحريني
1.2 Non-Bahraini	408,159	408,159		1.2 غير بحريني

Based on the above statistics, the target population for this survey is 552,068 from both genders and from people who are 18 and above. Using (Figure 4: Equation 1) from the National Education Association, a suitable sample size for the research that would reflect the whole community was found (Krejcie & Morgan, 197).

$$s = \frac{X^2 N P (1 - P)}{d^2(N - 1) + X^2 P (1 - P)}$$

Figure 4: Equation 1

Where:

S: required sample size

X²: the value of the chi-square for one degree of freedom = (3.841) at a confidence level of (0.05)

N: the population size

P: the population proportion (assumed to be 0.05 since this would provide the maximum sample size)

d: the degree of accuracy expressed as a proportion (0.05)

Table 2: The required sample size according to the National Education Association (Krejcie & Morgan, 1970)

N	X ²	P	D	S
552,068	3.841	0.5	0.05	384

Contacting the managers through email, phone, and in-person meetings were the first stage in obtaining permission to conduct the survey in various buildings. The managers were provided with information related to the project's objectives, timeframe, data collection equipment and techniques, the time needed, and frequency of questionnaire completion. In addition, the researcher's role, qualifications, and confidentiality of the study were described. After getting permission to conduct the survey, the questionnaire link was emailed to the offices. The link included information about the research in general, its length, purpose, methodology, and its non-judgmental nature.

The questionnaire was distributed to 508 respondents, and 393 occupants responded. The anticipated response rate is 81% (393/508), which is satisfactory. 51.91% of responders were men, while 48.90% were women. Their ages varied from 18 and 51 years or older. 14.97% of respondents worked in cubicles with partitions, 31.47% had enclosed private offices, and 47.72% had an open-plan office. Finally, 5.84% were in other types of office.

3.6 Questionnaire

This study consists of a survey designed to gather the necessary data and information from the participants throughout time to accomplish the research objectives. The survey was conducted over eight months, beginning in September 2021 and concluding in April 2022.

The questionnaire was available online. The online surveys were created using the web server application SurveyMonkey. It is a web server that allows users to create and publish online surveys, gather replies, and export the generated data to other apps. The survey was designed to have straightforward, accurate wording in terms of questions and options given. The language used in surveys should be acceptable for respondents and prepared at an appropriate reading level for the sample without requiring a prior understanding of the topic (Lasch et al. 2010).

Since Bahrain is an Arabic-speaking country, the questions were provided in Arabic along with English. Thus, participants could complete the survey in their preferred language. The questionnaire was initially designed in English and then translated to Arabic. Therefore, specialists were consulted and accepted the translation.

3.6.1 *Designing the questionnaire*

The researcher developed a descriptive survey questionnaire to assess numerous IEQ comfort aspects in a Bahraini office building. This study is a correlation study that employs a quantitative approach and an internet-based questionnaire. Participants must be at least 18 years old to participate. The survey instrument will be developed in English and Arabic to ensure equivalence and coherence across languages. A translation guideline approach will be created and followed.

The structured questionnaire consisted of five sections. The first section questioned the demographics and general information such as gender, age, dress code, years of experience, working hours, office type, and position. The second portion of the survey focused on the general satisfaction with IEQ aspects in general. The third section included thermal comfort, IEQ satisfaction, and IEQ comfort beliefs. The fourth section featured indoor environmental control and the behaviors used to exercise these controls inside the office. Finally, the fifth section included a measure of conformity intention and social-psychological characteristics like attitudes and group norms which might influence IEQ comfort beliefs.

A structured questionnaire with closed questions was used to ensure that participants gave specific answers to each question. Additionally, using closed questions make it easier to compare responses; they are accessible to code and analyze and less confusing for respondents (Williams 2003). To elicit accurate responses, the majority of the structured questions employed a five-point Likert scale (strongly disagree - strongly agree / very uncomfortable - very comfortable / not meet at all – highly meet). On the other hand, some questions allowed for multiple responses.

3.6.2 Testing Validity

This step of questionnaire design aims to evaluate whether or not the instrument measures what it is supposed to measure; this technique often entails employing a panel of experts in the field of study (Burton & Mazerolle, 2011). The validity of an instrument is evaluated using four tests: face, content, criteria, and concept. The most appropriate sort of validity is determined by the study's aims. The researcher's goal in this study is to investigate face and content validity. The validity face was chosen to guarantee that the instrument was simple to use, understandable, and readable. Content validity, in contrast, was evaluated to verify that the questions were factual, reliable, and relevant to the topic of research (Burton & Mazerolle, 2011).

The draft questionnaire was circulated to three experts: two in the field of architecture and one in education and thesis techniques. This approach was followed to guarantee that the questions were relevant and measured the study's objectives. Furthermore, the testing validity technique was utilized to double-check the wording of the questions. The researcher also sought the advice of a statistical expert to guarantee that the questions could be answered and

evaluated using the responses submitted. The questions were modified in response to the input received.

3.6.3 Pre-testing the reliability of the questionnaire - (Pilot Study)

The repeatability and consistency of a questionnaire or instrument are referred to as its reliability; this means that the questionnaire must consistently measure what it is designed to assess (Burton & Mazerolle, 2011; Williams, 2003). Various reliability tests, such as test-retest reliability, parallel-forms reliability, internal consistency, and split-half, can be used. The type of test used is determined by the type of data collected. Test-retest reliability is the most suitable approach for this research. It requires participants to complete a self-administered questionnaire twice, with the second time being after two to three weeks after the first. Then, using Spearman's Rank correlation coefficient, the two replies can be statistically compared (Williams, 2003).

The pilot study and testing of the questionnaire were done for the following reasons:

1. Test awareness and understanding of each question. Thus the researcher can rethink and clarify the wording of questions based on the feedback to avoid any confusion.
2. Examine the reliability of the questions that will make a significant contribution to the research objectives.
3. Establish the time required to complete questionnaires.

To enhance the form and wording of the questions, revisions were made based on the pilot sample's feedback and suggestions, which were gathered and considered after the questionnaire was tested.

The test-retest approach was used to assess reliability in this pilot study. This was accomplished by distributing the questionnaire to an 18-person sample. The questionnaire was then circulated to the same sample a second time two weeks later. The results of the two samples were compared to each other, and the data gathered were similar. The questionnaire questions were all understood, and the timing was fine by the sample.

3.6.4 Deploying the questionnaire

After ensuring the questionnaire's content validity and reliability, the internet-based questionnaire was distributed by visiting the main office building and providing the participant with the link. This procedure was done to check that the respondent completed the questionnaire correctly and to test if the participant was completing the questionnaire smoothly. However, some offices did not have the option of having the researcher present in person due to Covid-19 policies and other security reasons. As a result, the participant received the online link to access the questionnaire.

3.6.5 Data collection

An examination of the purpose of this study was carried out through the use of secondary data analysis. The data were collected through an online questionnaire and evaluated using the post-occupancy evaluation survey (POES) database. The survey consisted of an online, self-administered questionnaire, and it was sent to the people currently working in several office buildings in Bahrain.

3.6.6 Questionnaire questions

This part of the chapter includes the questionnaire structure and the questions that have been distributed to the participants. The online questionnaire is in the same sequence as the participants received it.

Effects of indoor environmental quality on user's comfort in offices buildings			
Welcome to My Survey			
Hello, I am a postgraduate researcher at the University of Bahrain. I am conducting a study on the Effects of Indoor Environmental Quality on User's Comfort in Offices Building. The following questions should take no more than 5 minutes to answer. All the data will remain confidential and used only for research purposes. Thank you for taking the time to assist me with this research. Note: Indoor environmental quality (IEQ) is a term that describes the state of a building's environment in terms of the health and well-being of people who use it. Thermal comfort is a person's state of mind in terms of whether they feel too hot or too cold. Contact: Name: Bayan Aburowais Email: Miss.b5@hotmail.com Supervisor: Dr. Hana Aljowder			
General/ Demographic			
1. Gender الجنس:			
☐ Male ذكر		☐ Female انثى	
2. Age العمر:			
☐ 18-28	☐ 29-39	☐ 40-50	☐ 51 or older
3. Dress code الزي الرسمي:			
☐ Suit بدلة	☐ Thoub/ Abaya ثوب/ عباية	☐ Casual غير رسمي	
4. In which sector do you work? في أي قطاع تعمل؟			
☐ Government Sector القطاع الحكومي	☐ Private Sector القطاع الخاص	☐ Semi-Government Sector القطاع شبه الحكومي	
5. How long have you been employed in this office? (Years) منذ متى وانت تعمل في هذا المكتب؟ (سنوات)			

☐ less than one year أقل من عام واحد	☐ 1-2 years	☐ 3-4 years	☐ More than four years أكثر من أربع سنوات
6. During the day, how many hours do you spend in the office? كم عدد الساعات التي تقضيها في المكتب خلال اليوم؟			
☐ 1-2 hours	☐ 3-5 hours	☐ 5-8 hours	☐ more than 8 hours أكثر من 8 ساعات
7. Your office type is: نوع مكتبك هو:			
☐ Private office مكتب خاص	☐ Open plan office مكتب مفتوح	☐ Cubicles مكتب مقصورة	☐ Other (please specify): -----
8. Your work position is: منصبك في العمل هو:			
☐ Chairman/CEO الرئيس التنفيذي	☐ General manager/Director المدير العام/ مدير	☐ Supervisor مشرف	☐ Staff موظف
			☐ Other (please specify):----- -
The office overall			
9. Does the office meet your comfort needs in general? ? (with 1 being not meet at all to 5 being highly meet): هل المكتب يلبي احتياجات راحتك بشكل عام؟ (مع 1 لا يلبي على الإطلاق و 5 يلبي بشكل كبير)			
☐ 1	☐ 2	☐ 3	☐ 4
☐ 5			
10. How would you rank your overall comfort of these following aspects:? (with 1 being very uncomfortable to 5 being very comfortable): كيف تقيم راحتك العامة من هذه الجوانب التالية: ؟ (مع اعتبار 1 غير مريح للغاية و 5 مريح للغاية)			
Indoor temperature درجة الحرارة			
☐ 1	☐ 2	☐ 3	☐ 4
☐ 5			
Indoor air quality (ventilation) جودة الهواء الداخلي (تهوية)			
☐ 1	☐ 2	☐ 3	☐ 4
☐ 5			
Natural lighting الإضاءة الطبيعية			
☐ 1	☐ 2	☐ 3	☐ 4
☐ 5			

Electric lighting الاضاءة الكهربائية				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Acoustics (level of noise) الصوتيات (مستوى الضوضاء)				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
views from inside the building to outside المنظر من داخل المبنى الى خارجه				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Thermal comfort, IEQ. comfort beliefs				
11. I think the following aspects influence my comfort at work: (with 1 being no influence at all to 5 being highly influenced): أعتقد أن الجوانب التالية تؤثر على راحتي في العمل: (مع اعتبار 1 ليس له تأثير على الإطلاق و 5 يؤثر بشدة)				
Indoor temperature درجة الحرارة				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Indoor air quality (ventilation) جودة الهواء الداخلي (التهوية)				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Natural lighting الاضاءة الطبيعية				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Electric lighting الاضاءة الكهربائية				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Acoustics (level of noise) الصوتيات (مستوى الضوضاء)				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Thermal comfort				
12. How would you describe the indoor air temperature in the summer? (with 1 being very uncomfortable to 5 being very comfortable): كيف تصف درجة الحرارة داخل المكتب في الصيف؟ (مع اعتبار 1 غير مريح للغاية و 5 مريح للغاية)				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

13. How would you describe the indoor air temperature in the winter? (with 1 being very uncomfortable to 5 being very comfortable): كيف تصف درجة الحرارة داخل المكتب في الشتاء؟ (مع اعتبار 1 غير مريح للغاية و 5 مريح للغاية)				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
14. I think the way I dress can affect my thermal comfort: (with 1 being strongly disagree to 5 being strongly agree): أعتقد أن الطريقة التي أرتدي بها ملابسني يمكن أن تؤثر على راحة درجة الحرارة: (مع اعتبار 1 لا أوافق بشدة و 5 موافق بشدة)				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
15. How do you usually adjust your indoor temperature in the office? (you can choose more than one answer) كيف تقوم عادة بضبط درجة الحرارة في المكتب؟ (يمكنك اختيار أكثر من إجابة واحدة)				
☐ Change your clothing style/material تغيير نمط/ نوع الملابس الخاصة بك		☐ Adjust the thermostat ضبط منظم الحرارة		☐ Sit next to the daylight الجلوس بجانب ضوء النهار
☐ Open or close the window shade فتح أو غلق الستارة		☐ Open or close the window فتح أو غلق النافذة		☐ Accept the current indoor temperature without changing it تقبل درجة الحرارة الحالية دون تغييرها
IEQ. control				
16. How much control do you have over the following aspects of the office? (with 1 being no control at all and 5 being complete control): ما مقدار التحكم الذي تتمتع به على الجوانب التالية في المكتب؟ (مع اعتبار 1 بلا تحكم على الإطلاق و 5 هو تحكم كامل)				
Indoor temperature درجة الحرارة				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Indoor air quality (ventilation) جودة الهواء الداخلي (التهوية)				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

Natural lighting الاضاءة الطبيعية				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Electric lighting الاضاءة الكهربائية				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Acoustics الصوتيات				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
17. My coworker accepts sharing the control over the following aspects: (with 1 being strongly not accept to 5 being strongly accept): يقبل زميلي في العمل مشاركة: التحكم في الجوانب التالية: (مع اعتبار 1 عدم تقبل بشدة و 5 تقبل بشدة)				
Thermostat settings اعدادات منظم الحرارة				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Opening and closing the windows فتح أو غلق النوافذ				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Electrical lighting الاضاءة الكهربائية				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
Opening and closing blinds and shades فتح أو غلق الستائر				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
18. Number of people sharing the control over the following aspects: عدد الأشخاص الذين يتشاركون التحكم في الجوانب التالية:				
Thermostat settings اعدادات منظم الحرارة				
☐ No access to control لا توجد وسيلة للتحكم (1)	☐ Only me أنا فقط (2)	☐ Sharing control with one other coworker تقاسم التحكم مع زميل واحد في العمل (3)	☐ Sharing control with Two coworkers تقاسم التحكم مع زميلين في العمل (4)	☐ Sharing control with Three or more coworkers تقاسم التحكم مع ثلاث زملاء أو أكثر (5)

فتح أو غلق النوافذ Opening and closing the windows				
☐ No access to control لا توجد وسيلة للتحكم (1)	☐ Only me أنا فقط (2)	☐ Sharing control with one other coworker تقاسم التحكم مع زميل واحد في العمل (3)	☐ Sharing control with Two coworkers تقاسم التحكم مع زميلين في العمل (4)	☐ Sharing control with Three or more coworkers تقاسم التحكم مع ثلاث زملاء أو أكثر (5)
مفاتيح الأضواء Lights switches				
☐ No access to control لا توجد وسيلة للتحكم (1)	☐ Only me أنا فقط (2)	☐ Sharing control with one other coworker تقاسم التحكم مع زميل واحد في العمل (3)	☐ Sharing control with Two coworkers تقاسم التحكم مع زميلين في العمل (4)	☐ Sharing control with Three or more coworkers تقاسم التحكم مع ثلاث زملاء أو أكثر (5)
فتح أو غلق النوافذ Opening and closing blinds and shades				
☐ No access to control لا توجد وسيلة للتحكم (1)	☐ Only me أنا فقط (2)	☐ Sharing control with one other coworker تقاسم التحكم مع زميل واحد في العمل (3)	☐ Sharing control with Two coworkers تقاسم التحكم مع زميلين في العمل (4)	☐ Sharing control with Three or more coworkers تقاسم التحكم مع ثلاث زملاء أو أكثر (5)
Measures of conformity intentions and social-psychological variables				
19. Are you sharing the office with another gender? هل تشارك المكتب مع جنس آخر؟				
☐ Yes نعم		☐ No لا		
20. I can freely speak about my indoor environment quality with my colleagues regardless the gender: (with 1 being strongly disagree to 5 being strongly agree) يمكنني التحدث بحرية عن جودة بيئتي الداخلية مع زملائي بغض النظر عن جنسهم: (مع اعتبار 1: لا أوافق بشدة و 5 موافق بشدة)				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
21. Sharing the office with other gender affect my indoor environment comfort within the space: (with 1 being strongly disagree to 5 being strongly				

تؤثر مشاركة المكتب مع الجنس الآخر على راحة بيئتي الداخلية داخل المكتب: (مع اعتبار 1 لا agree): يؤثر بشدة و 5 يؤثر بشدة)				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
22. Setting closely to my colleague can affect my indoor environment comfort. (with 1 being strongly disagree to 5 being strongly agree): الجلوس عن قرب شديد من زميلي يمكن أن يؤثر على راحة بيئتي الداخلية: (مع اعتبار 1 لا يؤثر بشدة و 5 يؤثر بشدة)				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
23. Working in a mixed environment (Including male & female) can disturb my indoor environment comfort. (with 1 being strongly disagree to 5 being strongly agree): العمل في بيئة مختلطة (بما في ذلك الذكور والإناث) يمكن أن يزعج راحة بيئتي الداخلية: (مع اعتبار 1 لا أوافق بشدة و 5 أوافق بشدة)				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
24. I am able to express my feeling toward my indoor environment comfort. (with 1 being strongly disagree to 5 being strongly agree): أنا قادر على التعبير عن شعوري تجاه البيئة الداخلية المريحة الخاصة بي. (مع اعتبار 1 لا أوافق بشدة و 5 موافق بشدة)				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
25. Inside the office, the opinion of the majority regarding the indoor environment is what matters; the minority opinion does not matter: (with 1 being strongly disagree to 5 being strongly agree): داخل المكتب ، رأي الأغلبية فيما يتعلق بالبيئة الداخلية هو: (مع اعتبار 1 لا أوافق بشدة و 5 موافق بشدة) ما يهم ؛ رأي الأقلية غير مهم:				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
26. Communicating with the same gender regarding the indoor environment is more effortless than the other gender: (with 1 being strongly disagree to 5 being strongly agree): التواصل مع نفس الجنس فيما يتعلق بالبيئة الداخلية أسهل من الجنس الآخر: (مع اعتبار 1 لا أوافق بشدة و 5 موافق بشدة)				
☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

This chapter discussed the methods for gathering data about occupants for testing hypotheses. The context, sample, instrument, and method for collecting data were all described. This chapter examined the survey methodology used in this study to assess the effects of indoor environmental quality (IEQ) in Bahrain office buildings. The acquired data allowed the researcher to address crucial research issues. The data findings are to be explained in Chapter 4: Data Analysis, Discussion, and Results.

Chapter Four: Data Analysis, Discussion & Findings

4. Chapter Four: Data Analysis, Discussion & Findings

4.1 Introduction

This chapter demonstrates the study's findings from factor analysis and descriptive analysis based on collected data. The factor analysis findings indicate factors connected to IEQ comfort criteria. In contrast, the findings of the descriptive analysis evaluate a hypothesized model that indicates links between work comfort and satisfaction with IEQ factors, contentment with the overall building, overall comfort outcomes, and social-psychological factors, as well as implies a good-fit model.

Furthermore, the research begins with a summary of the descriptive statistics gathered from the study. A series of variance analyses were employed to analyze IEQ comfort beliefs across building status, workplace context, and demographic characteristics in Bahrain.

Understanding the indoor office environment and its impact on occupants' comfort is crucial. This chapter include the analysis of the data that has been gathered in order to fulfill the following objectives:

1. Evaluate the acceptance of the quality of the indoor environment.
2. Analyze the factors that contribute to people's dissatisfaction with their indoor office environment
3. Investigate complicated aspects of IEQ and link them to user comfort.
4. Examine occupants' demands for a more comfortable office indoor environment and the link between IEQ and workplace comfort.
5. Study the role of personal control in IEQ and its link to occupant comfort.
6. Understand the effect of local beliefs and social elements on workers' comfort and behavior in office buildings in Bahrain.

4.2 Section 1: General/ Demographic

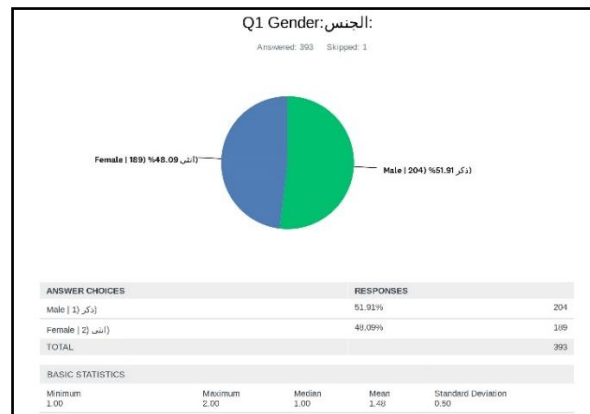


Figure 5: Question 1

This section will present the general demographics of the survey population. The first question of the survey was concerned with gender; refer to figure 5. The data collected shows that 48.09% of the participants were females, while 51.91% of them were males. Thus, the difference between the presentation of both genders is minor as the percentage difference is limited to 3.82%.

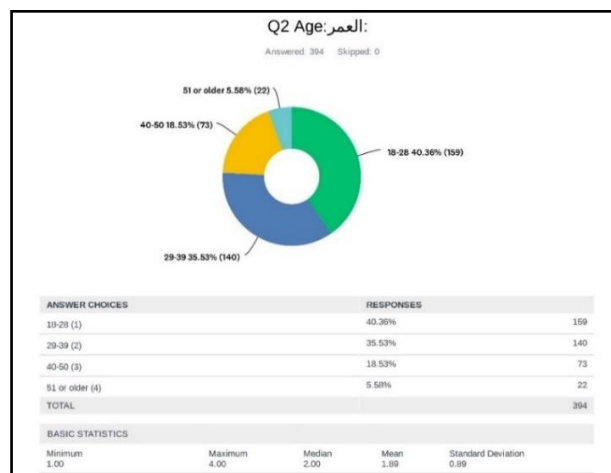


Figure 6: Question 2

The second question was about age. Refer to figure 6. The age category of each gender is discussed separately.

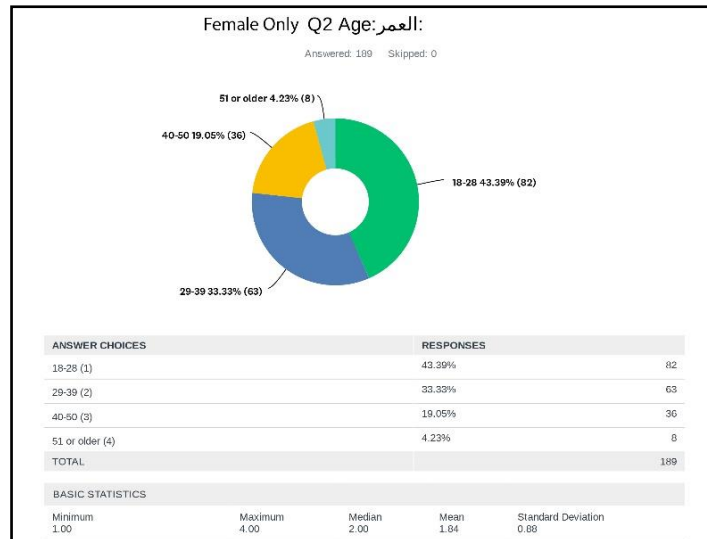


Figure 7: Question 2 Female only

As for the female participants, 43.39% of them were in age between 18 and 28, 33.33% were between 29 and 39, 19.05% were between 40 and 50 years old, and finally, 4.23% were 51 years old or older (figure 7).

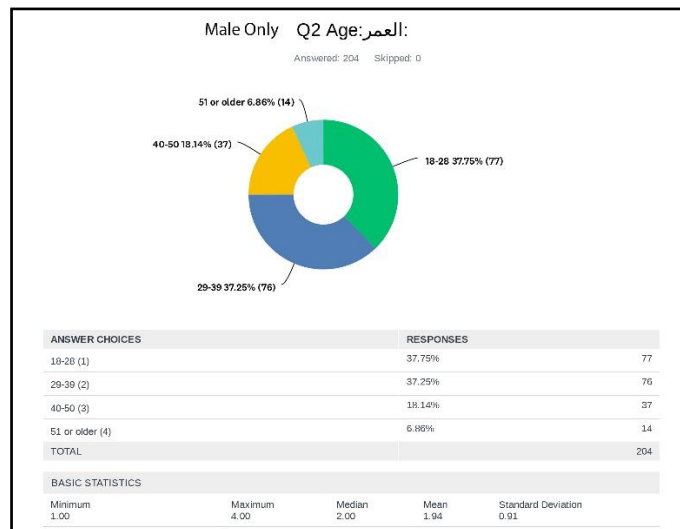


Figure 8: Question 2 Male only

On the other hand, 37.75% of the male population was between 18 and 28, 37.25% were between 29 and 39, 18.14% were between 40 and 50 years old, and 6.86% were 51 years old or older (figure 8).

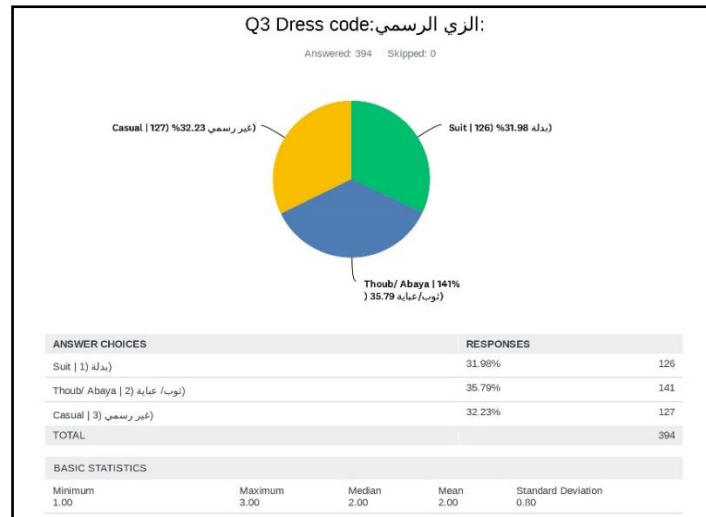


Figure 9: Question 3

Question three was about the dress code, and it is also discussed for both genders separately. The overall answers for both genders combined, that the percentage of the three answers were close. 31.98% of the participants were wearing suits, 35.79% were wearing thoub or abaya, and 32.23% were wearing casual (figure 9).

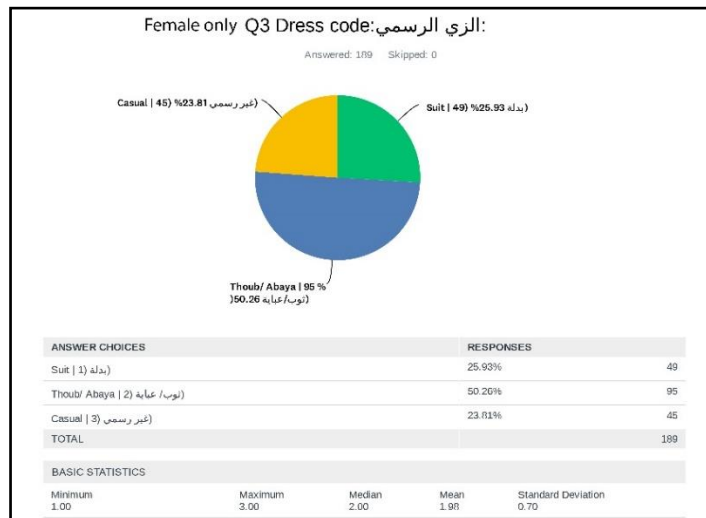


Figure 10: Question 3 Female only

However, female-only statistics show a different trend from the general. The statistics show that 50.26% of the female participants, which is approximately half of the female population, wore the abaya, while the other half was divided among suits and casual, with 25.93% of the participants wearing suits and 23.81% casual (figure 10).

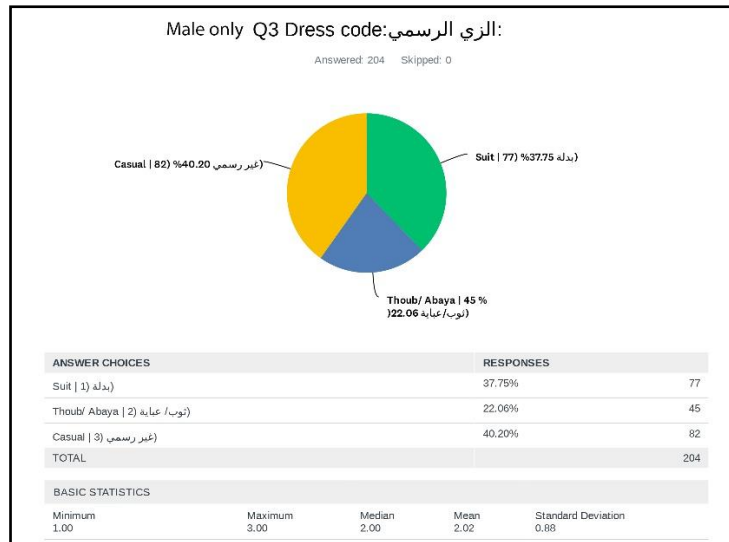


Figure 11: Question 3 male only

Male statistics also show the difference in trend. 22.06% of the males were wearing thoub, 37.75% suits, and 40.2% of them were wearing casuals (figure 11).



Figure 12: Question 5

In question 5, the participants were asked about the number of years of experience (see figure 12). For both genders combined, the statistics show that 22.84% of the survey population has experience of less than one year, 17.51% with experience between 1 and 2 years, 17.26% between 3 and 4 years, and finally 42.39% have experience of than four years (figure 12).

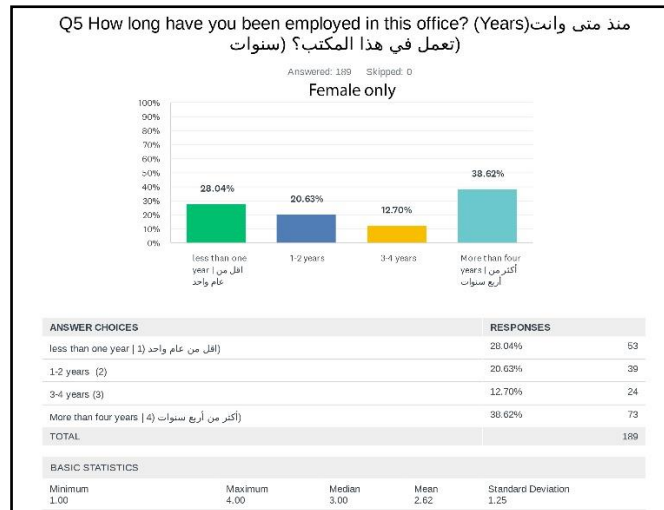


Figure 13: Question 5 Female only

Female statistics are similar numbers to general statistics. 28.04% of female participants have working experience of less than one year, 20.63% of them are with experience between 1 and 2 years, 12.7% between 3 and 4 years, and 38.62% of participants have experience of more than four years (figure 13).

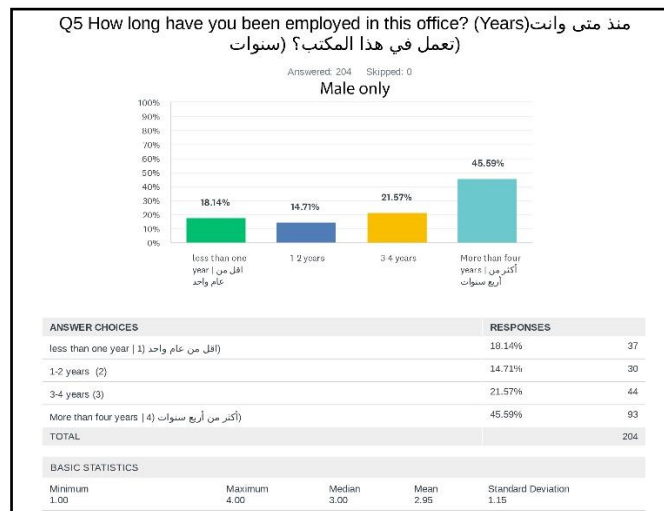


Figure 14: Question 5 Male only

As for males (see figure 14), the statistics are also similar to the general trend of the whole population. Statistics show that 18.14% were employed for less than one year, 14.71% of the participants were employed from 1 to 2 years ago, 21.57% from 3 to 4 years, and 45.59% from more than four years ago.

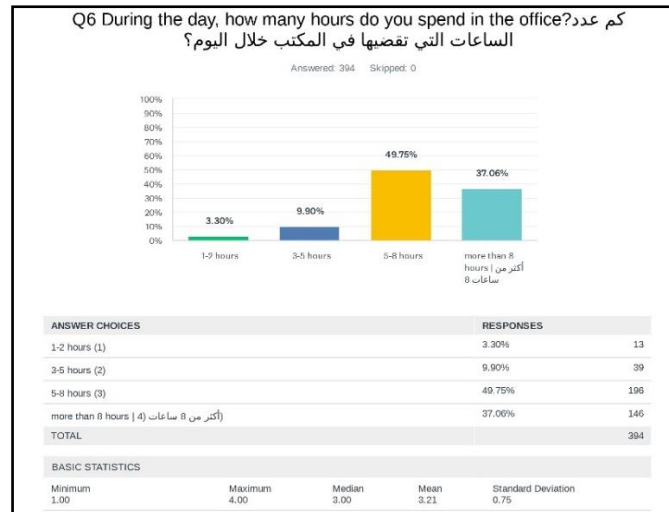


Figure 15: Question 6

Question 6 was about working hours and the number of time workers spends at their offices. The answers show that only 3.3% of employees spend 1 to 2 hours in the office. Moreover, 9.9% spend 3 to 5 hours while 49.75% and 37.06% spend 5 to 8 hours and more than 8 hours in their offices, respectively, see figure 15.

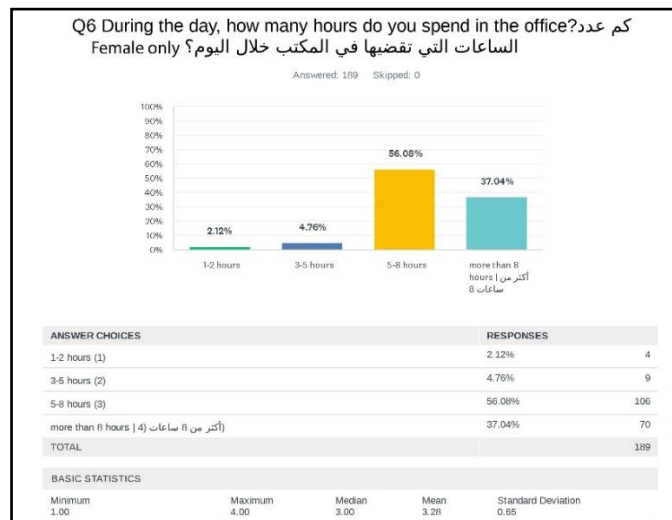


Figure 16: Question 6 Female only

The answers based on gender show that 2.12% of females workers work between 1 to 2 hours, 4.76% work for three to 5 hours in the office, 56.08% of female employees work between 5 to 8 hours, and 37.04% work for more than 8 hours. These percentages show a similar trend to the population in general.

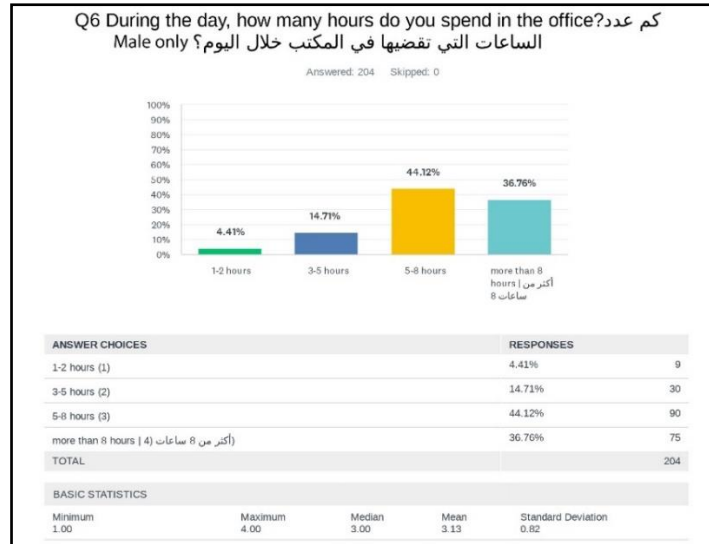


Figure 17: Question 6 Male only

On the other hand, 4.41% of male participants spend between 1 to 2 hours in their offices, and 14.12% spend 3 to 5 hours. While 44.12% and 36.76 spend between 5 to 8 hours and more than 8 hours in their offices, respectively (figure 17).

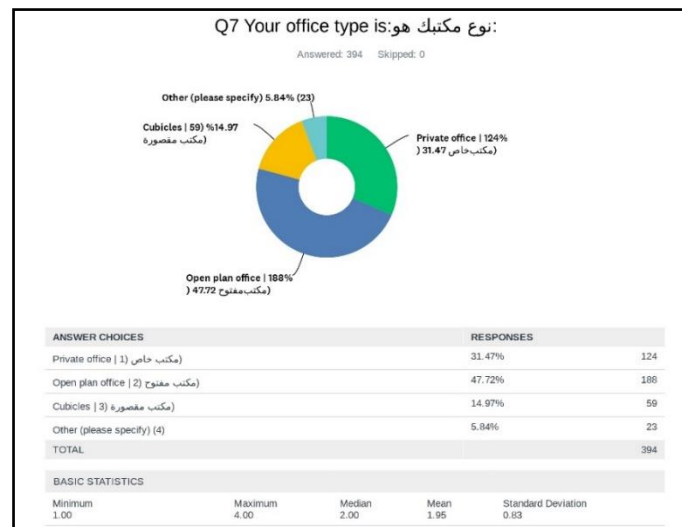


Figure 18: Question 7

As for the population type of office, this was investigated through question 7 in the survey. The answers show that nearly half of the participants work in an open-plan office, with a percentage of 47.72%. 31.47% work in private offices, while 14.97% work in cubicles, and 5.84% work in other types of offices (figure 18).

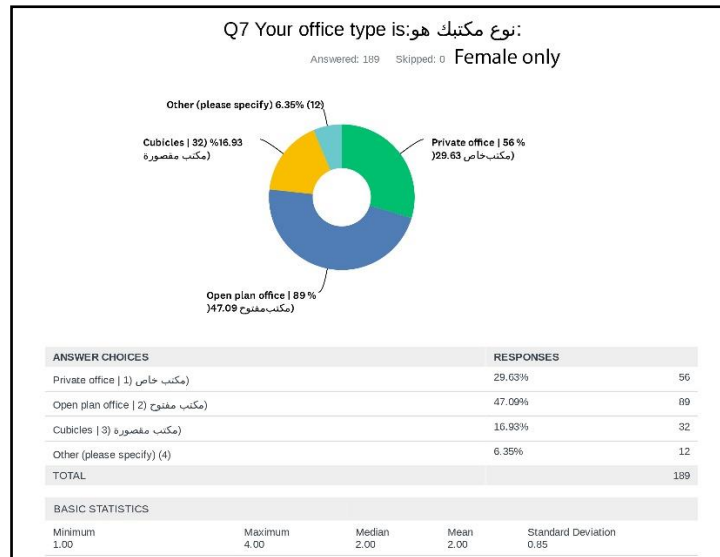


Figure 19: Question 7 Female only

Question 7 answers based on gender show similarity to the overall population, as 47.09% of the participants work in an open-plan office. 29.63% work in private offices, while 16.93% work in cubicles, and 6.35% have other types of offices (figure 19).

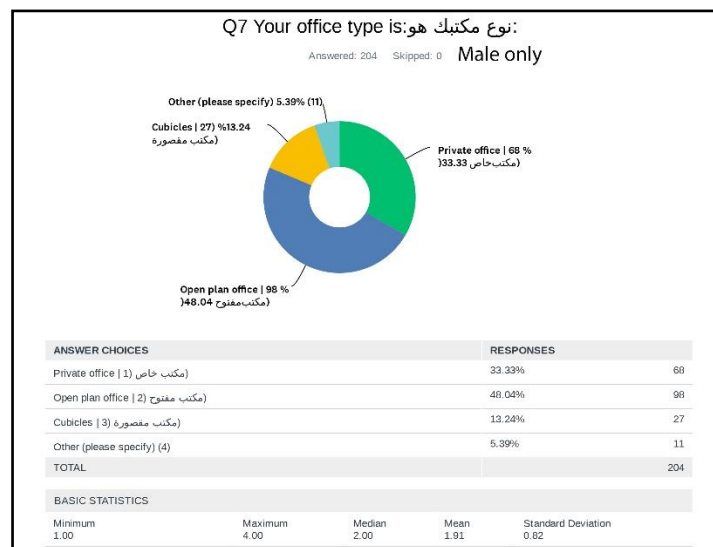


Figure 20: Question 7 Male only

As for males, the same trend is noticed. 48.04% of male participants work in shows that in open-plan offices. 33.33% work in private offices, while 13.24% work in cubicles and 5.39% in other types of offices (figure 20).

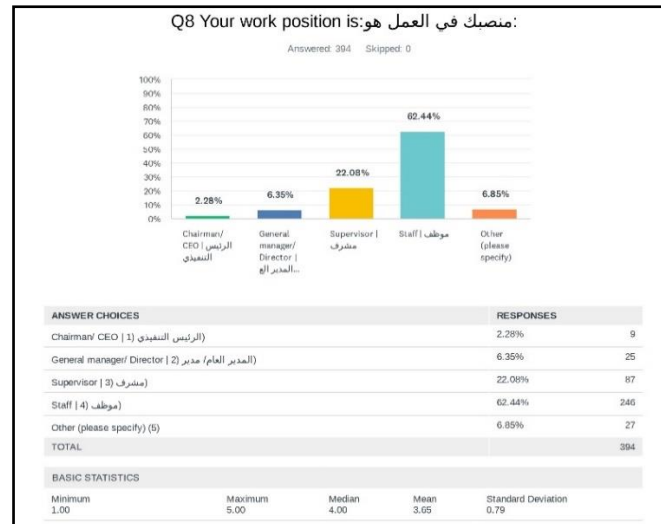


Figure 21: Question 8

Question 8 was to investigate the current work position. 62.44% of the overall participants work as standard employees, 22.08% work as supervisors, 6.35% are general managers or directors, and 2.28% work as chairmen or chief executive officers (CEOs). As for the 6.85% left, these participants fulfill other work positions.

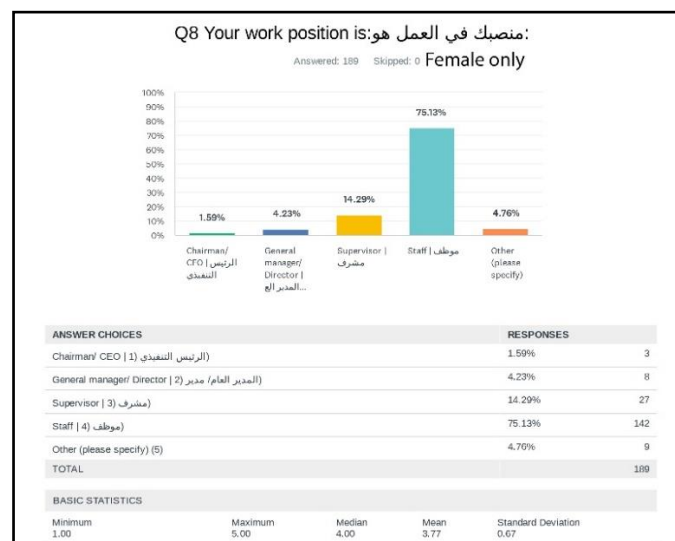


Figure 22: Question 8 Female only

Question 8 female statistics show that 75.13% work as a standard employee, 14.29% as supervisors, 4.23% as general managers or directors, and 1.59% as chairmen or CEOs. 4.76% of the participants fulfill other positions, see figure 22.

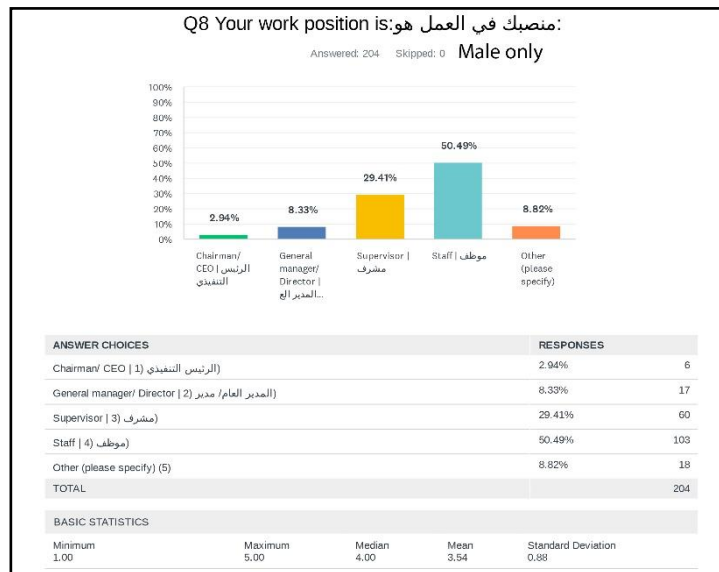


Figure 23: Question 8 Male only

On the other hand, male statistics related to question 8 show that 50.49% of male participants are standard employees, 29.41% are supervisors, 8.33% are general managers or directors, and 2.94% are chairmen or CEOs. Finally, 8.82% of the male participants have other positions at work (figure 23).

Table 3 summarizes the answers to the eight questions of the survey. As for the table, the first column shows the row number, the second column shows the question number, and the third column is about the choices of the question. Then the 4th column is about the percentage of the general answers. The fifth and sixth columns are for the percentage of each answer in terms of gender. Column five is dedicated to females, while six is for males. Lastly, the seventh column is about the variant between male and female answers.

Although for most of the questions, the variant was slight as the difference between male and female percentages was small. For some of the questions, the variant was more than 10%. For this situation, the cells are highlighted in yellow in table3. For variance of more than 15%, the cells are highlighted in red in table3.

Table 3: Comparison between General, males, and females from section one of the questionnaire (General/ demographics):

Question No.	Choices	General	Female	Male	Variant
01	Question 1:	Male	100%	-	51.91%
02	Gender	Female	100%	48.09%	-

03	Question 2:	18-28	40.36%	43.39%	37.75%	5.64%
04	Age	29-39	35.53%	33.33%	37.25%	-3.95%
05		40-50	18.53%	19.05%	18.14%	0.91%
06		51 or older	5.58%	4.23%	6.86%	-2.63%
07	Question 3:	Suit	31.98%	25.93%	37.75%	-11.82%
08	Dress code	Thob/ Abaya	35.79%	50.26%	22.06%	28.2%
09		Casual	32.32%	23.81%	40.20%	-16.39%
10	Question 4:	Government sector	27.01%	32.37%	21.48%	10.89%
11	In which sector do you work	Private sector	59.12%	53.24%	65.19%	-11.95%
12		Semi-Government sector	13.87%	14.39%	13.33%	1.06%
13	Question 5:	Less than one year	22.84%	29.04%	18.14%	10.9%
14	How long have you been employed in this office?	1-2 years	17.51%	20.63%	14.71%	5.92%
15		3-4 years	17.26%	12.70%	21.57%	-8.87%
16		More than four years	42.39%	38.62%	45.59%	-6.97%
17	Question 6:	1-2 hours	3.30%	2.12%	4.41%	-2.29%
18	During the day, how many hours do you spend in the office	3-5 hours	9.90%	4.76%	14.71%	-9.95%
19		5-8 hours	49.75%	56.08%	44.12%	11.93%
20		More than 8 hours	37.06%	37.04%	36.76%	0.28%
21	Question 7:	Private office	31.47%	29.63%	33.33%	-3.7%
22	Your office type is	Open plan office	47.72%	47.09%	48.04%	-0.95%
23		Cubicles	14.97%	16.93%	13.24%	3.69%
24		Other	5.84%	6.35%	5.39%	0.96%
25	Question 8:	Chairman/ CEO	2.28%	1.59%	2.94%	-1.35%
26	Your work position is	General manager/ director	6.35%	4.23%	8.33%	-4.1%
27		Supervisor	22.08%	14.29%	29.41%	-15.12%
28		Staff	62.44%	75.13%	50.49%	-24.64%
29		Other	6.85%	4.76%	8.82%	-4.06%

4.3 Section 2: The office overall

This section will compare the result of section two with overall statistics.

4.3.1 Question 9: Does the office meet your comfort needs in general? (with one being not meet at all to 5 being highly meet):

The previous section discussed the general population at first, then the statistics for both genders. In this section, the discussion will be based on gender, starting with females only and then males, and then by comparing the numbers of both.

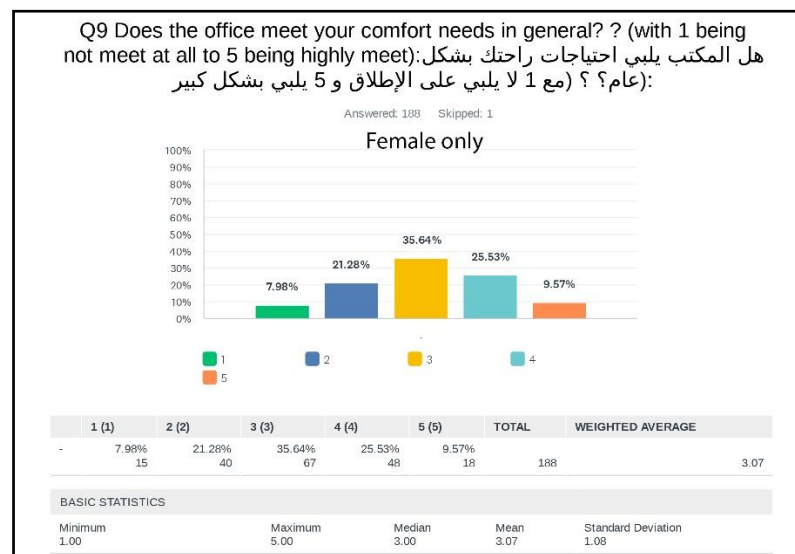


Figure 24: Question 9 Female only

Figure 24 shows the results of the overall comfort level of female participants. It shows that 35.64% of the responses were directed for 3 out of 5, which is the average rating. The figure indicates that the general comfort level of the workers who participated in the study does not adequately satisfy them, and it does not fulfill the entire degree of comfort. Their satisfaction falls somewhere in the middle of the scale. 7.98% of participants said that their workplace was not comfortable at all and 21.28% of them regarded their workplace as uncomfortable but not highly uncomfortable.

The statistics show that 29.26% of the female population ranked their degree of comfort in their offices as 1 or 2 out of 5. This number concede as high, indicating that enhancements should be made to the employee's work environment, and an understanding of their discomfort reasons should be developed in order to improve their working environment. On the other hand, 25.53% of the participants rated their comfort level at their offices as 4 out

of 5 (highly meet), which is relevantly satisfactory. Moreover, 9.57% rated their office comfort as excellent (i.e., 5 out of 5).

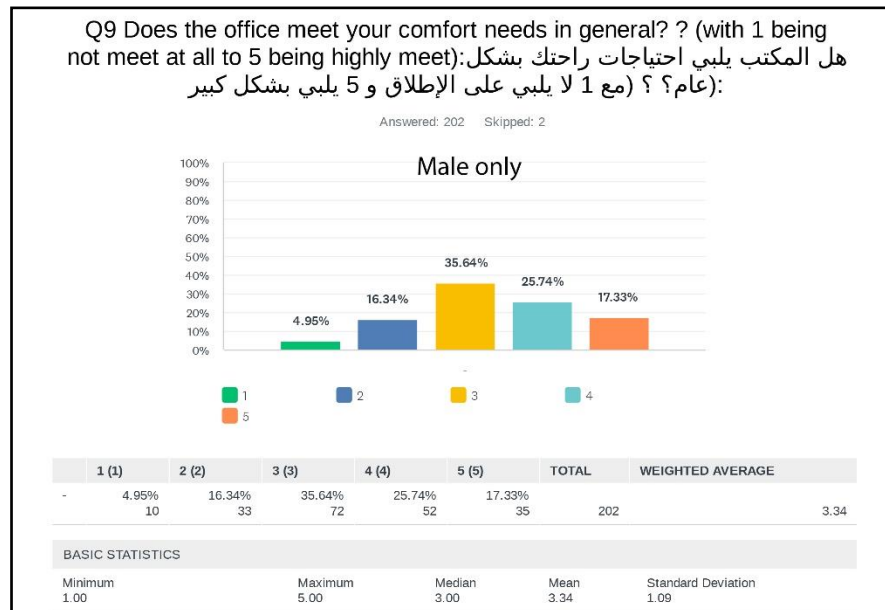


Figure 25: Question 9 Male only

Figure 25 shows the overall comfort level for males. It indicates that 35.64% of males believe that their comfort level is average, rating it 3 out of 5 ratings. The figure indicates that the general comfort level of the office does adequately satisfy the employees who participated in the survey as the percentages are more to the right of the average. However, it doesn't satisfy 21.29% of the population, which is nearly a quarter. Out of this 21.29%, 4.95% of employees said their workplace was not comfortable at all and ranked it by 1 out of 5, and 16.34% ranked it as uncomfortable but not highly uncomfortable with a rating of 2 out of 5. The percentage of 21.29% for discomfort is considered high, and the reasons behind that should be investigated to enhance the environment for these employees.

On the other hand, 25.74% of the male participants rated their comfort level at their offices as 4 out of 5, which is highly met and relevantly satisfactory. In addition, 17.33% rated their office comfort as excellent by rating it 5 out of 5.

Table 4: Comparison between General, males, and females of question 9.

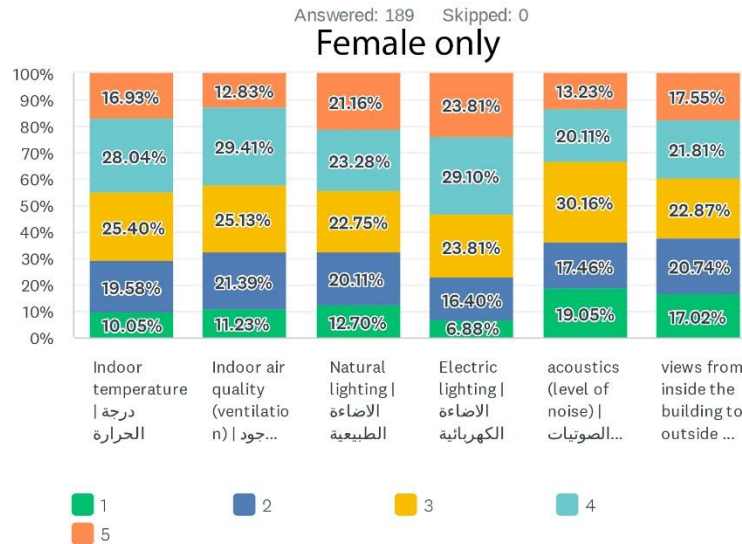
	Question No.	Choices	General	Female	Male	Variant
01	Question 9:	1	6.39%	7.98%	4.95%	3.02%
02	(1 being not	2	18.67%	21.28%	16.34%	4.94%
03	meet at all to	3	35.81%	35.64%	35.64%	0%
04	5 being highly	4	25.58%	25.53%	25.74%	-0.21%
05	meet)	5	13.55%	9.57%	17.33%	-7.76%

The responses to question 9 are summarized in table 4. It shows that the female rating level of discomfort was higher than the male. The average rating (i.e., 3 out of 5) was precisely the same percentage. 7.98% of females rated their comfort level inside their office as 1 out of 5, which is not meet at all, while only 4.95% of males gave the same ranking, for the rate of 2 out of 4, which is also an indication of discomfort, 21.28% of females ranked their comfort level as 2, and 16.34% of males did so. In both choices, the female percentage was higher of being uncomfortable than males.

In contrast, males show more levels of satisfaction when compared to females. 35.1% of female participants rated their office overall comfort level as 4 and 5 (highly meet). At the same time, 43.07% of male users rated their comfort level as 4 and 5 (highly meet). Males show more satisfaction levels than females.

4.3.2 Question 10: How would you rank your overall comfort in these following aspects? (with 1 being very uncomfortable to 5 being very comfortable)

Q10 How would you rank your overall comfort of these following aspects?:
(with 1 being very uncomfortable to 5 being very comfortable): كيف تقيم راحتك العامة من هذه الجوانب التالية ؟ (مع اعتبار 1 غير مريح للغاية و 5 مريح للغاية):



	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	TOTAL	WEIGHTED AVERAGE
Indoor temperature درجة الحرارة	10.05% 19	19.58% 37	25.40% 48	28.04% 53	16.93% 32	189	3.22
Indoor air quality (ventilation) جودة الهواء الداخلي ((تهوية))	11.23% 21	21.39% 40	25.13% 47	29.41% 55	12.83% 24	187	3.11
Natural lighting الاضاءة الطبيعية	12.70% 24	20.11% 38	22.75% 43	23.28% 44	21.16% 40	189	3.20
Electric lighting الاضاءة الكهربائية	6.88% 13	16.40% 31	23.81% 45	29.10% 55	23.81% 45	189	3.47
acoustics (level of noise) الصوتيات (مستوى الضوضاء)	19.05% 36	17.46% 33	30.16% 57	20.11% 38	13.23% 25	189	2.91
views from inside the building to outside المنظر من داخل المبنى الى خارجه	17.02% 32	20.74% 39	22.87% 43	21.81% 41	17.55% 33	188	3.02

Figure 26: Question 10 Female only

Looking at the female statistics for question 10 in figure 26, starting with Indoor temperature, 28.04% of employees assessed their indoor temperature as comfortable. Furthermore, 16.93% of employees rated their indoor temperature comfort as extremely good. 44.97% of users believe that their indoor temperature is generally reasonably pleasant.

26.97% of responses which is around a quarter of the occupants, rated their Indoor temperature comfort as 3 out of 5 (average). For them, their comfort toward indoor office temperature is in the middle, not very satisfying and not unsatisfying as well. In contrast, 16.28% rated their indoor temperature as not comfortable, and 8.65% rated their indoor

temperature as not comfortable at all. Thus, 24.93% of the occupants, almost a quarter, think that their indoor temperature is not satisfactory.

Around a quarter of the participants, or 25.4%, assessed their indoor temperature comfort as 3 out of 5 (average), which is in the center, not satisfying indoor temperature, and not unsatisfying. In comparison, 19.58 % found their indoor temperature pretty uncomfortable, and 10.08% found it entirely uncomfortably. 29.66 % of occupants, or almost a quarter, believe that their indoor temperature is unsatisfactory.

For indoor air quality, 29.41% of employees rated their comfort level as 4 out of 5, which is satisfactory. In addition, 12.83% of the occupants rated their indoor air quality as five, which means very comfortable and satisfying. Summing both, 42.24% think that their Indoor air quality is comfortable. 25.13% of the participants think that the air quality is average and rated it as 3 out of 5. On the other hand, 21.39% of the participants rated their indoor air quality as 2 out of 5, which is not comfortable, and 11.23% think that the indoor air quality is not comfortable at all. Thus, 32.62% of the participants think that their indoor air quality is not comfortable.

As for the participants' natural lighting comfort levels, 23.28 % evaluated their comfort level as 4 out of 5 (comfortable), indicating that they were relatively comfortable. Furthermore, 21.16 % believe that natural lighting is highly comfortable and rated it as 5 out of 5. 44.44% of the responses show that natural lighting comfort is highly satisfactory and comfortable for the employees in their indoor offices. Natural lighting was evaluated 3 out of 5 (average) by 22.75 % of the participants, which falls halfway between not very comfortable and not at all uncomfortable.

On the other hand, 20.11 % of the occupants judged natural lighting comfort as unsatisfactory and rated it 2 out of 5. Finally, 12.7% of the occupants said the natural lighting was not at all comfortable and rated it as 1 out of 5. This implies that 32.81% of respondents, which is more than a quarter of the female population, evaluated their natural lighting as uncomfortable.

The electrical lighting section has the highest comfort levels among all the other aspects. The electrical lighting was assessed as comfortable by 29.1 % of the occupants, and 23.81 % believe their electrical lighting is highly comfortable. More than half of the occupants, 52.91 %, assessed their electrical lighting as comfortable. Whereas 16.4 % of

occupants thought it was uncomfortable, and 6.88% of occupants rated their comfort level as not very much. In general, 23.28% of users believe that electrical lighting is uncomfortable, and 23.81% are in between.

Regarding the acoustics comfort level, 17.47% of occupants find the noise level uncomfortable, and 19.05 % find the acoustic level extremely uncomfortable. More than a quarter of the occupants, 34.12 %, considered the acoustic and noise level uncomfortable. Furthermore, 30.16 % of occupants described the comfort level as medium (i.e., not very comfortable or not very uncomfortable, which is a rating of 3 out of 4). 20.11% of respondents were satisfied with the acoustics' comfort level, and 13.23% were extremely satisfied. The overall acoustic comfort level was 33.34%.

Finally, The views from inside the building to outside comfort level are rated as the most uncomfortable. The highly comfortable level is held by 17.55 % of the occupants, and 21.81% of the occupants ranked it as a 4 out of 5 (comfortable) rating. The average comfort level was the highest, with 22.87% of the occupants. The second-to-last uncomfortable rating is 20.74%, and the very uncomfortable level is 17.02%.

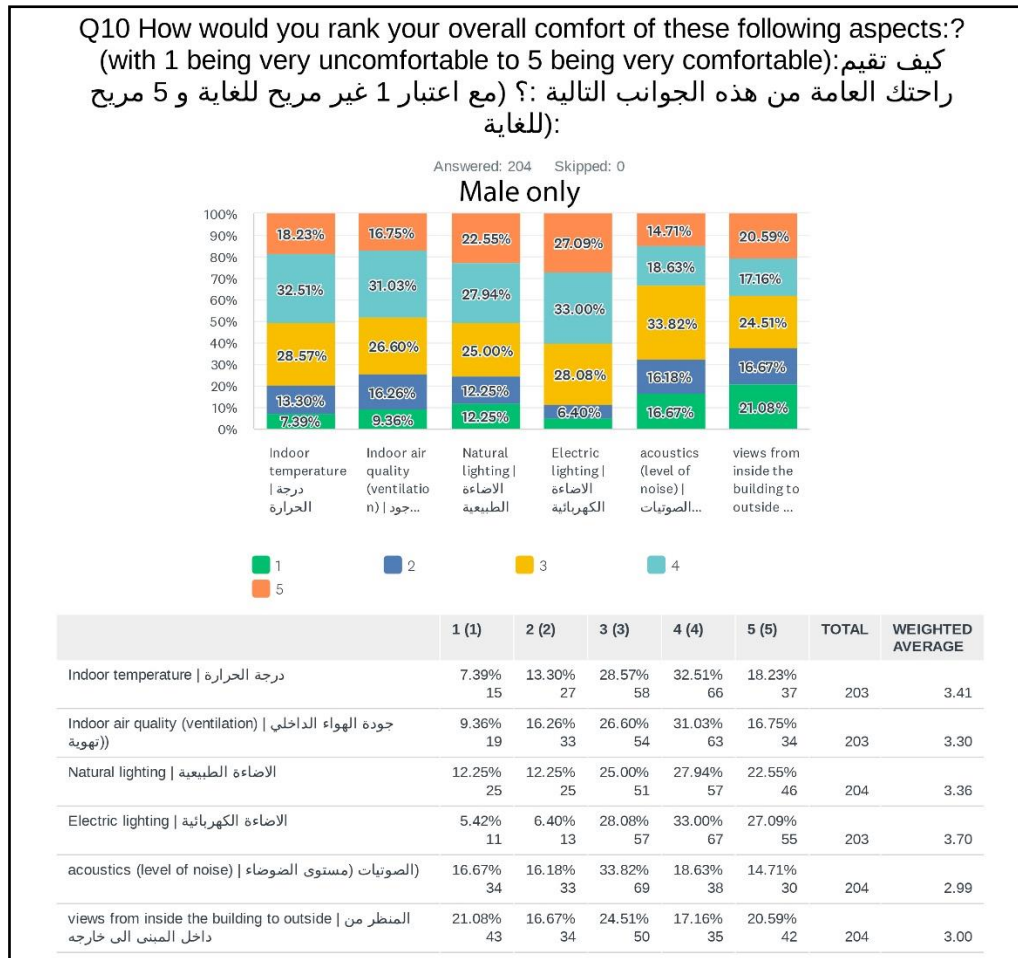


Figure 27: Question 10 Male only

Looking at the male statistics for question 10 in figure 27, starting with office indoor temperature, 32.51% of employees assessed their indoor temperature as comfortable. Furthermore, 18.23% of employees rated their indoor temperature comfort as extremely good. So, 50.74% of users believe that their indoor temperature is generally reasonably pleasant.

A quarter of the occupants, 28.57%, rated their indoor temperature comfort 3 out of 5 (average), which is in the middle, not very satisfying and not unsatisfying as well. In contrast, 13.3% rated their indoor temperature as not comfortable, and 7.39% rated their indoor temperature as not comfortable at all. 20.69% of the occupants, almost a quarter, think that their indoor temperature is not satisfactory.

As for indoor air quality, 31.03% of the employees rated their comfort level as 4 out of 5, which is satisfactory, and 16.75% of the occupants rated their indoor air quality as very comfortable and satisfying (i.e., 5 out of 5). This means that 47.78% of the male population

think that their indoor air quality is comfortable. For responses between comfortable and uncomfortable, 26.6% chose to rate their air quality 3 out of 5. While 16.26% of the occupants rated their indoor air quality as 2 out of 5, which is not comfortable, and 9.36% of the occupants think that the indoor air quality is not comfortable. 25.62% of occupants think that their indoor air quality is not comfortable.

In terms of natural lighting comfort levels, 27.49% of the occupants evaluated their comfort level as 4 out of 5 (very comfortable), indicating that they were relatively comfortable. Furthermore, 22.55% believe that natural lighting is comfortable. 50.04% of the occupants reported that their natural lighting comfort is highly satisfactory and comfortable. Natural lighting was evaluated as 3 out of 5 (average) by 25% of the occupants, which falls halfway between not very comfortable and not at all uncomfortable. On the other hand, 12.25% of the occupants judged natural lighting comfort as unsatisfactory, and the same percentage was for those who were not at all comfortable. This implies that 24.5% of respondents evaluated their natural lighting as uncomfortable.

The electrical lighting section has the highest comfort levels among all the other aspects. The electrical lighting was assessed as comfortable by 33% of the occupants, and 27.09 % believe that their electrical lighting is highly comfortable. More than half of the occupants, 60.09%, assessed their electrical lighting as comfortable. On the contrary, 28.08% of workers assessed their comfort levels with electrical lighting as 3 out of 5 (average), whereas 6.4% of occupants thought it was uncomfortable, and 5.42% of occupants rated their comfort level as not very much. In general, 11.82% of users believe that electrical lighting is uncomfortable.

Regarding the acoustics comfort level, 16.18% of occupants find the noise level uncomfortable, and 16.67% find the acoustic level extremely uncomfortable. More than a quarter of the participants, 32.85%, considered the acoustic and noise levels uncomfortable. Furthermore, 33.82% of occupants described the comfort level as "medium," "not very comfortable," or "not very uncomfortable." Besides, 18.63% of respondents were satisfied with the acoustics level of comfort, while 14.71% were extremely satisfied. The overall acoustic comfort level was 33.34%.

Finally, the views from inside the building to outside comfort levels are rated as the most uncomfortable. The highly comfortable level is held by 20.59% of the occupants, and 17.16% of the occupants ranked it as a 4 out of 5 (comfortable) rating. The average comfort

level was the highest, with 24.51% of the occupants. The second-to-last uncomfortable rating is 16.67%. At last, the very uncomfortable level was 21.08%.

Table 5: Comparison between General, males, and females of question 10.

Question 10: Choices			General	Female	Male	Variant
How would you rank your overall comfort in the following aspects:? (with 1 being very uncomfortable to 5 being very comfortable)						
01	Indoor temperature	1	8.65%	10.05%	7.39%	2.66%
02		2	16.28%	19.58%	13.3%	6.28%
03		3	26.97%	25.4%	28.57%	-3.17%
04		4	30.28%	28.04%	32.51%	-4.47%
05		5	17.81%	16.93%	18.23%	-1.3%
01	Indoor air quality (ventilation)	1	10.23%	11.23%	9.36%	1.87%
02		2	18.67%	21.39%	16.26%	5.13%
03		3	26.09%	25.13%	26.6%	-1.47%
04		4	30.18%	29.41%	31.03%	-1.62%
05		5	14.83%	12.83%	16.75%	-3.92%
01	Natural lighting	1	12.44%	12.7%	12.25%	0.45%
02		2	15.99%	20.11%	12.25%	7.86%
03		3	23.86%	22.75%	25%	-2.25%
04		4	25.89%	23.28%	27.94%	-4.66
05		5	21.83%	21.16%	22.55%	-1.39%
01	Electrical lighting	1	6.11%	6.88%	5.42%	1.46%
02		2	11.2%	16.4%	6.4%	10%
03		3	25.95%	23.81%	28.08%	-4.57%
04		4	31.04%	29.1%	33%	-3.9%
05		5	25.7%	23.81%	27.09%	-3.28%
01	Acoustics (level of noise)	1	17.77%	19.05%	16.67%	2.38%
02		2	17.01%	17.46%	16.18%	1.28
03		3	31.98%	30.16%	33.82%	-3.66%
04		4	19.29%	20.11%	18.63%	1.48
05		5	13.96%	13.23%	14.71%	-1.48%

01	views from	1	19.08%	17.02%	21.08%	-4.06%
02	inside the	2	18.83%	20.74%	16.67%	4.07
03	building to	3	23.66%	22.87%	24.51%	-1.64%
04	outside	4	19.34%	21.81%	17.16%	4.65%
05		5	19.08%	17.55%	20.59%	-3.04%

In every aspect of indoor environment quality, males' satisfaction level was higher than females except for views from inside the building to outside aspect, as it was higher for the females. Moreover, for acoustics satisfaction levels, the percentages were similar for males and females. Refer to table 5.

4.4 Section 3: Thermal comfort and IEQ comfort beliefs

4.4.1 Question 11: I think the following aspects influence my comfort at work:
(with 1 being no influence at all to 5 being highly influenced):

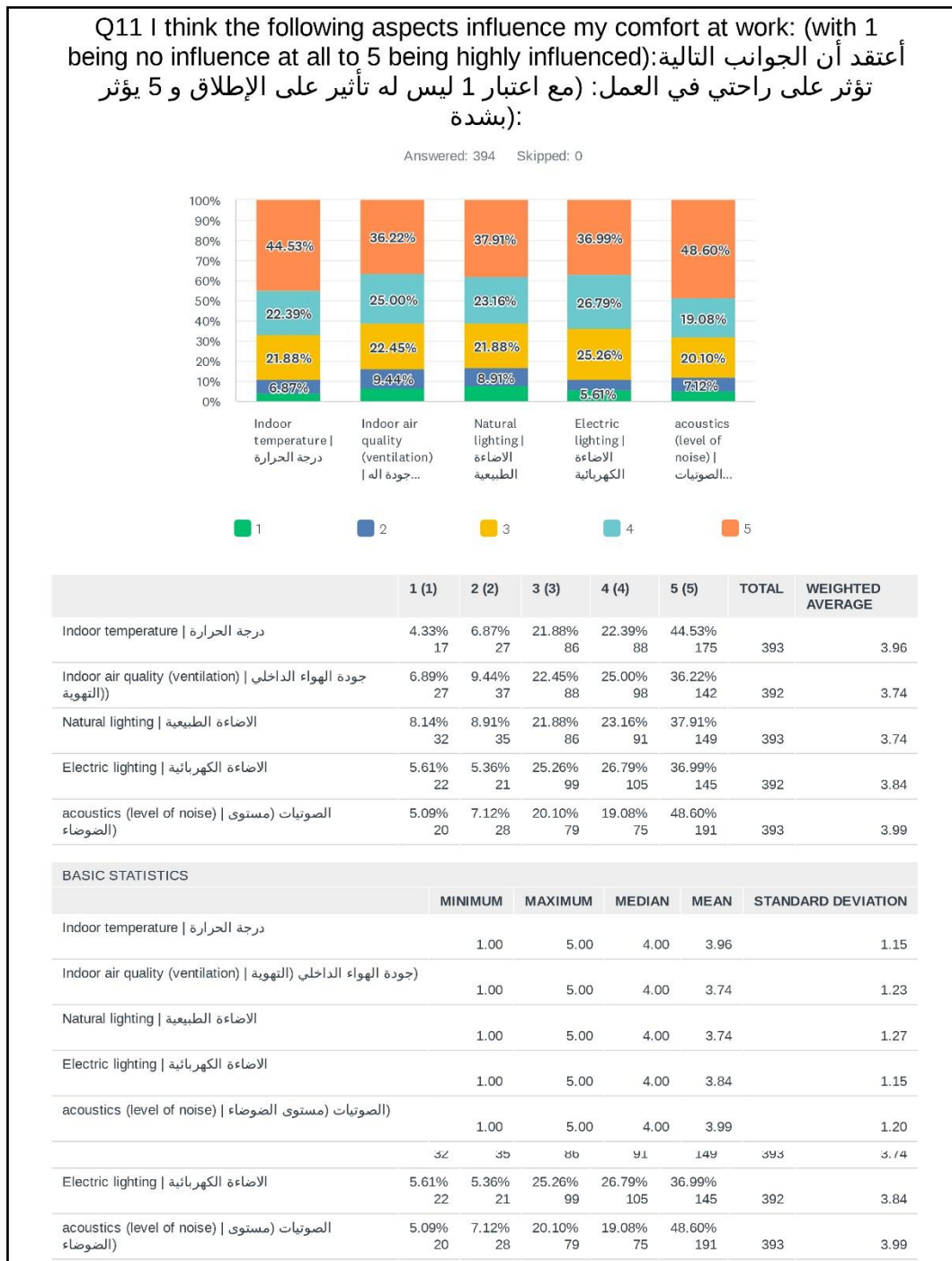


Figure 28: Question 11

Question 11 talks about beliefs about IEQ aspects that influence users' comfort (figure 28). Among all aspects, acoustics (level of noise) was the aspect that ranked the most influenced factor. 48.6% of the participants think that acoustics highly affect their comfort

level. 19.08% have rated the effect of acoustics as 4 out of 5 (influence). Furthermore, 67.68% of users think that acoustics affect their comfort level, more than half.

Summing the percentage of participants who ranked 4 and 5 for the different aspects that they believe affect their indoor temperature comes second in terms of ranking, and electrical lighting as third. Fourth is indoor environmental quality, and lastly comes the natural lighting.

Data shows that females' ratings of 4 and 5 for the different aspects that they believe will affect their indoor environment are higher than those of males. Males tend to rank the aspect with the average by the rate of 3 out of 5.

4.4.2 Question 12: How would you describe the indoor air temperature in the summer? (with 1 being very uncomfortable to 5 being very comfortable):

The percentage of participants who chose 1 out of 5 (i.e., very uncomfortable indoor air temperature) is 11.93% of all participants. Among these, 57.45% were females, and 45.55% were males. Almost all dress types were similar, which might conclude that the dress type might not interfere with satisfaction with indoor temperature. 36.17% were wearing a suit, 34.04% were wearing a thob or abaya, and 29.79% were wearing casual. As for the type of working place, most of the participants worked in an open-plan office, almost half, 46.81%. More than half, 65.96%, are regular employees, while 25.53% were working as supervisors, and 8.51% fulfilled other positions. Refer to Appendix 1 for more information.

Half of the sample who chose that the indoor temperature in summer is very uncomfortable were unsatisfied with their office comfort level. 51.06% of them said that the office does not meet their comfort level. 27.66% ranked it as 3 out of 5 (average).

Interestingly, even though the percentage of the dress code was similar to all options. 57.45% of the users chose the answer that changing their clothing style would help with the indoor temperature comfort level. As expected, almost half of the users did not have control over all aspects. Thus, a bigger percentage of the participants said that they could not share their thoughts about their indoor environment quality with their colleagues. Also, they stated that sharing the office with the opposite gender affects their comfort level.

19.04% of participants ranked their comfort level with indoor temperature as 5 out of 5, which means very comfortable. 56% of them were males, and 44% were females. Males are more satisfied with their indoor temperature than females. Almost all dress types were

similar, which might conclude that the dress type might not interfere with satisfaction with indoor temperature. 32% were wearing a suit, 30.67% were wearing thob or abaya, and 37.33% were wearing casual. Only 12% of the participants were working in cubicles, and it was precisely the same for open-plan offices and private offices. The largest percentage thinks that the office meets their comfort need. Thus, more than half ranked all indoor environment aspects as comfortable. Refer to Appendix 2 for more information.

66.67% of the participants chose to adjust the thermostat as a choice to achieve a more comfortable indoor temperature. Moreover, more than half of them have control over all indoor environment aspects. Almost half of them were sharing the office with the opposite gender. 60% of the users stated that they could freely speak about their indoor environment quality with their colleagues regardless of gender. Finally, the largest percentage thinks that sitting close to a colleague affects their comfort.

4.4.3 Question 13: How would you describe the indoor air temperature in the winter? (with 1 being very uncomfortable to 5 being very comfortable):

The statistics of users who chose **one and two as very uncomfortable** indoor air temperature (24.87% of all participants) show that 40% were females and 60% were males. Almost all dress types were similar, which might conclude that the dress type might not interfere with satisfaction with indoor temperature. 33.33% were wearing a suit, and 33.33% were wearing Thob/Abaya. 33.33% were wearing casual. All participants who chose uncomfortable indoor air temperature in the winter were regular staff, even though none of the participants had no control over indoor temperature.

The statistics of users who chose **four and five as very comfortable** indoor air temperatures (42.89% of all participants) show that 50% were males and 50% were females. Most of them were employed for more than four years. Most of the user was working in cubicles. 42.86% were working in open-plan offices, and 57.14% were in private offices. Most participants considered their overall comfort with indoor environment quality as comfortable.

4.5 Section 4: IEQ control

4.5.1 Question 16: How much control do you have over the following aspects of the office? (with 1 being no control at all and 5 being complete control):

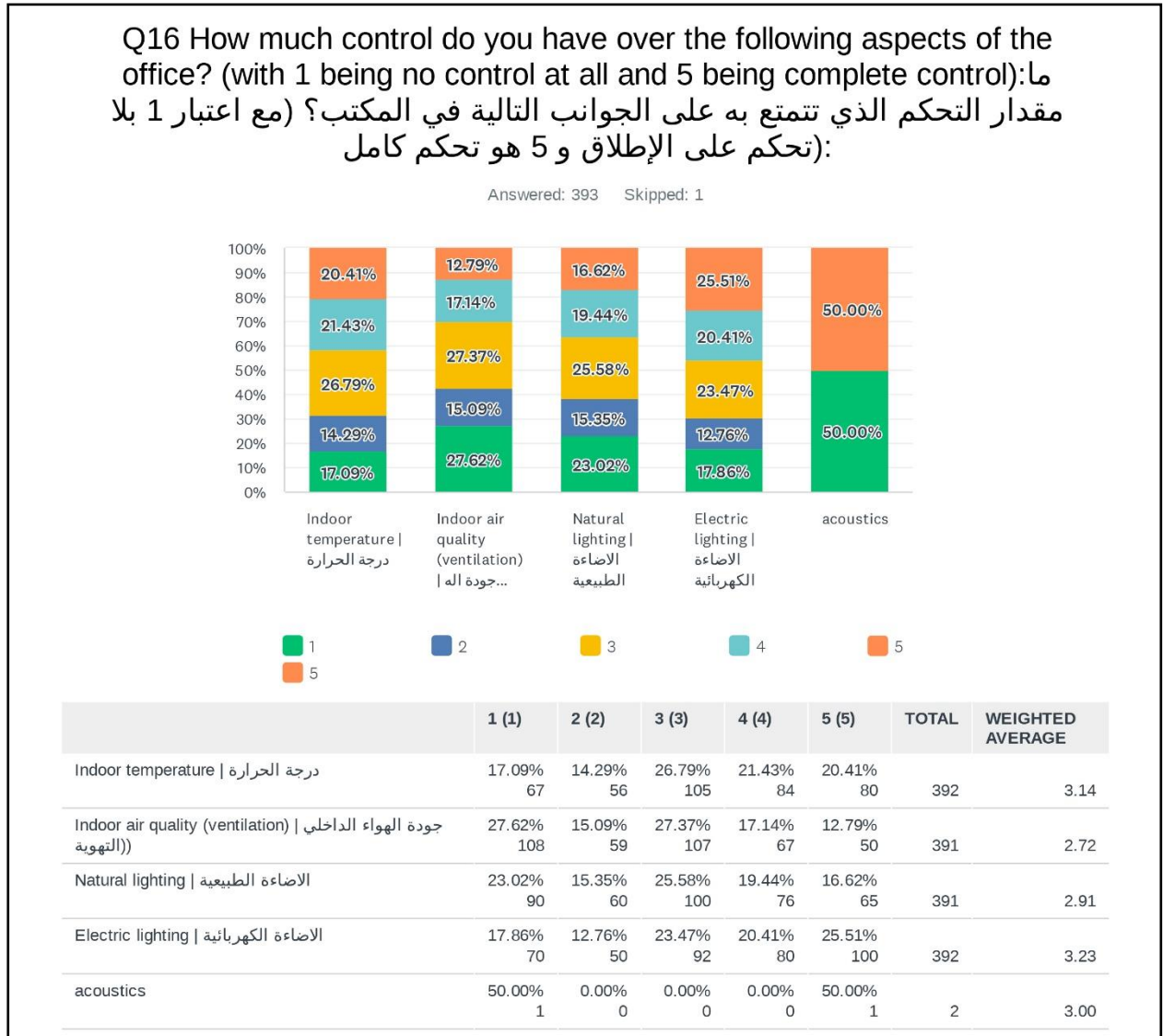


Figure 29: Question 16

4.5.1.1 Indoor temperature:

People who have almost complete control or total control of indoor temperature (i.e., ranked the question with 4 and 5 out of 5) were 54.6% males and 45.4% females. Males again show more dominance and control. 50% worked in the office for more than four years. Users who have control were more satisfied and thought that the office's internal environment met their needs. Moreover, their satisfaction level with indoor environment quality aspects was

high. Also, these participants described the indoor temperature in summer and winter as comfortable.

On the other hand, among those who lack control over the indoor temperature were 55.28% females and 44.72% males. The bigger percentage were working in an open-plan office. Most of them said that the office does not meet their comfort need. Most of the users also described their indoor temperature in winter and summer as not comfortable. 55.74% of the users adjust their indoor temperature by changing their clothing type, and 37.7% accept it as it is without changing (figure 29).

4.5.1.2 Indoor air quality:

People who ranked that they have almost complete control or total control of indoor air quality 4 and 5 out of 5 statistics were as follows: 53.85% were males, and 46.15% were females. Males again show more dominance and control. 41.88% worked in the office for more than four years. Users who have control were satisfied and thought that the office met their needs. Moreover, their satisfaction level with indoor environment quality aspects was high. Also, users described the indoor temperature in summer and winter as comfortable.

Users ranked that they do not have control regarding the indoor air quality statistics: 54.22% were females, and 45.78% were males. The bigger percentage were working in an open-plan office. Most of them said that the office does not meet their comfort need. Most of the users also described their indoor temperature in winter and summer as not comfortable. 51.81% of the users adjust their indoor temperature by changing their clothing type. And 32.53% accept it as it is without changing (figure 29).

4.5.1.3 Natural lighting:

People who ranked that they have almost complete control or total control of natural lighting 4 and 5 out of 5 statistics were as follows: 53.9% were males, and 46.1% were females. Males again show more dominance and control. 48.94% worked in the office for more than four years. Users who have control were satisfied and thought that the office met their needs. Moreover, their satisfaction level with indoor environment quality aspects was high. Also, users described the indoor temperature in summer and winter as comfortable.

Users ranked that they do not have control regarding the indoor air quality statistics: 52.35% were females, and 47.65% were males. The bigger percentage were working in an open-plan office. Most of them said that the office does not meet their comfort need. Most of

the users also described their indoor temperature in winter and summer as not comfortable. Thus, 50.67% of them adjust their indoor environment quality by adjusting the thermostat. 48.67% of the users adjust their indoor temperature by changing their clothing type. And 33.33% accept it as it is without changing (figure 29).

4.5.1.4 Electric lighting:

People who ranked that they have almost complete control or total control of electric lighting 4 and 5 out of 5 statistics were as follows: 55.87% were males, and 44.13% were females. Males again show more dominance and control. 46.67% worked in the office for more than four years. Users who have control were satisfied and thought that the office met their needs. Moreover, their satisfaction level with indoor environment quality aspects was high. Also, users described the indoor temperature in summer and winter as comfortable.

Users ranked that they did not have control regarding the indoor air quality statistics: 60% were females, and 40% were males. The bigger percentage were working in an open-plan office. Most of them said that the office does not meet their comfort need. Most of the users also described their indoor temperature in winter and summer as not comfortable. Thus, 40% of them adjust their indoor environment quality by adjusting the thermostat. 55.83% of the users adjust their indoor temperature by changing their clothing type. And 30.83% accept it as it is without changing (figure 29).

Table 6: Question 16 and Question 9

			Question 9: Does the office meet your comfort needs in general? ? (with 1 being not meet at all to 5 being highly meet)		
Question 16		Choices	Meet user comfort 4-5	Average 3	Not meet user comfort 1-2
How much control do you have over the following aspects of the office? (with 1 being no control at all and 5 being complete control)					
01	Combined aspects	4-5 Full control	69.69%	18.18%	12.12%
02		1-2 No control	10.72%	37.5%	51.78%
03	Indoor temperature	4-5 Full control	53.38%	33.74%	12.88%
04		1-2 No control	21.96%	33.33%	44.71%
05	Indoor air quality	4-5 Full control	62.07%	25.86%	12.07%
06		1-2 No control	26.67%	35.15%	38.18%
07	Electrical lighting	4-5 Full control	55.31%	28.49%	16.2%
08		1-2 No control	21.18%	38.98%	39.83%
09	Natural lighting	4-5 Full control	59.58%	24.29%	17.15%
10		1-2 No control	22.27%	41.89%	35.81%

Users with complete control over indoor air quality have a higher comfort level regarding their office environment. Second comes natural lighting. Third is electrical lighting and lastly is indoor temperature.

However, people with no control of indoor temperature showed higher levels of non-comfortability regarding their indoor office environment. Having complete control over the indoor temperature does not come first in ensuring the user's comfort level. Thus, not controlling the indoor environment does come first in affecting user comfort level. Second comes electrical lighting. Third is indoor air quality, and lastly, natural lighting. Refer to table 6.

4.5.2 Question 18: Number of people sharing the control over the following aspects:

Table 7: Question 18 and Question 9

			Question 9: Does the office meet your comfort needs in general? ? (with 1 being not meet at all to 5 being highly meet)		
Question 18	Choices		Meet user comfort 4-5	Average 3	Not meet user comfort 1-2
The number of people sharing the control over the following aspects:					
01	Number of people sharing the control	No access to control	35.17%	37.93%	26.9%
02		Only me	58.33%	26.19%	15.47%
03		Sharing control with one other coworker	45.04%	36.94%	18.02%
04		Sharing control with two coworkers	22.63%	45.26%	22.11%
05		Sharing control with three or more coworkers	31.55%	33.98%	31.55%

Users who have absolute control showed a higher comfort level regarding their indoor environment inside the office space and a lower percentage of discomfort level. However, users sharing the control with three or more coworkers show a higher discomfort level regarding their indoor environment. Surprisingly higher discomfort level than those with no access to control at all. Refer to table 7.

4.6 Section 5: Measures of conformity intentions and social-psychological variables

4.6.1 Question 17: My coworker accepts sharing the control over the following aspects: (with one being strongly not accept to 5 being strongly accept):

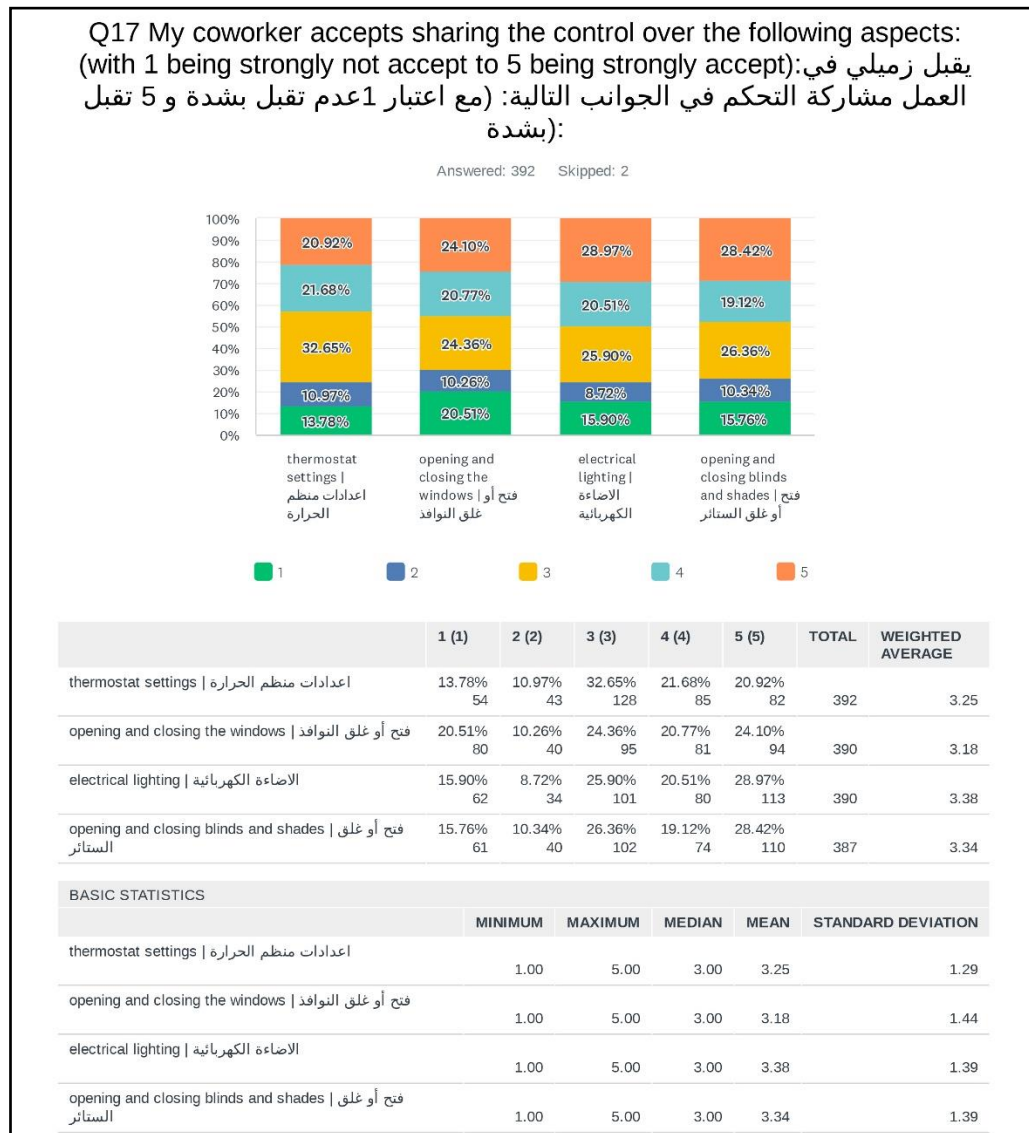


Figure 30: Question 17

Users with colleagues who accept sharing control have a higher satisfaction and comfort level than users with colleagues who do not (figure 30).

4.6.2 Question 19: Are you sharing the office with another gender?

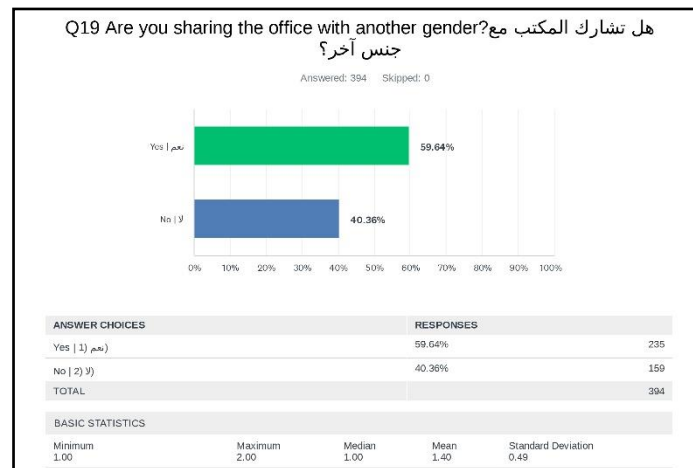


Figure 31: Question 19

Table 8: Question 19 and Question 9

			Question 9: Does the office meet your comfort needs in general? ? (with 1 being not meet at all to 5 being highly meet)		
Question 19		Choices	Meet user comfort 4-5	Average 3	Not meet user comfort 1-2
Are you sharing the office with another gender?					
01	Are you sharing the office with another gender?	Yes	30.77%	40.17%	29.06%
02		No	51.59%	29.3%	19.11%

Statistics in figure 31 and table 8 show that people who are not sharing the office with the opposite gender have a higher comfort level than those who share the office with the opposite gender.

4.6.3 Question 20: I can freely speak about my indoor environment quality with my colleagues regardless the gender: (with one being strongly disagree to 5 being strongly agree):

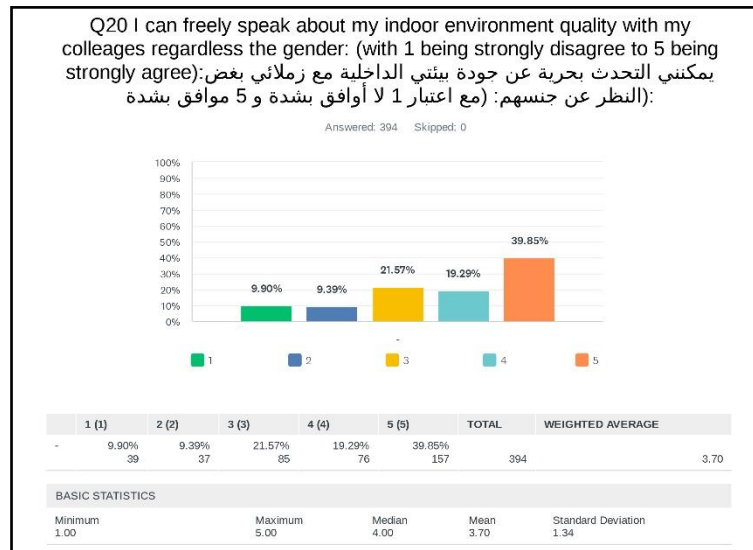


Figure 32: Question 19

Table 9: Question 19 and Question 9

			Question 9: Does the office meet your comfort needs in general? ? (with 1 being not meet at all to 5 being highly meet)		
Question 20		Choices	Meet user comfort 4-5	Average 3	Not meet user comfort 1-2
I can freely speak about my indoor environment quality with my colleagues regardless the gender: (with one being strongly disagree to 5 being strongly agree)					
01	I can freely speak about my indoor environment quality with my colleagues regardless the gender	4-5 Agree	47.83%	33.04%	19.13%
02		1-2 Disagree	21.05%	35.53%	43.42%

The difference between the percentages is pronounced. Users who can freely speak about their indoor environment quality with their colleagues have comfort levels that are much higher than those who cannot. Refer to figure 32 and table 9.

4.6.4 Question 22: Setting closely to my colleague can affect my indoor environment comfort. (with one being strongly disagree to 5 being strongly agree):

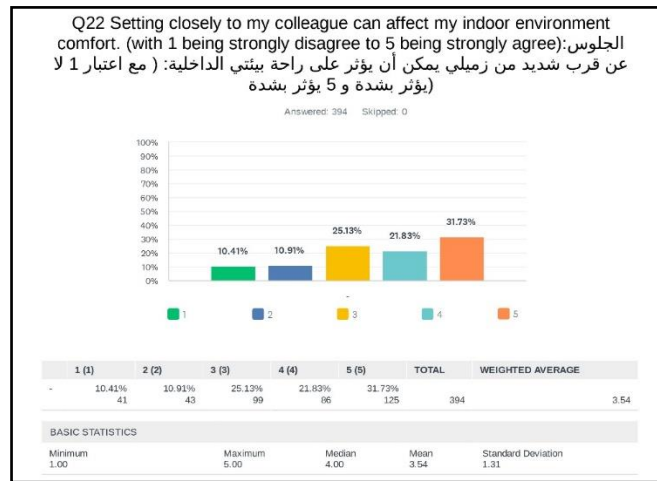


Figure 33: Question 22

53.56% of participants, which is nearly half of the participants, think that sitting close to their colleagues affects their comfort in an indoor office environment. Only 21.32% of them think that it does not affect their comfort levels (figure 33).

4.6.5 Question 23: Working in a mixed environment (Including males & females) can disturb my indoor environment comfort. (with one being strongly disagree to 5 being strongly agree):

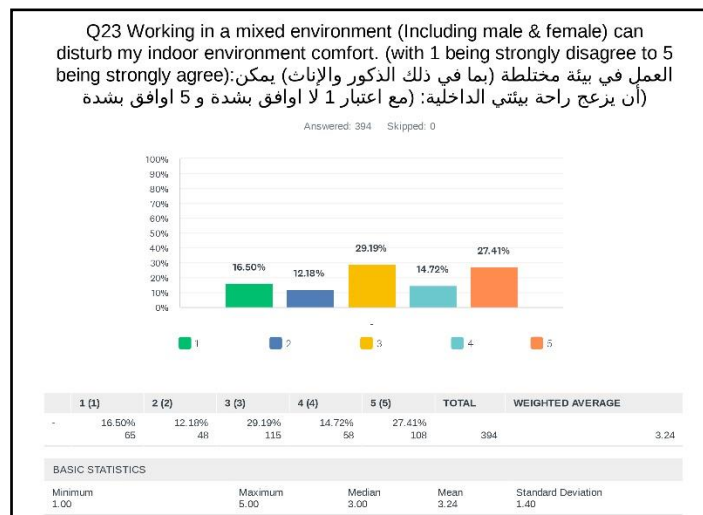


Figure 34: Question 22

42.31% of the participants think that the mixed environment affects their comfort level, and question 19 supports that (figure 34).

4.6.6 Question 24: I am able to express my feeling toward my indoor environment comfort. (with 1 being strongly disagree to 5 being strongly agree):

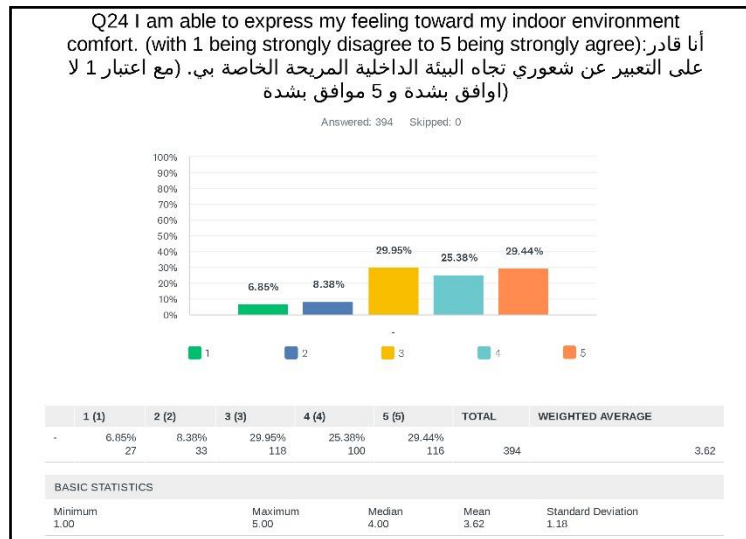


Figure 35: Question 22

The statistics show that a considerably high percentage of the participants cannot express their thoughts towards the indoor environment. Thus, question number 20 shows that the people who cannot speak have a higher level of discomfort inside the office (figure 35).

4.7 Comparing General/ Demographic with overall office comfort level:

4.7.1 Question two and question 9:

Table 10: Question 2 and Question 9

			Question 9: Does the office meet your comfort needs in general? ? (with 1 being not meet at all to 5 being highly meet)		
Question 2	Choices		Meet user comfort 4-5	Average 3	Not meet user comfort 1-2
Age:					
01	18-28	Male	42.86%	33.77%	23.38%
02		Female	28.05%	37.80%	34.15%
03		Both	28.93%	35.85%	28.93%
04	29-39	Male	40%	38.67%	21.33%
05		Female	32.25%	40.32%	27.42%
06		Both	36.23%	39.86%	23.91%
07	40-50	Male	25%	38.89%	36.11%
08		Female	52.78%	19.44%	27.77%
09		Both	44.44%	29.17%	26.39%
10	51 or older	Male	78.57%	21.43%	0%
11		Female	50%	50%	0%
12		Both	68.18%	31.82%	0%

The age variable shows a very clear outcome, which is that the older the employee is, the higher the satisfaction level. More likely because of the position of the employee, as older employees tend to be higher in rank and hold more powerful positions. They usually have access to control, refer to table 10.

4.7.2 Question three and question 9:

Table 11: Question 3 and Question 9

			Question 9: Does the office meet your comfort needs in general? ? (with 1 being not meet at all to 5 being highly meet)		
Question 3		Choices	Meet user comfort 4-5	Average 3	Not meet user comfort 1-2
Dress code:					
01	Suit	Male	40.26%	36.36%	23.37%
02		Female	40.81%	24.49%	34.69%
03		Both	40.48%	31.75%	27.77%
04	Thoub/ Abaya	Male	37.21%	34.88%	27.91%
05		Female	31.91%	40.43%	27.66%
06		Both	33.33%	39.13%	27.54%
07	Casual	Male	48.78%	35.37%	15.85%
08		Female	35.55%	37.78%	26.67%
09		Both	44.1%	36.22%	19.69%

The kind of clothing does not seem to affect the user's sense of comfort. The percentages were relatively close, with slight differences, refer to table 11.

4.7.3 Question four and question 9:

Table 12: Question 4 and Question 9

			Question 9: Does the office meet your comfort needs in general? ? (with 1 being not meet at all to 5 being highly meet)		
Question 4		Choices	Meet user comfort 4-5	Average 3	Not meet user comfort 1-2
In which sector do you work?					
01	Government Sector	Male	51.73%	34.48%	13.79%
02		Female	31.11%	33.33%	35.55%
03		Both	39.19%	33.78%	27.03%
04	Private Sector	Male	34.09%	37.5%	28.41%
05		Female	27.03%	37.84%	35.14%
06		Both	31.48%	37.65%	30.87%
07	Semi- Government Sector	Male	38.89%	38.89%	22.22%
08		Female	35%	25%	40%
09		Both	36.85%	31.58%	31.58%

According to the results in table 12, the government sector reports a higher degree of satisfaction than the private. However, the differences are considered not significant.

4.7.4 Question five and question 9:

Table 13: Question 5 and Question 9

			Question 9: Does the office meet your comfort needs in general? ? (with 1 being not meet at all to 5 being highly meet)		
Question 5		Choices	Meet user comfort 4-5	Average 3	Not meet user comfort 1-2
How long have you been employed in this office? (Years)					
01	Less than one year	Male	35.14%	37.84%	27.02%
02		Female	22.64%	43.4%	33.96%
03		Both	31.11%	41.11%	27.78%
04	1-2 years	Male	36.67%	40%	23.33%
05		Female	30.77%	33.33%	35.9%
06		Both	33.33%	36.23%	30.44%
07	3-4 years	Male	47.72%	29.55%	22.72%
08		Female	29.17%	33.33%	37.5%
09		Both	41.17%	30.88%	27.94%
10	More than four years	Male	46.15%	36.26%	17.58%
11		Female	48.61%	31.94%	19.44%
12		Both	46.95%	34.76%	18.29%

The number of years of experience reflects the comfort level and employee satisfaction level. The more experience, the higher the level of satisfaction. Refer to table 13.

4.7.5 Question six and question 9:

Table 14: Question 6 and Question 9

			Question 9: Does the office meet your comfort needs in general? ? (with 1 being not meet at all to 5 being highly meet)		
Question 6		Choices	Meet user comfort 4-5	Average 3	Not meet user comfort 1-2
During the day, how many hours do you spend in the office?					
01	1-2 hours	Male	66.66%	11.11%	22.22%
02		Female	50%	50%	0%
03		Both	64.54	23.08%	15.38%
04	3-5 hours	Male	40%	43.33%	16.67%
05		Female	44.44%	22.22%	33.33%
06		Both	41.02%	38.46%	20.51%
07	5-8 hours	Male	42.7%	42.7%	14.61%
08		Female	34.28%	43.81%	21.91%
09		Both	18.55%	43.3%	38.15%
10	more than 8 hours	Male	41.89%	27.03%	31.08%
11		Female	34.29%	24.29%	41.43%
12		Both	37.93%	26.21%	35.87%

The number of hours spent in the office does not have a significant impact on the comfort level of the employees. Employees who work between one to two hours show similar trends to those who work more.

4.7.6 Question seven and question 9:

Table 15: Question 7 and Question 9

			Question 9: Does the office meet your comfort needs in general? ? (with 1 being not meet at all to 5 being highly meet)		
Question 7		Choices	Meet user comfort 4-5	Average 3	Not meet user comfort 1-2
Your office type is					
01	Private Office	Male	62.12%	25.76%	12.13%
02		Female	58.93%	19.64%	21.43%
03		Both	60.65%	22.95%	16.4%
04	Open plan office	Male	36.74%	39.8%	23.47%
05		Female	23.86%	47.73%	28.41%
06		Both	30.48%	43.85%	25.67%
07	Cubicles	Male	29.63%	33.33%	37.03%
08		Female	21.88%	37.5%	40.63%
09		Both	25.42%	35.59%	38.98%

Participants who have their own private offices show a higher satisfaction level.

Secondly comes the employees who work in an open plan office. On the other hand, employees who work in cubicles show the lowest satisfaction levels.

4.7.7 Question eight and question 9:

Table 16: Question 8 and Question 9

			Question 9: Does the office meet your comfort needs in general? ? (with 1 being not meet at all to 5 being highly meet)		
Question 8		Choices	Meet user comfort 4-5	Average 3	Not meet user comfort 1-2
Your work position is					
01	Chairman/ CEO	Male	66.66%	16.67%	16.67%
02		Female	66.66%	0%	33.33%
03		Both	66.66%	11.11	22.22%
04	General manager/ Director	Male	64.71%	17.65%	17.65%
05		Female	37.5%	62.5%	0%
06		Both	56%	32%	12%
07	Supervisor	Male	44.07%	44.07%	11.86%
08		Female	57.7%	38.46%	3.85%
09		Both	48.23%	42.35%	9.42%
10	Staff	Male	34.32%	34.31%	31.37%
11		Female	29.57%	34.51%	35.91%
12		Both	31.43%	34.69%	33.88%

Work position affects the user's comfort. CEOs and chairmen show the highest comfort levels. Then, general managers and directors, and after that, the supervisors. Regular employees who do not hold a powerful position have the lowest comfort levels.

4.8 Overall statistics

The total number of responses was 507; after filtering the answers by excluding all uncompleted and irrelevant answers, the number of responses was reduced to 393. Refer to Appendix 1 for more information.

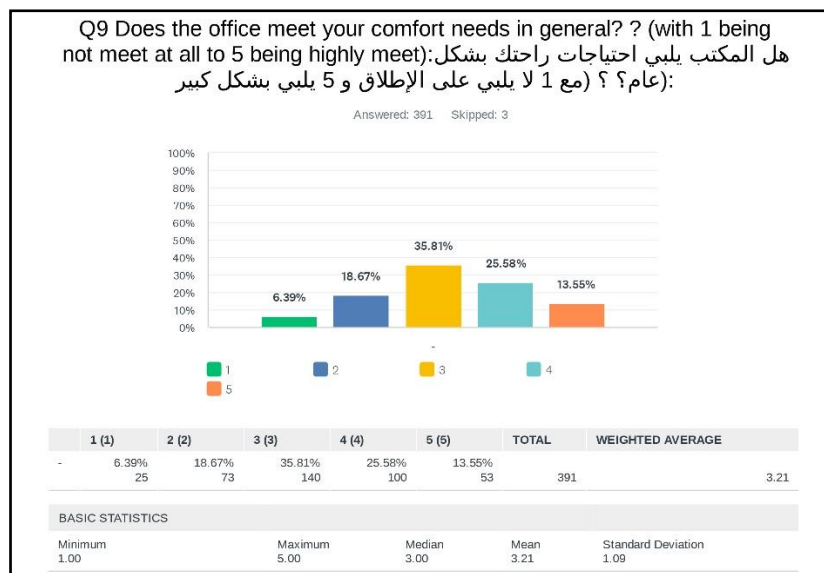
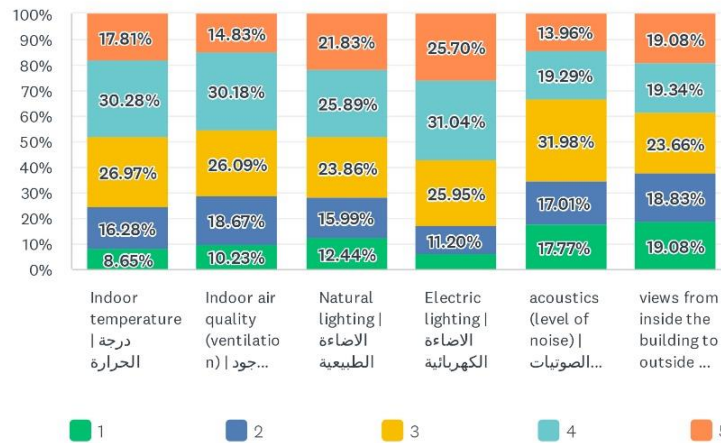


Figure 36: question 9 statistic

Figure 36 shows the results of the overall comfort level survey. Figure 36 indicates that 35.81% of the population rated their comfort level as average (i.e., 3 out of 5). The figure indicates that the general comfort level of the office does not adequately satisfy the employees, as it does not fulfill the entire degree of comfort. It falls somewhere in the middle of the satisfaction scale. In addition, among all the answers, 6.39% of the employees said their workplace was not comfortable at all, and 18.67% of employees regarded their workplace as uncomfortable. This means that 25.05% of the participants are not comfortable with their indoor office environment. Thus, a deep understanding of the factors behind this discomfort should be gained to improve their working environment. On the other side, 25.58% of the participants rated their comfort level at their offices as 4 out of 5, which is relevantly satisfactory. Finally, 13.55% believe their office comfort is excellent.

Q10 How would you rank your overall comfort of these following aspects?:
(with 1 being very uncomfortable to 5 being very comfortable): كيف تقيم راحتك العامة من هذه الجوانب التالية: ؟ (مع اعتبار 1 غير مريح للغاية و 5 مريح للغاية):

Answered: 394 Skipped: 0



	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	TOTAL	WEIGHTED AVERAGE
Indoor temperature درجة الحرارة	8.65% 34	16.28% 64	26.97% 106	30.28% 119	17.81% 70	393	3.32
Indoor air quality (ventilation) جودة الهواء الداخلي ((تهوية))	10.23% 40	18.67% 73	26.09% 102	30.18% 118	14.83% 58	391	3.21
Natural lighting الاضاءة الطبيعية	12.44% 49	15.99% 63	23.86% 94	25.89% 102	21.83% 86	394	3.29
Electric lighting الاضاءة الكهربائية	6.11% 24	11.20% 44	25.95% 102	31.04% 122	25.70% 101	393	3.59
acoustics (level of noise) الصوتيات (مستوى الضوضاء)	17.77% 70	17.01% 67	31.98% 126	19.29% 76	13.96% 55	394	2.95
views from inside the building to outside المنظر من داخل المبنى الى خارجه	19.08% 75	18.83% 74	23.66% 93	19.34% 76	19.08% 75	393	3.01
BASIC STATISTICS							
	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION		
Indoor temperature درجة الحرارة	1.00	5.00	3.00	3.32	1.19		
Indoor air quality (ventilation) جودة الهواء الداخلي ((تهوية))	1.00	5.00	3.00	3.21	1.20		
Natural lighting الاضاءة الطبيعية	1.00	5.00	3.00	3.29	1.31		
Electric lighting الاضاءة الكهربائية	1.00	5.00	4.00	3.59	1.16		
acoustics (level of noise) الصوتيات (مستوى الضوضاء)	1.00	5.00	3.00	2.95	1.28		
views from inside the building to outside المنظر من داخل المبنى الى خارجه	1.00	5.00	3.00	3.01	1.38		

Figure 37: question 10 statistic

Looking at the statistics for question 10 in figure 37, starting with Indoor temperature, 30.28% of employees assessed their indoor temperature as comfortable. Furthermore, 17.85% of employees rated their indoor temperature comfort as extremely comfortable. The two

percentage combined shows that almost half of the participants believe that their indoor temperature is satisfactory, which is excellent.

26.97% of the participants, which is nearly a quarter of them, rated their indoor temperature comfort as 3 out of 5, which is in the middle, not very satisfying and not unsatisfied as well. At the same time, 16.28% rated their indoor temperature as not comfortable and 8.65% as not comfortable at all. This means that another quarter of the participants was not satisfied with the indoor temperature.

30.18% of employees rated their comfort level towards indoor air quality as 4 out of 5, which is satisfactory, and 14.83% were very comfortable and satisfying and rated it as 5 out of 5. 45.01% of the participants are comfortable or very comfortable with the air quality inside their offices. 26.09% of them were in between and rated it as 3 out of 5. In addition, 18.67% of the occupants rated their indoor air quality as 2 out of 5, which is not comfortable. 10.23% of the occupants think that the indoor air quality is not comfortable at all, with a rate of 1 out of 5. This means that 29.9% of the participants think that their indoor air quality is not comfortable.

As for natural lighting comfort level, 25.89 % of the occupants evaluated their comfort level as 4 out of 5, indicating that they were relatively comfortable. Furthermore, 21.83 % believe that natural lighting is comfortable. 47.72% of the survey population, which is almost half of it, are comfortable or highly comfortable with the natural lighting in their offices. Natural lighting was ranked as 3 out of 5 by 23.86 % of the participants.

On the other side, 15.99 % of the occupants judged natural lighting comfort as unsatisfactory, and 12.44% were not at all comfortable. This implies that 28.43% of respondents are uncomfortable with their office's natural lighting, which is more than a quarter of the survey population.

The electrical lighting section has the highest comfort levels among all the other aspects. The electrical lighting was assessed as comfortable by 31.04 % of the occupants. 25.7 % believe their electrical lighting is highly comfortable. 56.74 % assessed their electrical lighting as comfortable or highly comfortable. 25.95% of workers assessed their comfort level with electrical lighting as 3 out of 5, whereas 11.2 % of occupants thought it was uncomfortable, and 6.11% of occupants rated it as highly uncomfortable. Overall, 17.31% of

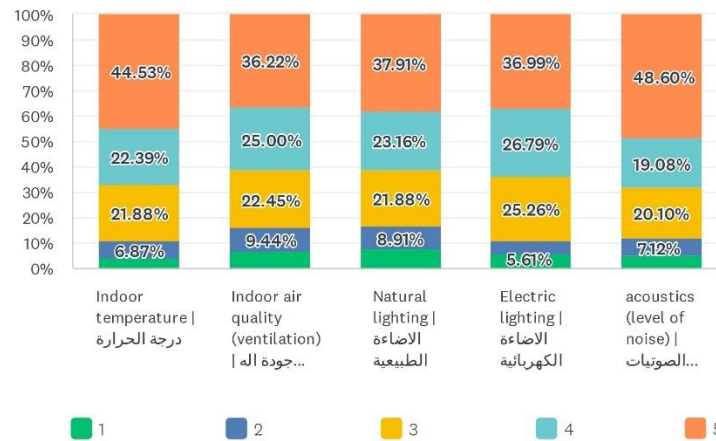
participants believe that electrical lighting is uncomfortable or highly uncomfortable inside their office.

The acoustics comfort level is rated as the most uncomfortable. 17.01 % of the participants find the noise level uncomfortable, and 17.77 % find the acoustic level extremely uncomfortable. More than a quarter of the participants considered the acoustic and noise level as uncomfortable or highly uncomfortable. Furthermore, 31.98 % of occupants described the comfort level as medium (i.e., not highly comfortable nor highly uncomfortable). Besides, 19.29% of the survey population were satisfied with the acoustics' comfort level, and 13.96 % were extremely satisfied. The overall acoustic comfort level was 33.25 %.

Finally, the statics of the views inside the building were about identical for each rating level. The highly comfortable level is held by 19.08 % of the participants, and 19.34% of them rated it as comfortable, with a rating of 4 out of 5. The average comfort level (i.e., 3 out of 5) was the highest, with 23.66 % of the participants. 18.83 % of the participants ranked it as uncomfortable, and 19.08% as highly uncomfortable.

Q11 I think the following aspects influence my comfort at work: (with 1 being no influence at all to 5 being highly influenced): أعتقد أن الجوانب التالية: (مع اعتبار 1 ليس له تأثير على الإطلاق و 5 يؤثر بشدة):

Answered: 394 Skipped: 0



	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	TOTAL	WEIGHTED AVERAGE
Indoor temperature درجة الحرارة	4.33% 17	6.87% 27	21.88% 86	22.39% 88	44.53% 175	393	3.96
Indoor air quality (ventilation) جودة الهواء الداخلي (التهوية)	6.89% 27	9.44% 37	22.45% 88	25.00% 98	36.22% 142	392	3.74
Natural lighting الاضاءة الطبيعية	8.14% 32	8.91% 35	21.88% 86	23.16% 91	37.91% 149	393	3.74
Electric lighting الاضاءة الكهربائية	5.61% 22	5.36% 21	25.26% 99	26.79% 105	36.99% 145	392	3.84
acoustics (level of noise) الصوتيات (مستوى الضوضاء)	5.09% 20	7.12% 28	20.10% 79	19.08% 75	48.60% 191	393	3.99

BASIC STATISTICS						
	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION	
Indoor temperature درجة الحرارة	1.00	5.00	4.00	3.96	1.15	
Indoor air quality (ventilation) جودة الهواء الداخلي (التهوية)	1.00	5.00	4.00	3.74	1.23	
Natural lighting الاضاءة الطبيعية	1.00	5.00	4.00	3.74	1.27	
Electric lighting الاضاءة الكهربائية	1.00	5.00	4.00	3.84	1.15	
acoustics (level of noise) الصوتيات (مستوى الضوضاء)	1.00	5.00	4.00	3.99	1.20	
	32	35	86	91	149	393
Electric lighting الاضاءة الكهربائية	5.61% 22	5.36% 21	25.26% 99	26.79% 105	36.99% 145	392
acoustics (level of noise) الصوتيات (مستوى الضوضاء)	5.09% 20	7.12% 28	20.10% 79	19.08% 75	48.60% 191	393

Figure 38: question 11 statistic

Regarding the occupants' beliefs about comfort, the acoustics and level of noise are the most critical factors determining their comfort. 48.6 % of participants believe that acoustics significantly impact their comfort level, which is almost half of the population.

Furthermore, 19.08 % of the occupants assessed the acoustics as having a 4 out of 5 comfort rating. Therefore, 67.68 % of employees believe that acoustics impact their comfort (figure 38).

Indoor temperature is the second most crucial factor impacting occupants' comfort within the office, with 66.92 % of occupants believing it impacts their comfort. This percentage represents those who rated the indoor temperature by 4 and 5 out of 5. 44.53 % rated it as 5 out of 5 as they believe that the indoor temperature significantly impacted their comfort, while 22.39 % as 4 out of 5.

Furthermore, electrical lighting is the third aspect that influences user comfort within the workplace area. 63.78 % of workplace occupants believe that electrical lighting impacts their comfort. 36.99 % believe that electrical lighting significantly impacts their comfort level (i.e., rating of 5 out of 5), and 26.79 % of the participants believe that it impacts their comfort level (i.e., rating of 4 out of 5).

According to 61.22 % of the participants, air quality is seen as a factor that impacts their comfort level. 36.22 % rated it as 5 out of 5 scales, feeling that air quality significantly influences their degree of comfort, and 25% assessed the air quality in the office as 4 out of 5, saying that it influences their level of comfort.

For the occupant who ranked the aspects by 3 out of 5, the rating percentage was nearly the same for all aspects. The indoor temperature influences 21.88 % of users, and the same percentage goes to the influence of natural lighting influences. Moreover, 22.45 % of occupants believe that indoor air quality is essential. In addition, 25.26 % rated electrical lighting influence as in the middle. Finally, the percentage for acoustics is 20.1%.

In contrast to most factors that occupants feel influence their comfort, 17.05 % of users say that natural lighting is the least influential aspect of their comfort level. At the same time, 8.14 % of the users used a scale of 1 out of 5 to describe their belief that natural lighting affects their comfort level in the office. Moreover, 8.91 % chose the scale 2 out of 5.

The second most minor factor is indoor air quality; the occupant believes that it affects their comfort inside the office is 16.33%. 6.89% chose the scale 1 out of 5, and 9.44% chose the scale 2 out of 5 to describe their belief in air quality influence.

To sum up, question 9 summary is the average answer of meeting the comfort need inside the office space is 3 out of 5 (average) on the scale. Next, question 10, about ranking the comfort level of each aspect, says that the more significant percentage is between 4 and 5 (comfortable) for all the aspects except the acoustics. This, the more significant percentage was 3 (average). And most of the occupants rated the acoustic as uncomfortable. Remarkably few users ranked the acoustics above 3. And the most pleasant and comfortable aspect in their ranking was electrical lighting.

4.9 Research Question

4.9.1 Testing the hypotheses

This research has four hypotheses. The hypotheses are:

1. Users who work with average thermal levels (not too hot or too cold) are more likely to believe that (IEQ) positively impacts their work comfort than those with high thermal comfort, like too hot or too cold.

The first hypothesis can be tested using the analysis of question ten (table17).

Table 17: Question 10 and Question 9

			Question 9: Does the office meet your comfort needs in general? ? (with 1 being not meet at all to 5 being highly meet)		
Q. 10:	Choices		Meet user comfort 4-5	Average 3	Not meet user comfort 1-2
How would you rank your overall comfort in the following aspects:?					
01	Indoor	4-5 Very comfortable	57.44%	32.45%	10.11%
02	temperature	1-2 Very uncomfortable	11.22%	33.67%	55.11%

The statistics state that 57.55% of the users who work with average thermal levels (not too hot or too cold) described the indoor office environment as comfortable. In contrast, 55.11% of the users who work with high thermal comfort (too hot or too cold) have described the indoor office environment as uncomfortable. Hypothesis one is accepted, where the questionnaire result supports the hypothesis's accuracy.

2. IEQ comfort beliefs are positively connected to the perceived ease of using IECs.

Testing hypothesis two will be in two parts. The first part will test the hypothesis with easy control access to all IEQ aspects. Part two will test the hypothesis with ease of control to each aspect separated (table18).

As for part one, Among all the users with complete control access to all IEQ aspects, 69.69% have described their indoor office environment as comfortable. At the same time, 51.78% of those with no control access to all IEQ aspects described their indoor office environment as uncomfortable.

For part two, all aspects support the accuracy of hypothesis two. Moreover, users with easy control over indoor air quality have higher comfort levels than the other aspects. The order of having control over the aspects that most affect the employee's comfort is as follows: 1) Indoor air quality, 2) Natural lighting, 3) Electrical lighting, and 4) Indoor temperature. Hypothesis two is accepted because the questionnaire results reflect the validity of the hypothesis.

Table 18: Question 16 and Question 9

			Question 9: Does the office meet your comfort needs in general? ? (with 1 being not meet at all to 5 being highly meet)		
Question 16	Choices		Meet user comfort 4-5	Average 3	Not meet user comfort 1-2
How much control do you have over the following aspects of the office? (with 1 being no control at all and 5 being complete control):					
01	Combined aspects	4-5 Full control	69.69%	18.18%	12.12%
02		1-2 No control	10.72%	37.5%	51.78%
03	Indoor temperature	4-5 Full control	53.38%	33.74%	12.88%
04		1-2 No control	21.96%	33.33%	44.71%
05	Indoor air quality	4-5 Full control	62.07%	25.86%	12.07%
06		1-2 No control	26.67%	35.15%	38.18%
07	Electrical lighting	4-5 Full control	55.31%	28.49%	16.2%
08		1-2 No control	21.18%	38.98%	39.83%
09	Natural lighting	4-5 Full control	59.58%	24.29%	17.15%
10		1-2 No control	22.27%	41.89%	35.81%

3. Occupants with access to IEQ Controls (e.g., thermostats, blinds and shades, light switches, and windows) are more likely to feel IEQ. has a favorable influence on their job comfort than their colleagues.

According to the data obtained from question 18 and presented in table 19. Question 18 data states that worker with easy control consists of complete control individually or with one coworker only. Data shows that people who have control but share with two coworkers or more do not indicate that they will necessarily have a comfortable indoor environment.

Hypothesis three is not confirmed because it is not very specific.

Table 19: Question 18 and Question 9

			Question 9: Does the office meet your comfort needs in general? ? (with 1 being not meet at all to 5 being highly meet)		
Question 18	Choices		Meet user comfort 4-5	Average 3	Not meet user comfort 1-2
The number of people sharing the control over the following aspects:					
01	Number of people sharing the control	No access to control	35.17%	37.93%	26.9%
02		Only me	58.33%	26.19%	15.47%
03		Sharing control with one other coworker	45.04%	36.94%	18.02%
04		Sharing control with two coworkers	22.63%	45.26%	22.11%
05		Sharing control with three or more coworkers	31.55%	33.98%	31.55%

4. IEQ-comfort belief is linked to demographic parameters such as age, clothing type, working sector, working years, working hours, office type, and work position.

Demographic parameters results show that there are aspects that do affect comfort belief; however, not all of them. The hypothesis aimed to suggest that all aspects may affect IEQ. However, the data collected showed otherwise. Statistics show that age does affect the beliefs toward comfort. Secondly, years of experience also influence IEQ's comfort beliefs.

Office type is also linked to IEQ comfort beliefs. Lastly, work position is an aspect that affects the IEQ comfort beliefs.

On the other hand, it was suggested that clothing type could influence IEQ comfort beliefs, but the research findings show that clothing type does not affect IEQ comfort beliefs. The difference between clothing type categories was almost similar. Secondly, the Working hour's aspect appears not directly linked to affecting IEQ comfort belief, where the data numbers were close to each other. Hypothesis four can be accepted if it is more precise. It could be rewritten as: IEQ comfort beliefs are linked to demographic parameters such as age, number of years of experience, office type, and work position. The fourth hypothesis is not confirmed.

Chapter Five:

Summary,

Conclusion,

recommendations,

and future research

5. Chapter Five: Summary, Conclusion, recommendations, and future research

5.1 Introduction

This chapter examines the primary objectives of this study and its implications. The key findings from the survey analysis conducted in the earlier sections are examined and connected to the study's stated aims in Chapter 1. These objectives are:

1. Evaluate the acceptance of the quality of the indoor environment.
2. Identify the factors that contribute to people's dissatisfaction with their indoor environment.
3. Study complex aspects of indoor environmental quality (IEQ) related to user's comfort.
4. Examine the occupants' needs and the relationship between IEQ and comfort at the workplace.
5. Look into the role of personal control over IEQ and its relationship with occupants' comfort.
6. Investigate local beliefs and social factors that play a role in users' comfort and behavior.

This study explored the links between occupant satisfaction, indoor environmental quality (IEQ) parameters, facility satisfaction, and work performance. In this study, occupants' satisfaction with the IEQ of their work settings, including temperature conditions, indoor air quality, lighting conditions, view circumstances, auditory conditions, privacy conditions, and personal control, was assessed through a survey.

5.2 Summary of the study, discussion, and recommendation

This study included multi-dimensional areas to investigate the critical factor influencing office users' IEQ satisfaction and comfort level. These factors included demographics, the office's overall comfort beliefs, thermal comfort and IEQ factors that influence comfort beliefs, indoor environment quality control, Measures of conformity intentions, and social-psychological variables. This method is in line with the findings of recent studies (Chen et al., 2020; Huebner et al., 2016).

This research aimed to investigate the connections between occupants' satisfaction with IEQ criteria, contentment with the facility as a whole, and overall work performance and satisfaction in an office building. Two out of four hypotheses (H1 and H2) were entirely supported, and two were not confirmed (H3, H4).

Research hypotheses are:

Hypotheses 1: Users who work with average thermal levels (not too hot or too cold) are more likely to believe that (IEQ) positively impacts their work comfort than those with high thermal comfort, like too hot or too cold. (Hypothesis one is accepted, where the questionnaire result supports the hypothesis's accuracy.)

Hypotheses 2: IEQ comfort beliefs are positively connected to the perceived ease of use. (Hypothesis two is accepted because the questionnaire results reflect the validity of the hypothesis.)

Hypotheses 3: Occupants with access to IEQ Controls (e.g., thermostats, blinds and shades, light switches, and windows) are more likely to feel IEQ has a favorable influence on their job comfort than their colleagues. (Hypothesis three is not confirmed).

Hypotheses 4: IEQ-comfort belief is linked to demographic parameters such as age, clothing type, working sector, working years, working hours, office type, and work position. (Hypothesis Four is not confirmed).

The following is a summary of the key results and implications of each objective:

1. Evaluate the acceptance of the quality of the indoor environment.

Males show more levels of satisfaction when compared to females. The demographic findings revealed that age, number of years of experience, type of workplace, and position all have an impact on indoor environmental quality. However, in Bahrain, the clothes worn, the working sector, and the number of working hours have no significant impact on user comfort. The age variable has a significant impact on IEQ comfort level. The higher the level of satisfaction, the older the employee.

2. Identify the factors that contribute to people's dissatisfaction with their indoor environment.

Females' discomfort ratings were higher than males' ratings, as males expressed more satisfaction than females on the overall comfort level of their office's indoor environment quality. In every aspect of IEQ, males were more satisfied than females, except views from the building to the outside, where females' satisfaction was higher than males. As for acoustical satisfaction, it was comparable among males and females. Thus, the female dissatisfaction rate was consistently more significant than the male rate in all domains. Among all aspects, acoustics (noise level) scored as the most influential component that might impact the user's comfort.

Indoor temperature follows acoustics in significance. The third is the electrical lighting. Fourth is indoor air quality and lastly comes natural lighting. Females are more likely to believe that indoor environment factors affect their comfort in the workplace. In contrast, males believe that indoor environment factors do not significantly impact their comfort. Unlike the anticipated hypothesis, the relationship between clothing and indoor temperature satisfaction may not exist.

3. Study complex aspects of indoor environmental quality (IEQ) related to user's comfort.

Section one (general information and demographics) of the questionnaire concluded that age, years of experience, office type, and position are the factors that affect IEQ. However, clothing type, working sector, and working hours do not significantly affect a user's comfort level. The age variable gives an obvious indication of its effect on IEQ. The older the employee, the greater the level of satisfaction. However, clothing type does not have a significant impact on the degree of comfort.

As for the governmental and private sectors, there is no significant difference between the two in terms of worker comfort. Employees who work inside the office for extended hours have similar comfort levels as those who spend a few hours inside the office. The employee who spends at least three hours at the office exhibits the same level of comfort as the other employee who

spends more than eight hours. However, it has not been shown that working hours significantly influence the degree of indoor comfort. Users who work in private offices are more satisfied than other office types. The following kind of office to show the second satisfaction is works in an open office layout—consequently, cubical reports lower satisfaction levels. Work position influences the user's degree of comfort; CEOs and chairmen report the most significant levels of comfort. The supervisors comprise the second level, followed by the general managers and directors. At the same time, standard employees are the least comfortable.

4. Examine the occupants' needs and the relationship between IEQ and comfort at the workplace.

Regression research indicates that occupants working in private offices are more likely to have a favorable perception of the interior environment's quality and comfort. In support of earlier research (e.g., Kim et al., 2013) revealing that users of private office spaces are happier with several elements of indoor environment quality, the current results extend this knowledge to comfort perception. They are more likely to believe that indoor air quality, natural light, and acoustics positively affect their productivity than occupants of shared offices and cubicles. In contrast to other IECs (e.g., thermostats, blinds and shades, and operable windows), the amount of control accessibility to light switches has a considerable influence on the IEQ productivity beliefs when other predictors are included. Similarly, Kim et al., 2017 showed that worker who was given personal control and those who controlled task lighting reported better levels of lighting comfort. Upon closer inspection, the data indicate that access to certain IECs influences tenants' perception of IEQ comfort. Those who possess customized and exclusive control over the light switches, thermostats, windows, shades, and blinds are more likely to feel that IEQ influences their comfort than those who do not have IECs or who share with one or more coworkers.

5. Look into the role of personal control over IEQ and its relationship with occupants' comfort.

Users with total control over indoor air quality feel more comfortable in their workplace environment. Second, there is control over natural light. Third is electrical lighting and lastly is indoor temperature. However, people without control of indoor temperature showed higher levels of non-comfortability regarding their office environment. Complete control over the indoor temperature does not come first in ensuring the user's comfort level. Thus, not controlling the indoor environment does come first in affecting user comfort level. Second, comes electrical lighting. Third is indoor air quality; lastly, natural lighting affects comfort with the control level. Users with colleagues who accept sharing control have a higher satisfaction and comfort level than users with colleagues who do not want to accept sharing control.

Moreover, the survey indicated that residents of workplaces and those with access to indoor environment quality control are associated with a more favorable IEQ comfort belief. From the standpoint of the type of workplace, a balance between private offices and open cubicle areas is a crucial early-stage design choice. Substantiate the need for additional private office spaces. If enclosed private office space is unfeasible, having more control access over indoor environment aspects is an alternative.

Additionally, this research showed that attitudes towards IEC sharing enhance perceived ease of control IECs and belief in IEQ comfort. In particular, exclusive control of a thermostat may improve IEQ's belief in comfort, which may not be achievable in many structures. Utilizing personalized temperature controls properly will need interdisciplinarity to integrate a perspective—iterative method. When designing an effective control system, end-user input is crucial. Validations and technical advancements are required for specialists in the social, natural, and applied sciences (Bavaresco et al., 2019).

6. Investigate local beliefs and social factors that play a role in users' comfort and behavior.

People who are not sharing the office with another gender have a higher comfort level than those who share the office with another gender. Also, people who are not sharing the office with the other gender have lower discomfort levels than those who share the office with the other gender. According to the literature, daily cultural and environmental attitudes impact certain aspects of IEQ (Mansour,2014). Users who can freely speak about their indoor environment quality with their colleague's comfort level are much higher than those who cannot. In contrast, in the same situation for discomfort, people who cannot speak have a higher percentage of discomfort than those who can.

Lastly, designers and engineers must consider the cultural context while designing. As indicated in this research, incorporating subjective, the qualitative factor is an effective method of getting more profound knowledge of occupants' perspectives, which may also aid in the customization of design. Studies have shown, for instance, that comfort is often influenced by indoor environmental quality, and that occupant perceptions are influenced mainly by demography (e.g., gender and birthplace) and occupational activities (Kang, Ou, and Mak, 2017).

The statistical evidence and conclusions presented in this research give several insights. This includes the evaluation of design techniques that facilitate objective-driven decision-making, and the value of collaborating across many fields is emphasized. Various situations expand the knowledge of the quality and comfort of the indoor environment. While it would be ideal for providing a comprehensive range of architectural solutions to improve the overall quality of the indoor environment, this research contributes to the design process by identifying the most significant aspects. The strongest predictors of satisfaction with indoor environmental quality are occupants' strong beliefs regarding the effect of indoor environmental quality on comfort, which can justify the improvement of indoor environmental quality comfort beliefs through a multidimensional approach for decision-makers.

5.3 Conclusions & Significant findings

This study evaluates the influence of multidimensional elements on occupants' perceptions of the quality and comfort of the indoor environment. One of the critical outcomes of this study reveals that private offices with individual control are more conducive to eliciting a good perception of the quality and comfort of the interior environment. This research illustrates the perplexing dilemma faced by academics and designers owing to the lack of available private office space in many buildings. This study's results help in selecting successful building control systems by determining which degree of IEC controls increases IEQ comfort belief. Moreover, the findings indicate the significance of national variances and contribute to the expanding collection of information about the quality of the interior environment. Regulatory authorities and standard makers might consider a local solution to the highlighted problems to enable user-centric buildings.

The demographic findings showed that indoor environmental quality is influenced by age, a number of years of experience, kind of workplace, and position. However, the clothes worn, the working sector, and the number of working hours do not significantly affect user comfort in Bahrain. The age variable influence IEQ comfort level significantly. The older the employee, the higher the level of satisfaction shown.

In addition, building-specific factors may influence more focused and successful building upgrade choices and enhance building operations. Moreover, this research may bridge the gap between building technology and occupant-centered policy by using various approaches, such as qualitative methodology, to examine the occupants' views of building performance in more depth. Local, culturally-based qualitative assessments may enhance establishing a customized policy. Incorporating the perspectives of sociologists with those of the building sector's users is also required to comprehend more the influence of building technologies and socio-psychological aspects on the quality of the interior environment in various nations or areas. In conclusion, this study gives building designers and regulators insights into establishing prospective indoor environmental quality methods that incorporate technical and behavioral factors for a well-built workplace.

5.4 Research limitations and Future Research

This study has several limitations, which raises possible issues for future research. First, the participants from the government sector were fewer than the private sector due to the difficulty of reaching the government offices. Second, this research found that social

impact elements (group norms and sharing control conformance) were statistically negligible. This result may be because these measurements were more closely tied to IEC controls, indirectly impacting IEQs. Lastly, this study only examines the direct effects of the proposed independent variables (i.e., IEQ satisfaction) on IEQ comfort belief based on theories.

Further studies in this area can focus on the government sector and explore more about their workplace indoor environment. A separate study specifically targeted to the government sector would be useful for a better understanding of their office environment. A future study can focus on the direct measurements of the IEQs on social impact and dynamic group elements. Thus, a more focused study of each factor and its influence on the occupants' social impact is important. Moreover, Future research could investigate the opposite relationship to determine if comfort affects IEQ satisfaction or if productive or happier occupants were more tolerant of deficiencies in their indoor environment.

6. References

- Abdou, O.A., 1997. Effects of luminous environment on worker productivity in building spaces. *Journal of architectural engineering*, 3(3), pp.124-132. Doi: [https://doi.org/10.1061/\(ASCE\)1076-0431\(1997\)3:3\(124\)](https://doi.org/10.1061/(ASCE)1076-0431(1997)3:3(124))
- Aboulnaga, M.M. (2006) Towards green buildings: Glass as a building element—the use and misuse in the gulf region. *Renewable energy*, 31(5), pp.631-653. Doi: <https://doi.org/10.1016/j.renene.2005.08.017>
- Ajzen, I. (1991) The theory of planned behavior. *Organizational behavior and human decision processes*, 50(2), 179-211. Doi: [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)
- Akimoto, T., Tanabe, S.I., Yanai, T. and Sasaki, M. (2010) Thermal comfort and productivity-Evaluation of workplace environment in a task conditioned office. *Building and Environment*, 45(1), pp.45-50. Doi: <https://doi.org/10.1016/j.buildenv.2009.06.022>
- Al Horr, Y., Arif, M., Kaushik, A., Mazroei, A., Katafygiotou, M., and Elsarrag, E. (2016) Occupant productivity and office indoor environment quality: A review of the literature. *Building and Environment*, 105, pp.369-389. Doi: <https://doi.org/10.1016/j.buildenv.2016.06.001>
- Al-Atrash, F.Z. (2018) Adaptive thermal comfort and personal control over office indoor environment in a Mediterranean hot summer climate—the case of Amman, Jordan. Retrieved from: <https://publikationen.bibliothek.kit.edu/1000088485/20764498>
- Aleo, F., Sciuto, S. and Viadana, R., 1994. Solar transmission measurements in outdoor conditions of non-homogeneous shading devices. In *Proceedings of the European conference on energy performance and indoor climate in buildings* (pp. 1074-1079).
- Alexander, C., 2002. *The nature of order: the process of creating life*. Taylor & Francis.
- American Society of Heating, Refrigerating, Air-Conditioning Engineers and American National Standards Institute. (2004) *Thermal environmental conditions for human occupancy* (Vol. 55, No. 2004). American Society of Heating, Refrigerating and Air-Conditioning Engineers.
- American Society of Heating. (2013) Refrigerating and Air-Conditioning Engineers (ASHRAE). *ASHRAE Handbook 2013 Fundamentals, R.T.S. Cooling Load Calculations*, 18.
- Andersen, M., Rubin, M., Powles, R. and Scartezzini, J.L., 2005. Bi-directional transmission properties of Venetian blinds: experimental assessment compared to ray-tracing calculations. *Solar Energy*, 78(2), pp.187-198. Doi: <https://doi.org/10.1016/j.solener.2004.06.005>
- Antikainen, R., Lappalainen, S., Lonnqvist, A., Maksimainen, K., Reijula, K. and Uusi-Rauva, E. (2008) Exploring the relationship between indoor air and productivity. *Scandinavian Journal of Work*

Environment and Health, 34(4), pp.79-82. Retrieved from:

https://www.sjweh.fi/article/download.php?abstract_id=1214&file_nro=1

Aries, M. (2005) Human Lighting Demands. *Technische Universiteit Eindhoven*.

Aronoff, S. and Kaplan, A.G. (1995) *Total workplace performance: Rethinking the office environment*. Wdl Publications.

Augustin, S., Frankel, N. and Coleman, C., 2009. *Place advantage: Applied psychology for interior architecture*. John Wiley & Sons.

Ayr, U., Cirillo, E., Fato, I. and Martellotta, F. (2003) A new approach to assessing the performance of noise indices in buildings. *Applied acoustics*, 64(2), pp.129-145. Doi: [https://doi.org/10.1016/S0003-682X\(02\)00075-0](https://doi.org/10.1016/S0003-682X(02)00075-0)

Bach, F.W., 1965. The whys and wherefores of the open-plan office. *Kommunikation*, 1, pp.103-106.

Bae, S., Asojo, A.O. and Martin, C.S., 2020. Impact of occupants' demographics on indoor environmental quality satisfaction in the workplace. *Building Research & Information*, 48(3), pp.301-315.

Bako-Biro, Z. (2004) Human perception, S.B.S. symptoms and performance of office work during exposure to air polluted by building materials and personal computers. *International Centre for Indoor Environment and Energy*, 2, pp.215-223.

Bako-Biro, Z., Wargocki, P., Weschler, C.J. and Fanger, P.O. (2004) Effects of pollution from personal computers on perceived air quality, S.B.S. symptoms and productivity in offices. *Indoor air*, 14(3), pp.178-187. Retrieved from: <http://www.innenraumanalytik.at/Newsletter/bakobiro.pdf>

Banbury, S. and Berry, D.C., 1997. Habituation and dishabituation to speech and office noise. *Journal of Experimental Psychology: Applied*, 3(3), p.181. doi: <https://doi.org/10.1037/1076-898X.3.3.181>

Banbury, S.P. and Berry, D.C. (2005) Office noise and employee concentration: Identifying causes of disruption and potential improvements. *Ergonomics*, 48(1), pp.25-37. Doi: <https://doi.org/10.1080/00140130412331311390>

Bavaresco, M.V., D'Oca, S., Ghisi, E. and Lamberts, R., 2019. Technological innovations to assess and include the human dimension in the building-performance loop: A review. *Energy and Buildings*, 202, p.109365. Doi: <https://doi.org/10.1016/j.enbuild.2019.109365>

Bernstein, E.S. and Turban, S. (2018) The impact of the 'open'workspace on human collaboration. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 373(1753), p.20170239. Doi: <https://doi.org/10.1098/rstb.2017.0239>

Bluyssen, P.M., Aries, M. and van Dommelen, P. (2011) Comfort of workers in office buildings: The European HOPE project. *Building and Environment*, 46(1), pp.280-288. Doi:

<https://doi.org/10.1016/j.buildenv.2010.07.024>

Boake, T.M., Bes, B. and Arch, M., 2014. Hot climate double façades: avoiding solar gain. *Facade Tectonics*, 14, pp.2-24. Retrieved from: <http://www.tboake.com/bio/facadetectonics2014boake-rev.pdf>

Bonda, P. and Sosnowchik, K. (2006) *Sustainable commercial interiors*. John Wiley & Sons.

Boyce, P. (1998) Why daylight? *Proceedings of Daylight Technologies for Energy Efficiency in Buildings*. Ottawa, Ontario, Canada, 359-365.

Boyce, P.R. (1997) Light, sight and photobiology. *Lighting Futures*, 2(1), pp.3-6.

Boyce, P.R., 1974. Users' assessments of a landscaped office. *Journal of Architectural Research*, 3(3), pp.44-62.

Brenner, P. and Cornell, P. (1994) The balance between privacy and collaboration in knowledge worker teams. *Human Factors in Organizational Design and Management.*, Stockholm, Sweden.

Browning, W.D. and Romm, J.J. (1995) Greening the bottom line: Increasing productivity through energy-efficient design. *N.I.S.T. special publication*, (888), pp.1-8.

BuildingGreen (2004). Expanding the engineers' comfort zone: Working with adaptive thermal comfort. *Environmental Building News*, 13(7), Retrieved from BuildingGreen website: <http://www.buildinggreen.com/auth/article.cfm/2004/7/1/Expanding-the-Engineers-Comfort-Zone-Working-with-Adaptive-Thermal-Comfort/#sidebar-3>

Burton, L.J. and Mazerolle, S.M., 2011. Survey instrument validity part I: Principles of survey instrument development and validation in athletic training education research. *Athletic Training Education Journal*, 6(1), pp.27-35. Doi: <https://doi.org/10.4085/1947-380X-6.1.27>

Castaldo, V.L., Pigliautile, I., Rosso, F., Cotana, F., De Giorgio, F. and Pisello, A.L. (2018) How subjective and non-physical parameters affect occupants' environmental comfort perception. *Energy and Buildings*, 178, pp.107-129. Doi: <https://doi.org/10.1016/j.enbuild.2018.08.020>

Chang, C.Y. and Chen, P.K. (2005) Human response to window views and indoor plants in the workplace. *HortScience*, 40(5), pp.1354-1359. Doi: <https://doi.org/10.21273/HORTSCI.40.5.1354>

Chen, C.F., Hong, T., de Rubens, G.Z., Yilmaz, S., Bandurski, K., Bélafi, Z.D., De Simone, M., Bavaresco, M.V., Wang, Y., Liu, P.L. and Barthelmes, V.M. (2020) Culture, conformity, and carbon? A multi-country analysis of heating and cooling practices in office buildings. *Energy Research & Social Science*, 61, p.101344. Doi: <https://doi.org/10.1016/j.erss.2019.101344>

Chen, C.F., Yilmaz, S., Pisello, A.L., De Simone, M., Kim, A., Hong, T., Bandurski, K., Bavaresco, M.V., Liu, P.L. and Zhu, Y. (2020) The impacts of building characteristics, social psychological and

cultural factors on indoor environment quality productivity belief. *Building and Environment*, 185, p.107189. Doi: <https://doi.org/10.1016/j.buildenv.2020.107189>

Chiang, C.M. and Lai, C.M., 2002. A study on the comprehensive indicator of indoor environment assessment for occupants' health in Taiwan. *Building and Environment*, 37(4), pp.387-392.

Choi, J.H., Aziz, A. and Loftness, V. (2009) September. Decision support for improving occupant environmental satisfaction in office buildings: The relationship between sub-set of IEQ. satisfaction and overall environmental satisfaction. In *Proceedings of the 9th International Conference Healthy Buildings*, Syracuse, NY U.S.A. (Vol. 747). Doi: [https://doi.org/10.1016/S0360-1323\(01\)00034-8](https://doi.org/10.1016/S0360-1323(01)00034-8)

Choi, S., 2011. *The relationships among indoor environmental quality, occupant satisfaction, work performance, and sustainability ethic in sustainable buildings*. University of Minnesota. Retrieved from: <https://www.proquest.com/openview/602fc012d53db3b5c754cb8184b0ef87/1?pq-origsite=gscholar&cbl=18750>

Clements-Croome, D. (2015) Creative and productive workplaces: a review. *Intelligent Buildings International*. Doi: <https://doi.org/10.1080/17508975.2015.1019698>

Clements-Croome, D. and Baizhan, L. (2000) Productivity and indoor environment. In *Proceedings of Healthy Buildings* (Vol. 1, No. 1, pp. 629-634). Retrieved from: https://www.researchgate.net/profile/Derek-Clements-Croome/publication/279126933_Productivity_and_indoor_environment/links/5f5b92bd92851c07895d87d3/Productivity-and-indoor-environment.pdf

Clements-Croome, D. ed. (2006) *Creating the productive workplace*. Taylor & Francis.

Construction, MH. (2014) The drive toward healthier buildings: The market drivers and impact of building design and construction on occupant health, wellbeing and productivity. *Smart Market Report*.

D'Oca, S., Chen, C.F., Hong, T. and Belafi, Z. (2017) Synthesizing building physics with social psychology: An interdisciplinary framework for context and occupant behavior in office buildings. *Energy research & social science*, 34, pp.240-251. Doi: <https://doi.org/10.1016/j.erss.2017.08.002>

d'Oca, S., Podjed, D., Vetršek, J., Dolinšek, S. and op't Veld, P. (2019) Contextual and behavioural factors influencing human-building interaction in university offices: a cross-cultural comparison. In *E3S Web of Conferences* (Vol. 111, p. 04064). EDP Sciences.

Day, J.K. and Gunderson, D.E., 2015. Understanding high performance buildings: The link between occupant knowledge of passive design systems, corresponding behaviors, occupant comfort and

environmental satisfaction. *Building and Environment*, 84, pp.114-124. Doi:

<https://doi.org/10.1016/j.buildenv.2014.11.003>

De Croon, E., Sluiter, J., Kuijer, P.P. and Frings-Dresen, M. (2005) The effect of office concepts on worker health and performance: a systematic review of the literature. *Ergonomics*, 48(2), pp.119-134.

Doi: <https://doi.org/10.1080/00140130512331319409>

D'Oca, S., Corgnati, S., Pisello, A.L. and Hong, T., 2016. Introduction to an occupant behavior motivation survey framework. Retrieved from: <https://escholarship.org/uc/item/8td7p9x1>

Elzeyadi, I. (2011) Daylighting-bias and biophilia: quantifying the impact of daylighting on occupants health. *US Green Building Council*. http://www.usgbc.org/sites/default/files/OR10_Daylighting%20Bias%20and%20Biophilia.pdf.

Environmental Protection Agency. (1998) Inside IAQ. EPA's Indoor Air Quality Research Update. A comparison of indoor and outdoor concentrations of hazardous air pollutants. U.S. Washington DC.

Evans, G.W. and Johnson, D., 2000. Stress and open-office noise. *Journal of applied psychology*, 85(5), p.779. Doi: <https://doi.org/10.1037/0021-9010.85.5.779>

Fange, P.O. (2002) Human requirements in future air-conditioned environments. In *Advances in building technology* (pp. 29-38). Elsevier. Doi: <https://doi.org/10.1016/B978-008044100-9/50006-1>

Fanger, P. O. (2008). *Poor & indoor air quality decreases human productivity*. Retrieved from ICEE website: http://www.byg.dtu.dk/Sektioner/IK/health_+_productivity/poor%20indoor%20Oair%20quality.aspx

Fanger, S.J., 2011. Corporate Office Employee Analysis: Transformation from Closed Office Layout to Open Floor Plan Environment. . Retrieved from: <https://digitalcommons.unl.edu/archthesis/123/>

Feige, A., Wallbaum, H., Janser, M. and Windlinger, L. (2013) Impact of sustainable office buildings on occupant's comfort and productivity. *Journal of Corporate Real Estate*. Doi: <https://doi.org/10.1108/JCRE-01-2013-0004>

Festinger, L., Schachter, S. and Back, K. (1950) Social pressures in informal groups; a study of human factors in housing. Retrieved from: <https://psycnet.apa.org/record/1951-02994-000>

Fisher, S., 1990. Environmental change, control and vulnerability. *On the move: The psychology of change and transition*, pp.53-65.

Fisk, W. and Seppanen, O. (2007) Providing better indoor environmental quality brings economic benefits. Retrieved from: <https://www.osti.gov/biblio/924794>

Fisk, W.J. (2000) Health and productivity gains from better indoor environments and their relationship with building energy efficiency. *Annual review of energy and the Environment*, 25(1),

pp.537-566. Retrieved from: <https://www.camfil.com/damdocuments/29947/127802/health-and--productivity-gains-from-improved-indoor-enviornments.pdf>

Fisk, W.J., Black, D. and Brunner, G. (2012) Changing ventilation rates in U.S. offices: Implications for health, work performance, energy, and associated economics. *Building and Environment*, 47, pp.368-372. Doi: <https://doi.org/10.1016/j.buildenv.2011.07.001>

Fleming, D. (2004) Facilities management: a behavioural approach. *Facilities*. Doi: <https://doi.org/10.1108/02632770410517933>

Fransson, N., Västfjäll, D. and Skoog, J. (2007) In search of the comfortable indoor Environment: A comparison of the utility of objective and subjective indicators of indoor comfort. *Building and Environment*, 42(5), pp.1886-1890. Doi: <https://doi.org/10.1016/j.buildenv.2006.02.021>

Frontczak, M., Schiavon, S., Goins, J., Arens, E., Zhang, H. and Wargocki, P. (2012) Quantitative relationships between occupant satisfaction and satisfaction aspects of indoor environmental quality and building design. *Indoor air*, 22(2), pp.119-131. Doi: <https://doi.org/10.1111/j.1600-0668.2011.00745.x>

Fundamentals, A.H. (2005) American Society of Heating. *Refrigerating and Air-Conditioning Engineers*.

Garnys, V., 2007. Indoor environment quality, design, and the value of facility ecology. *Environment Design Guide*, pp.1-6. Retrieved from: <https://www.jstor.org/stable/26148753>

Gillis, K. and Gatersleben, B., 2015. A review of psychological literature on the health and wellbeing benefits of biophilic design. *Buildings*, 5(3), pp.948-963. Doi: <https://doi.org/10.3390/buildings5030948>

Goldman, R.F. (1999) Extrapolating ASHRAE's comfort model. *HVAC&R Research*, 5(3), pp.189-194. . Retrieved from: <https://www.tandfonline.com/doi/abs/10.1080/10789669.1999.10391232?journalCode=uahvc20>

Gossauer, E. and Wagner, A., 2012. Post-occupancy evaluation and thermal comfort: state of the art and new approaches. *Advances in building energy research*, pp.151-175.

Gou, Z., Lau, S.S.Y. and Chen, F. (2012) Subjective and objective evaluation of the thermal Environment in a three-star green office building in China. *Indoor and Built Environment*, 21(3), pp.412-422. Doi: <https://doi.org/10.1177/1420326X11419311>

Guagnano, G.A., Stern, P.C. and Dietz, T. (1995) Influences on attitude-behavior relationships: A natural experiment with curbside recycling. *Environment and behavior*, 27(5), pp.699-718. Doi: <https://doi.org/10.1177/001391659527500>

- Handbook, A.S.H.R.A.E. (2005) Fundamentals, american Society of heating, refrigeration and air conditioning engineers. *Inc. Atlanta, GA.*
- Haynes, B.P. (2007) The impact of the behavioural Environment on office productivity. *Journal of facilities management*. Doi: <https://doi.org/10.1108/14725960710775045>
- Haynes, B.P. (2008) An evaluation of the impact of the office environment on productivity. *Facilities*. Doi: <https://doi.org/10.1108/02632770810864970>
- Heerwagen, J. (2000) Green buildings, organizational success and occupant productivity. *Building Research & Information*, 28(5-6), pp.353-367. Doi: <https://doi.org/10.1080/096132100418500>
- Heerwagen, J. (2003) The sustainable office: Links to worker health, wellbeing and productivity. *The Office of Government wide Policy (Ed.), Innovative Workplace Strategies*, pp.29-35.
- Heerwagen, J.H. (2003) Bio-inspired design: What can we learn from nature. *Unpublished manuscript*. Retrieved from: <https://biomimicry.typepad.com/bioinspire/files/BioInspire.1-01.15.03.pdf>
- Heerwagen, J.H. and Heerwagen, D.R. (1986) Lighting and psychological comfort. *Lighting Design and Application*, 16(4), pp.47-51.
- Heerwagen, J.H. and Orians, G.H. (1986) Adaptations to windowlessness: A study of the use of visual decor in windowed and windowless offices. *Environment and behavior*, 18(5), pp.623-639. Doi: <https://doi.org/10.1177/0013916586185003>
- Hellwig, R.T. (2015) Perceived control in indoor environments: a conceptual approach. *Building Research & Information*, 43(3), pp.302-315. Doi: <https://doi.org/10.1080/09613218.2015.1004150>
- Hensen, J.L.M. (1991) *On the thermal interaction of building structure and heating and ventilating system*. Technische Universiteit Eindhoven. Retrieved from: http://papers.cumincad.org/cgi-bin/works/2015%20+dave=2:/Show?diss_hensen
- Herzberg, F.I. (1966) *Work and the Nature of Man*.
- Heschong, L. (1979) *Thermal delight in architecture*. M.I.T. press.
- Huizenga, C., Abbaszadeh, S., Zagreus, L. and Arens, E.A. (2006) Air quality and thermal comfort in office buildings: results of a large indoor environmental quality survey. *Proceeding of Healthy Buildings 2006*, 3, pp.393-397. Retrieved from: <https://escholarship.org/uc/item/7897g2f8>
- Indoor Air Quality Scientific Findings Resource Bank (IAQ-SFRB) (2010). *Overview of L.A.Q.* Retrieved from IAQ-SFRB. website: <http://www.iaqscience.lbl.gov/overview.html>
- Indoor Environment Department (I.E.D.) (2010). *Indoor Environment Department Publications 1995-2010*. Retrieved from I.E.D. website: http://eetd.lbl.gov/IED/IED-PubList_With-abs.pdf

- Ireland, T. and Garnier, S. (2018) Architecture, space and information in constructions built by humans and social insects: a conceptual review. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 373(1753), p.20170244.
- John, G., Clements-Croome, D. and Jeronimidis, G., 2005. Sustainable building solutions: a review of lessons from the natural world. *Building and environment*, 40(3), pp.319-328. Doi: <https://doi.org/10.1016/j.buildenv.2004.05.011>
- Jones, L. (2008) *Environmentally responsible design: Green and sustainable design for interior designers*. John Wiley & Sons.
- Kaarlela-Tuomaala, A., Helenius, R., Keskinen, E. and Hongisto, V., 2009. Effects of acoustic environment on work in private office rooms and open-plan offices—longitudinal study during relocation. *Ergonomics*, 52(11), pp.1423-1444. Doi: <https://doi.org/10.1080/00140130903154579>
- Kang, S., Ou, D. and Mak, C.M. (2017) The impact of indoor environmental quality on work productivity in university open-plan research offices. *Building and Environment*, 124, pp.78-89. Doi: <https://doi.org/10.1016/j.buildenv.2017.07.003>
- Kaplan, R. (1993) *Urban forestry and the workplace*. Forest Service, USDA. Retrieved from: https://deepblue.lib.umich.edu/bitstream/handle/2027.42/148477/1993_Urban_forestry_and_workplace_In_Gobster.pdf?sequence=1
- Kaplan, R. and Kaplan, S. (1989) *The experience of nature: A psychological perspective*. Cambridge university press.
- Karjalainen, S. (2012) Thermal comfort and gender: a literature review. *Indoor air*, 22(2), pp.96-109. Doi: <https://doi.org/10.1111/j.1600-0668.2011.00747.x>
- Kats, G. (2013) *Greening our built world: costs, benefits, and strategies*. Island Press.
- Kats, G., Alevantis, L., Berman, A., Mills, E. and Perlman, J., 2003. The costs and financial benefits of green buildings. *A report to California's sustainable building task force*, 134.
- Keighley, E.C., 1970. Acceptability criteria for noise in large offices. *Journal of Sound and Vibration*, 11(1), pp.83-93. Doi: [https://doi.org/10.1016/S0022-460X\(70\)80108-0](https://doi.org/10.1016/S0022-460X(70)80108-0)
- Kellert, S.R., 2008. Dimensions, elements, and attributes of biophilic design. *Biophilic design: the theory, science, and practice of bringing buildings to life*, pp.3-19.
- Kellert, S.R., Heerwagen, J. and Mador, M., 2011. *Biophilic design: the theory, science and practice of bringing buildings to life*. John Wiley & Sons.
- Kim, J., de Dear, R., Candido, C., Zhang, H. and Arens, E. (2013) Gender differences in office occupant perception of indoor environmental quality (IEQ). *Building and Environment*, 70, pp.245-256. Doi: <https://doi.org/10.1016/j.buildenv.2013.08.022>

- Kim, J., Hong, T., Jeong, J., Koo, C. and Kong, M. (2017) An integrated psychological response score of the occupants based on their activities and the indoor environmental quality condition changes. *Building and Environment*, 123, pp.66-77. Doi: <https://doi.org/10.1016/j.buildenv.2017.06.046>
- Klepeis, N.E., Nelson, W.C., Ott, W.R., Robinson, J.P., Tsang, A.M., Switzer, P., Behar, J.V., Hern, S.C. and Engelmann, W.H. (2001) The National Human Activity Pattern Survey (N.H.A.P.S.): a resource for assessing exposure to environmental pollutants. *Journal of Exposure Science & Environmental Epidemiology*, 11(3), pp.231-252. Retrieved from: <https://www.nature.com/articles/7500165>
- Knez, I. and Thorsson, S. (2006) Influences of culture and environmental attitude on thermal, emotional and perceptual evaluations of a public square. *International journal of biometeorology*, 50(5), pp.258-268. Doi: <https://doi.org/10.1007/s00484-006-0024-0>
- Krčmářová, J. (2009) EO Wilson's concept of Biophilia and the environmental movement in the U.S.A. *Klaudyán: Internet Journal of Historical Geography and Environmental History*, 6(1/2), pp.4-17. Retrieved from: http://prfdec.natur.cuni.cz/~ksgrrsek/klaudyán/dwnl/200901/01_Krcmarova_pdf.pdf
- Krejcie, R.V. and Morgan, D.W. (1970) Determining sample size for research activities. *Educational and psychological measurement*, 30(3), pp.607-610. Doi: <https://doi.org/10.1177/00131644700300030>
- Kroner, W., Stark-Martin, J. A., & Willemain, T. (1992) *Using advanced office technology to increase productivity*. Troy, NY: Center for Architectural Research.
- Kuhn, E., 2006. Solar control: a general evaluation method for facades with venetian blinds or other solar control systems. *Energy & Buildings* 38, 648–660. Doi: <https://doi.org/10.1016/j.enbuild.2005.10.002>
- Kwok, A.G. and Rajkovich, N.B. (2010) Addressing climate change in comfort standards. *Building and Environment*, 45(1), pp.18-22. Doi: <https://doi.org/10.1016/j.buildenv.2009.02.005>
- Labor Market Regulatory Authority. (2006) Survey's Most Important Results. Available at: <https://lmra.bh.portal/en/page/show/89> (Accessed on: 11th Nov 2021)
- Lai, J.H. and Yik, F.W., 2007. Perceived importance of the quality of the indoor environment in commercial buildings. *Indoor and built environment*, 16(4), pp.311-321. Doi: <https://doi.org/10.1177/1420326X07080463>

- Lan, L., Wargocki, P. and Lian, Z. (2012) Optimal thermal Environment improves performance of office work. *Rehva Journal*, 49(1), pp.12-17. Retrieved from: https://www.rehva.eu/fileadmin/hvac-dictio/01-2012/optimal-thermal-environment-improves-performance-of-office-work_rj1201.pdf
- Langdon, F.J., 1966. Modern Offices: A User Survey. National Building Studies Research Paper 41. Retrieved from: <https://eric.ed.gov/?id=ED036098>
- Langer, S. and Bekö, G. (2013) Indoor air quality in the Swedish housing stock and its dependence on building characteristics. *Building and Environment*, 69, pp.44-54. Doi: <https://doi.org/10.1016/j.buildenv.2013.07.013>
- Langevin, J., Wen, J. and Gurian, P.L. (2013) Modeling thermal comfort holistically: Bayesian estimation of thermal sensation, acceptability, and preference distributions for office building occupants. *Building and Environment*, 69, pp.206-226. Doi: <https://doi.org/10.1016/j.buildenv.2013.07.017>
- Lasch, K.E., Marquis, P., Vigneux, M., Abetz, L., Arnould, B., Bayliss, M., Crawford, B. and Rosa, K., 2010. PRO development: rigorous qualitative research as the crucial foundation. *Quality of life research*, 19(8), pp.1087-1096. Doi: <https://doi.org/10.1007/s11136-010-9677-6>
- Leaman, A. and Bordass, B., 2001. Assessing building performance in use 4: the Probe occupant surveys and their implications. *Building Research & Information*, 29(2), pp.129-143. Doi: <https://doi.org/10.1080/09613210010008045>
- Lee, E.S., DiBartolomeo, D.L. and Selkowitz, S.E., 1998. Thermal and daylighting performance of an automated venetian blind and lighting system in a full-scale private office. *Energy and buildings*, 29(1), pp.47-63. Doi: [https://doi.org/10.1016/S0378-7788\(98\)00035-8](https://doi.org/10.1016/S0378-7788(98)00035-8)
- Lee, S.Y. and Brand, J.L., 2005. Effects of control over office workspace on perceptions of the work environment and work outcomes. *Journal of environmental psychology*, 25(3), pp.323-333. Doi: <https://doi.org/10.1016/j.jenvp.2005.08.001>
- Lee, Y.S. (2010) Office layout affecting privacy, interaction, and acoustic quality in LEED-certified buildings. *Building and Environment*, 45(7), pp.1594-1600. Doi: <https://doi.org/10.1016/j.buildenv.2010.01.007>
- Leech, J.A., Nelson, W.C., T B.U.R.N.E.T.T., R.I.C.H.A.R.D., Aaron, S. and Raizenne, M.E. (2002) It's about time: a comparison of Canadian and American time-activity patterns. *Journal of Exposure Science & Environmental Epidemiology*, 12(6), pp.427-432. Retrieved from: <https://www.nature.com/articles/7500244>
- Li, D.H. (2010) A review of daylight illuminance determinations and energy implications. *Applied Energy*, 87(7), pp.2109-2118. Doi: <https://doi.org/10.1016/j.apenergy.2010.03.004>

- Li, D.H. and Tsang, E.K. (2008) An analysis of daylighting performance for office buildings in Hong Kong. *Building and Environment*, 43(9), pp.1446-1458. Doi: <https://doi.org/10.1016/j.buildenv.2007.07.002>
- Liang, H.H., Chen, C.P., Hwang, R.L., Shih, W.M., Lo, S.C. and Liao, H.Y., 2014. Satisfaction of occupants toward indoor environment quality of certified green office buildings in Taiwan. *Building and Environment*, 72, pp.232-242. Doi: <https://doi.org/10.1016/j.buildenv.2013.11.007>
- Lim, Y.W., Kandar, M.Z., Ahmad, M.H., Ossen, D.R. and Abdullah, A.M. (2012) Building façade design for daylighting quality in typical government office building. *Building and Environment*, 57, pp.194-204. Doi: <https://doi.org/10.1016/j.buildenv.2012.04.015>
- Lin, Z. and Deng, S. (2008) A study on the thermal comfort in sleeping environments in the subtropics—developing a thermal comfort model for sleeping environments. *Building and Environment*, 43(1), pp.70-81. Doi: <https://doi.org/10.1016/j.buildenv.2006.11.026>
- Lohr, V.I., Pearson-Mims, C.H. and Goodwin, G.K. (1996) Interior plants may improve worker productivity and reduce stress in a windowless environment. *Journal of environmental horticulture*, 14(2), pp.97-100. Doi: <https://doi.org/10.24266/0738-2898-14.2.97>
- MacKerron, G. and Mourato, S. (2013) Happiness is greater in natural environments. *Global environmental change*, 23(5), pp.992-1000. Doi: <https://doi.org/10.1016/j.gloenvcha.2013.03.010>
- Mahbob, N.S., Kamaruzzaman, S.N., Salleh, N. and Sulaiman, R., 2013. Correlation and regression studies of indoor environmental quality (IEQ), human productivity, comfort and stress level in office buildings. *Advanced Science Letters*, 19(1), pp.342-345. Doi: <https://doi.org/10.1166/asl.2013.4707>
- Mansour, O.E. (2014) Indoor air quality: an enviro-cultural perspective. *Eco-Architecture V: Harmonisation between Architecture and Nature*, 142, p.187.
- Maslow, A.H. (1943) A theory of human motivation. *Psychological review*, 50(4), p.370.
- Meir, I.A., Garb, Y., Jiao, D. and Cicelsky, A. (2009) Post-occupancy evaluation: An inevitable step toward sustainability. *Advances in building energy research*, 3(1), pp.189-219. Doi: <https://doi.org/10.3763/aber.2009.0307>
- Moezzi, M. (2009) Are comfort expectations of building occupants too high?. Doi: <https://doi.org/10.1080/09613210802611009>
- Muzaffar, P.N.A., Noor, N.M. and Mahmud, S.A., 2020. A COMPARATIVE STUDY ON THE IMPACTS OF OPEN PLAN AND CLOSED OFFICE LAYOUT TOWARDS EMPLOYEES' PERCEIVED PRODUCTIVITY. *Jurnal Penyelidikan Sains Sosial (JOSSR)*, 3(6), pp.49-58. Retrieved from: <http://www.jossr.com/PDF/JOSSR-2020-06-03-26.pdf>

- Nabhan, G.P., St Antoine, S., Kellert, S. and Wilson, E. (1993) The loss of floral and faunal story: The extinction of experience. *The biophilia hypothesis*, pp.229-250.
- Nagy, E., Yasunaga, S. and Kose, S. (1995) Japanese office employees' psychological reactions to their underground and above-ground offices. *Journal of environmental psychology*, 15(2), pp.123-134. Doi: [https://doi.org/10.1016/0272-4944\(95\)90020-9](https://doi.org/10.1016/0272-4944(95)90020-9)
- National Research Council Canada (NRCC). (2009) *Open-plan office lighting environment*. Retrieved from NRCC website: <http://www.nrc.cnrc.gc.ca/eng/projects/irc/cope/lighting>. Html
- Ne'Eman, E. and Hopkinson, R.G. (1970) Critical minimum acceptable window size: a study of window design and provision of a view. *Lighting Research & Technology*, 2(1), pp.17-27. Doi: <https://doi.org/10.1177/14771535700020010701>
- Nemecek, J. and Grandjean, E., 1973. Noise in landscaped offices. *Applied Ergonomics*, 4(1), pp.19-22.
- O.S.E.L.A.N.D., N. (1999) *Environmental factors affecting office worker performance A review of evidence*. Doi: [https://doi.org/10.1016/0003-6870\(73\)90006-9](https://doi.org/10.1016/0003-6870(73)90006-9)
- O'Brien, W. and Gunay, H.B., 2014. The contextual factors contributing to occupants' adaptive comfort behaviors in offices—A review and proposed modeling framework. *Building and Environment*, 77, pp.77-87. Doi: <https://doi.org/10.1016/j.buildenv.2014.03.024>
- Ogbonna, A.C. and Harris, D.J. (2008) Thermal comfort in sub-Saharan Africa: field study report in Jos-Nigeria. *Applied Energy*, 85(1), pp.1-11. Doi: <https://doi.org/10.1016/j.apenergy.2007.06.005>
- Olesen, B.W. and Brager, G.S. (2004) A better way to predict comfort: The new ASHRAE standard 55-2004. Retrieved from: <https://escholarship.org/uc/item/2m34683k>
- Olesen, B.W. and Parsons, K.C. (2002) Introduction to thermal comfort standards and to the proposed new version of EN ISO 7730. *Energy and buildings*, 34(6), pp.537-548. Doi: [https://doi.org/10.1016/S0378-7788\(02\)00004-X](https://doi.org/10.1016/S0378-7788(02)00004-X)
- Öz, A.M. and Ergönül, S., 2015. Improving Occupant's Satisfaction and Productivity in Sustainable Building Design. *Journal of Sustainable Architecture and Civil Engineering*, 13(4), pp.39-48. Doi: <https://doi.org/10.5755/j01.sace.13.4.13048>
- Paciuk, M.T. (1990) The role of personal control of the environment in thermal comfort and satisfaction at the workplace. Retrieved from: <https://www.proquest.com/openview/a06a0ab61894bce108cc42f911e2c602/1?pq-origsite=gscholar&cbl=18750&diss=y>

- Parsaee, M., Demers, C.M., Hébert, M., Lalonde, J.F. and Potvin, A. (2019) A photobiological approach to biophilic design in extreme climates. *Building and Environment*, 154, pp.211-226. Doi: <https://doi.org/10.1016/j.buildenv.2019.03.027>
- Pfeffer, M., Korf, H.W. and Wicht, H., 2018. Synchronizing effects of melatonin on diurnal and circadian rhythms. *General and comparative endocrinology*, 258, pp.215-221. Doi: <https://doi.org/10.1016/j.ygcen.2017.05.013>
- Putra, J.C.P. (2017) A study of thermal comfort and occupant satisfaction in office room. *Procedia engineering*, 170, pp.240-247. Doi: <https://doi.org/10.1016/j.proeng.2017.03.057>
- Qi, M.W., Li, X.F., Weschler, L.B. and Sundell, J., 2014. CO 2 generation rate in Chinese people. *Indoor Air*, 24(6), pp.559-566. Doi: <https://doi.org/10.1111/ina.12110>
- Quang, T.N., He, C., Knibbs, L.D., De Dear, R. and Morawska, L. (2014) Co-optimisation of indoor environmental quality and energy consumption within urban office buildings. *Energy and Buildings*, 85, pp.225-234. Doi: <https://doi.org/10.1016/j.enbuild.2014.09.021>
- Ramzy, N.S., 2015. Biophilic qualities of historical architecture: In quest of the timeless terminologies of 'life' in architectural expression. *Sustainable Cities and Society*, 15, pp.42-56. Doi: <https://doi.org/10.1016/j.scs.2014.11.006>
- Rea, M.S., Figueiro, M.G. and Bullough, J.D. (2002) Circadian photobiology: an emerging framework for lighting practice and research. *Lighting research & technology*, 34(3), pp.177-187. Doi: <https://doi.org/10.1191/1365782802lt057oa>
- Ricciardi, P. and Buratti, C. (2018) Environmental quality of university classrooms: Subjective and objective evaluation of the thermal, acoustic, and lighting comfort conditions. *Building and Environment*, 127, pp.23-36. Doi: <https://doi.org/10.1016/j.buildenv.2017.10.030>
- Roelofsen, P. (2016) A computer model for the assessment of employee performance loss as a function of thermal discomfort or degree of heat stress. *Intelligent Buildings International*, 8(4), pp.195-214. Doi: <https://doi.org/10.1080/17508975.2015.1011071>
- Rubin, A.I., Collins, B.L. and Tibbott, R.L. (1978) *Window blinds as a potential energy saver: A case study*. U.S. Department of Commerce, National Bureau of Standards.
- Ryan, C.O., Browning, W.D., Clancy, J.O., Andrews, S.L. and Kallianpurkar, N.B., 2014. Biophilic design patterns: emerging nature-based parameters for health and well-being in the built environment. *ArchNet-IJAR: International Journal of Architectural Research*, 8(2), p.62. Retrieved from: <https://earthwise.education/wp-content/uploads/2019/10/Biophilicdesign-patterns.pdf>

- Sadick, A.M. and Issa, M.H. (2017) Occupants' indoor environmental quality satisfaction factors as measures of school teachers' wellbeing. *Building and Environment*, 119, pp.99-109. Doi: <https://doi.org/10.1016/j.buildenv.2017.03.045>
- Sbci, U.N.E.P. (2009) Buildings and climate change: Summary for decision-makers. *United Nations Environmental Programme, Sustainable Buildings and Climate Initiative, Paris*, pp.1-62.
- Seppänen, O.A. and Fisk, W. (2006) Some quantitative relations between indoor environmental quality and work performance or health. *Hvac&R Research*, 12(4), pp.957-973. Retrieved from: <https://www.tandfonline.com/doi/abs/10.1080/10789669.2006.10391446>
- Shahzad, S., Brennan, J., Theodossopoulos, D., Hughes, B. and Calautit, J.K. (2017) Energy and comfort in contemporary open plan and traditional personal offices. *Applied energy*, 185, pp.1542-1555. Doi: <https://doi.org/10.1016/j.apenergy.2016.02.100>
- Simmler, H. and Binder, B., 2008. Experimental and numerical determination of the total solar energy transmittance of glazing with venetian blind shading. *Building and Environment*, 43(2), pp.197-204. Doi: <https://doi.org/10.1016/j.buildenv.2006.10.011>
- Singh, A., Syal, M., Grady, S.C. and Korkmaz, S., 2010. Effects of green buildings on employee health and productivity. *American journal of public health*, 100(9), pp.1665-1668. Doi: <https://doi.org/10.2105/AJPH.2009.180687>
- Snow, F.J. (1982) March. American Society of heating, refrigeration, and air conditioning engineers (ASHRAE) thermographic standard 101 P. In *Thermal Infrared Sensing Applied to Energy Conservation in Building Envelopes* (Vol. 313, pp. 94-98). International Society for Optics and Photonics. Doi: <https://doi.org/10.1117/12.932959>
- Snyder, J. (2020) Energy-saving strategies for luminaire-level lighting controls. *Building and Environment*, 169. Doi: <https://doi.org/10.1016/j.buildenv.2018.10.026>
- Social Insurance Organization (2021) *Statistical research of registered working in Bahrain*. Available at: <https://www.iga.gov.bh/en/category/statistics-and-population> . (Accessed: 2 January 2022).
- Soderlund, J. and Newman, P., 2015. Biophilic architecture: a review of the rationale and outcomes. *AIMS environmental science*, 2(4), pp.950-969. Doi: <https://doi.org/10.3934/environsci.2015.4.950>
- Spengler, J.D. (1999) Buildings operations and ETS exposure. *Environmental health perspectives*, 107(suppl 2), pp.313-317. Doi: <https://doi.org/10.1289/ehp.99107s2313>
- Staddon, S.C., Cycil, C., Goulden, M., Leygue, C. and Spence, A., 2016. Intervening to change behaviour and save energy in the workplace: A systematic review of available evidence. *Energy Research & Social Science*, 17, pp.30-51. Doi: <https://doi.org/10.1016/j.erss.2016.03.027>

Standard, A.S.H.R.A.E. (2010) 55. Thermal Environmental Conditions for Human Occupancy; Atlanta: American Society Of Heating, Refrigerating And Airconditioning Engineers.

Standard, ASHRAE (2004) Standard 55-2004, Thermal environmental conditions for human occupancy. *American Society of Heating, Refrigerating and Air Conditioning Engineers, Atlanta, GA.*

Stern, P.C., Dietz, T., Abel, T., Guagnano, G.A. and Kalof, L. (1999) A value-belief-norm theory of support for social movements: The case of environmentalism. *Human ecology review*, pp.81-97. Doi: <https://www.jstor.org/stable/24707060>

Stillman, J., 2018. New Harvard Study: Your Open-Plan Office Is Making Your Team Less Collaborative. *Kättesaadav: https://www.inc.com/jessica-stillman/new-harvard-study-you-open-plan-office-is-making-your-team-less-collaborative.html.*

Sundstrom, E., Town, J.P., Rice, R.W., Osborn, D.P. and Brill, M., 1994. Office noise, satisfaction, and performance. *Environment and behavior*, 26(2), pp.195-222. Doi: <https://doi.org/10.1177/001391659402600204>

Szczurek, A., Maciejewska, M., Teuerle, M. and Wylomańska, A. (2015) Method to characterize collective impact of factors on indoor air. *Physica A: Statistical Mechanics and its Applications*, 420, pp.190-199. Doi: <https://doi.org/10.1016/j.physa.2014.10.094>

Tanabe, S.I., Haneda, M. and Nishihara, N., 2015. Workplace productivity and individual thermal satisfaction. *Building and environment*, 91, pp.42-50. Doi: <https://doi.org/10.1016/j.buildenv.2015.02.032>

Tetlow, R.M., Beaman, C.P., Elmualim, A.A. and Couling, K. (2012) The impact of occupant behaviour on the variation between the design and in-use energy consumption of non-domestic buildings: An experimental approach. In *3rd Annual T.S.B.E. EngD Conference Proceedings. University of Reading.*

Thalin, W., 2017. *Transitioning Workplace Environments From an FM Perspective.* Arizona State University.

Thatcher, A. and Milner, K., 2012. The impact of a 'green' building on employees' physical and psychological wellbeing. *Work*, 41(Supplement 1), pp.3816-3823. Doi: <https://doi.org/10.3233/WOR-2012-0683-3816>

The Committee on the Environment, Public Health and Food Safety (ENVI). (2004) European Action Plan 2004-2010 in favor of the environment and health. European Parliament.

Tremblay, S. and Jones, D.M., 1998. Role of habituation in the irrelevant sound effect: Evidence from the effects of token set size and rate of transition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 24(3), p.659.

- Tzempelikos, A. (2008) The impact of venetian blind geometry and tilt angle on view, direct light transmission and interior illuminance. *Solar energy*, 82(12), pp.1172-1191. Doi: <https://doi.org/10.1016/j.solener.2008.05.014>
- Tzempelikos, A. and Athienitis, A.K., 2003. Modeling and evaluation of a window with integrated motorized venetian blinds. In *Proceedings of 3rd International Solar Energy Society World Congress*.
- ul Haq, M.A., Hassan, M.Y., Abdullah, H., Rahman, H.A., Abdullah, M.P., Hussin, F. and Said, D.M., 2014. A review on lighting control technologies in commercial buildings, their performance and affecting factors. *Renewable and Sustainable Energy Reviews*, 33, pp.268-279. Doi: <https://doi.org/10.1016/j.rser.2014.01.090>
- Van Der Voordt, T.J. (2004) Productivity and employee satisfaction in flexible workplaces. *Journal of Corporate Real Estate*. Doi: <https://doi.org/10.1108/14630010410812306>
- Van Hoof, J., Mazej, M. and Hensen, J.L., 2010. Thermal comfort: research and practice. *Frontiers in Bioscience-Landmark*, 15(2), pp.765-788. Retrieved from: https://www.researchgate.net/profile/Jan-Hensen/publication/258291389_Thermal_comfort_Research_and_practice/links/0deec52b30c518bad7000000/Thermal-comfort-Research-and-practice.pdf
- Varjo, J., Hongisto, V., Haapakangas, A., Maula, H., Koskela, H. and Hyönä, J. (2015) Simultaneous effects of irrelevant speech, temperature and ventilation rate on performance and satisfaction in open-plan offices. *Journal of Environmental Psychology*, 44, pp.16-33. Doi: <https://doi.org/10.1016/j.jenvp.2015.08.001>
- Veitch, J.A., 1990. Office noise and illumination effects on reading comprehension. *Journal of Environmental Psychology*, 10(3), pp.209-217. Doi: [https://doi.org/10.1016/S0272-4944\(05\)80096-9](https://doi.org/10.1016/S0272-4944(05)80096-9)
- Veitch, J.A., Charles, K.E., Farley, K.M. and Newsham, G.R. (2007) A model of satisfaction with open-plan office conditions: COPE field findings. *Journal of Environmental Psychology*, 27(3), pp.177-189. Doi: <https://doi.org/10.1016/j.jenvp.2007.04.002>
- Vernon, H.M. and Bedford, T. (1926) A Physiological Study of the Ventilation and Heating in Certain Factories. A Physiological Study of the Ventilation and Heating in Certain Factories., (35). Retrieved from: <https://www.cabdirect.org/cabdirect/abstract/19272700353>
- Wagner, A., Gossauer, E., Moosmann, C., Gropp, T. and Leonhart, R. (2007) Thermal comfort and workplace occupant satisfaction—Results of field studies in German low energy office buildings. *Energy and buildings*, 39(7), pp.758-769. Doi: <https://doi.org/10.1016/j.enbuild.2007.02.013>
- Wargocki, P. (2008) *Perceived air quality, sbs-symptoms and productivity in a low- polluting and a non-low-polluting building*. Retrieved from ICEE website: http://www.byg.dtu.dk/Sektioner/IK/health+_productivity/Perceived%20air%20quality.aspx

- Wargocki, P., Lagercrantz, L., Witterseh, T., Sundell, J., Wyon, D.P. and Fanger, P.O. (2002) Subjective perceptions, symptom intensity and performance: a comparison of two independent studies, both changing similarly the pollution load in an office. *Indoor air*, 12(2), pp.74-80. Doi: <https://doi.org/10.1034/j.1600-0668.2002.01101.x>
- Wargocki, P., Sundell, J., Bischof, W., Brundrett, G., Fanger, P.O., Gyntelberg, F., Hanssen, S.O., Harrison, P., Pickering, A., Seppänen, O. and Wouters, P. (2002) Ventilation and health in non-industrial indoor environments: report from a European multidisciplinary scientific consensus meeting (E.U.R.O.V.E.N.). *Indoor air*, 12(2), pp.113-128. Doi: <https://doi.org/10.1034/j.1600-0668.2002.01145.x>
- Wargocki, P., Wyon, D.P. and Fanger, P.O. (2000) Productivity is affected by the air quality in offices. In *Proceedings of Healthy Buildings* (Vol. 1, No. 1, pp. 635-40). Retrieved from: [https://static1.squarespace.com/static/60e356f45fe3a60d76a8dc08/t/630ebe9e6670d76c2a7c3519/1661910688220/Productivity is affected by the air quality in off.pdf](https://static1.squarespace.com/static/60e356f45fe3a60d76a8dc08/t/630ebe9e6670d76c2a7c3519/1661910688220/Productivity+is+affected+by+the+air+quality+in+off.pdf)
- Wargocki, P., Wyon, D.P., Sundell, J., Clausen, G. and Fanger, P.O. (2000) The effects of outdoor air supply rate in an office on perceived air quality, sick building syndrome (S.B.S.) symptoms and productivity. *Indoor air*, 10(4), pp.222-236. Retrieved from: <http://www.innenraumanalytik.at/Newsletter/wargocki.pdf>
- WHO. (2004) Fourth Ministerial Conference on Environment and Health. Review of evidence on housing and health. Copenhagen: World Health Organization. Europe. EUR/04/5046267/BD/1
- Whole Building Design Guide (WBDG) (2008). *Daylighting*. Retrieved from WBDG website: <http://www.wbdg.org/resources/daylighting.php>
- Williams, A. (2003) How to... Write and analyse a questionnaire. *Journal of orthodontics*, 30(3), pp.245-252. Doi: <https://doi.org/10.1093/ortho.30.3.245>
- Wilson, E.O., 1984. Biophilia. Massachusetts.
- Wilson, M. and Nicol, J.F. (1994) Tolerated noise levels in the U.K. and Pakistan and simultaneous thermal comfort. *Renewable energy*, 5(5-8), pp.1006-1008. Doi: [https://doi.org/10.1016/0960-1481\(94\)90126-0](https://doi.org/10.1016/0960-1481(94)90126-0)
- Woo, J.M. and Postolache, T.T. (2008) The impact of work environment on mood disorders and suicide: Evidence and implications. *International journal on disability and human development: I.J.D.H.D.*, 7(2), p.185. doi: <https://doi.org/10.1515/IJDHD.2008.7.2.185>
- Wotton, E. (1982) *An investigation of the effects of windows and lighting in offices*. Health and Welfare Canada.

Wouters-Adriaens, M.P. and Westerterp, K.R., 2008. Low resting energy expenditure in Asians can be attributed to body composition. *Obesity*, 16(10), pp.2212-2216. Doi:

<https://doi.org/10.1038/oby.2008.343>

Wyon, D.P. (1996) October. Indoor environmental effects on productivity. In *Proceedings of IAQ* (Vol. 96, pp. 5-15).

Wyon, D.P. (2004) The effects of indoor air quality on performance and productivity. *Indoor air*, 14, pp.92-101. Doi: <https://doi.org/10.1111/j.1600-0668.2004.00278.x>

Xu, X., Maki, A., Chen, C.F., Dong, B. and Day, J.K. (2017) Investigating willingness to save energy and communication about energy use in the American workplace with the attitude-behavior-context model. *Energy research & social science*, 32, pp.13-22 doi: <https://doi.org/10.1016/j.erss.2017.02.011>

Yang, I.H. and Nam, E.J. (2010) Economic analysis of the daylight-linked lighting control system in office buildings. *Solar Energy*, 84(8), pp.1513-1525. Doi:

<https://doi.org/10.1016/j.solener.2010.05.014>

Zhang, N., Cao, B., Wang, Z., Zhu, Y. and Lin, B. (2017) A comparison of winter indoor thermal environment and thermal comfort between regions in Europe, North America, and Asia. *Building and Environment*, 117, pp.208-217. Doi: <https://doi.org/10.1016/j.buildenv.2017.03.006>

Zhang, Y. and Barrett, P. (2012) Factors influencing the occupants' window opening behaviour in a naturally ventilated office building. *Building and Environment*, 50, pp.125-134. Doi:

<https://doi.org/10.1016/j.buildenv.2011.10.018>

7. Appendices:

Appendix 1:

Gender:الجنس:

Answer Choices	Responses	
Male ذكر	51.91%	204
Female انثى	48.09%	189
Answered		393
Skipped		1

Age:العمر:

Answer Choices	Responses	
18-28	40.36%	159
29-39	35.53%	140
40-50	18.53%	73
51 or older	5.58%	22
Answered		394
Skipped		0

Dress code:الذي الرسمي:

Answer Choices	Responses	
Suit بدلة	31.98%	126
Thoub/ Abaya ثوب/ عباية	35.79%	141
Casual غير رسمي	32.23%	127
Answered		394
Skipped		0

In which sector do you work?في أي قطاع تعمل؟

Answer Choices	Responses	
Government Sector القطاع الحكومي	27.01%	74
Private Sector القطاع الخاص	59.12%	162
Semi-Government Sector القطاع شبه الحكومي	13.87%	38
Where do you work? (optional)		73
Answered		274
Skipped		120

How long have you been employed in this office? (Years)منذ متى وانت تعمل في هذا المكتب؟ (سنوات)

(سنوات)

Answer Choices	Responses	
less than one year اقل من عام واحد	22.84%	90
1-2 years	17.51%	69
3-4 years	17.26%	68
More than four years أكثر من أربع سنوات	42.39%	167
Answered		394
Skipped		0

During the day, how many hours do you spend in the office?كم عدد الساعات التي

تقضيها في المكتب خلال اليوم؟

Answer Choices	Responses
----------------	-----------

1-2 hours	3.30%	13
3-5 hours	9.90%	39
5-8 hours	49.75%	196
more than 8 hours أكثر من 8 ساعات	37.06%	146
Answered	394	
Skipped	0	

Your office type is: نوع مكتبك هو:

Answer Choices	Responses	
Private office مكتب خاص	31.47%	124
Open plan office مكتب مفتوح	47.72%	188
Cubicles مكتب مقصورة	14.97%	59
Other (please specify)	5.84%	23
Answered	394	
Skipped	0	

Your work position is: منصبك في العمل

هو:

Answer Choices	Responses	
Chairman/ CEO الرئيس التنفيذي	2.28%	9
General manager/ Director المدير العام/ مدير	6.35%	25
Supervisor مشرف	22.08%	87
Staff موظف	62.44%	246
Other (please specify)	6.85%	27
Answered	394	
Skipped	0	

Does the office meet your comfort needs in general? ? (with 1 being not meet at all to 5 being highly meet): هل المكتب (يلبي احتياجات راحتك بشكل عام؟ ؟ (مع 1 لا يلبي على الإطلاق و 5 يلبي بشكل كبير

											Weighted	
	1		2		3		4		5		Total	Average
-	6.39%	25	18.67%	73	35.81%	140	25.58%	100	13.55%	53	391	3.21
	Answered											391
	Skipped											3

How would you rank your overall comfort of these following aspects:? (with 1 being very uncomfortable to 5 being very comfortable): (كيف تقيم راحتك العامة من هذه الجوانب التالية ؟؟ (مع اعتبار 1 غير مريح للغاية و 5 مريح للغاية):

											Weighted	
	1		2		3		4		5		Total	Average
					1		1					
Indoor temperature درجة الحرارة	8.65	3	16.2	6	26.9	0	30.2	1	17.8	7		
	%	4	8%	4	7%	6	8%	9	1%	0	393	3.32

Indoor air quality (ventilation) جودة الهواء الداخلي (تهوية)	1										391	3.21
	10.2	4	18.6	7	26.0	0	30.1	1	14.8	5		
Natural lighting الاضاءة الطبيعية	3%	0	7%	3	9%	2	8%	8	3%	8	394	3.29
	12.4	4	15.9	6	23.8	9	25.8	0	21.8	8		
Electric lighting الاضاءة الكهربائية	6.11	2	11.2	4	25.9	0	31.0	2	25.7	0	393	3.59
	%	4	0%	4	5%	2	4%	2	0%	1		
acoustics (level of noise) الصوتيات (مستوى الضوضاء)	17.7	7	17.0	6	31.9	2	19.2	7	13.9	5	394	2.95
	7%	0	1%	7	8%	6	9%	6	6%	5		
views from inside the building to outside المنظر من داخل المبنى الى خارجه	19.0	7	18.8	7	23.6	9	19.3	7	19.0	7	393	3.01
	8%	5	3%	4	6%	3	4%	6	8%	5		
Answered											394	
Skipped											0	

I think the following aspects influence my comfort at work: (with 1 being no influence at all to 5 being highly influenced):
 (أعتقد أن الجوانب التالية تؤثر على راحتي في العمل: (مع اعتبار 1 ليس له تأثير على الإطلاق و 5 يؤثر بشدة):

												Weighted	
	1		2		3		4		5		Total	Average	
Indoor temperature درجة الحرارة	1											393	3.96
	4.3	1	6.8	2	21.8	8	22.3	8	44.5	7			
	3%	7	7%	7	8%	6	9%	8	3%	5			
Indoor air quality (ventilation) جودة الهواء الداخلي (التهوية)	1											392	3.74
	6.8	2	9.4	3	22.4	8	25.0	9	36.2	4			
	9%	7	4%	7	5%	8	0%	8	2%	2			
Natural lighting الاضاءة الطبيعية	1											393	3.74
	8.1	3	8.9	3	21.8	8	23.1	9	37.9	4			
	4%	2	1%	5	8%	6	6%	1	1%	9			
Electric lighting الاضاءة الكهربائية	1											392	3.84
	5.6	2	5.3	2	25.2	9	26.7	0	36.9	4			
	1%	2	6%	1	6%	9	9%	5	9%	5			
acoustics (level of noise) الصوتيات ((مستوى الضوضاء	1											393	3.99
	5.0	2	7.1	2	20.1	7	19.0	7	48.6	9			
	9%	0	2%	8	0%	9	8%	5	0%	1			
Answ													
ered											394		
Skipp													
ed											0		

How would you describe the indoor air temperature in the summer? (with 1 being very uncomfortable to 5 being very comfortable): (كيف تصف درجة الحرارة داخل المكتب في الصيف؟ (مع اعتبار 1 غير مريح للغاية و 5 مريح للغاية):

	1	2	3	4	5	Total	Weighted Average
	4	6	10	10	7		
-	11.93%	7	16.50%	5	26.14%	3	26.40%
	4	19.04%	5			394	3.24
	Answered						394
	Skipped						0

How would you describe the indoor air temperature in the winter? (with 1 being very uncomfortable to 5 being very comfortable): (كيف تصف درجة الحرارة داخل المكتب في الشتاء؟ (مع اعتبار 1 غير مريح للغاية و 5 مريح للغاية):

	1	2	3	4	5	Total	Weighted Average
	4	5	12	10	6		
-	11.42%	5	13.45%	3	32.23%	7	26.65%
	5	16.24%	4			394	3.23
	Answered						394
	Skipped						0

I think the way I dress can affect my thermal comfort: (with 1 being strongly disagree to 5 being strongly agree): (أعتقد أن الطريقة التي أرتدي بها ملابس يمكن أن تؤثر على راحة درجة الحرارة: (مع اعتبار 1 لا أوافق بشدة و 5 موافق بشدة):

	1	2	3	4	5	Total	Weighted Average
	3	3	10	7	15		
-	8.12%	2	8.63%	4	26.40%	4	18.27%
	2	38.58%	2			394	3.71
	Answered						394
	Skipped						0

How do you usually adjust your indoor temperature in the office? (you can choose more than one answer) كيف تقوم عادة بضبط درجة الحرارة في المكتب؟ (يمكنك اختيار أكثر من إجابة واحدة)

Answer Choices	Responses
Change your clothing style/material نوع الملابس الخاصة بك تغيير نمط/	42.60% 167
Adjust the thermostat ضبط منظم الحرارة	57.91% 227
Sit next to the daylight الجلوس بجانب ضوء النهار	10.46% 41
Open or close the window shade فتح أو غلق الستارة	19.90% 78
Open or close the window فتح أو غلق النافذة	18.11% 71
Accept the current indoor temperature without changing it تقبل درجة الحرارة الحالية دون تغييرها	24.23% 95
	Answered 392
	Skipped 2

How much control do you have over the following aspects of the office? (with 1 being no control at all and 5 being complete control): (ما مقدار التحكم الذي تتمتع به على الجوانب التالية في المكتب؟ (مع اعتبار 1 بلا تحكم على الإطلاق و 5 هو تحكم كامل):

	1	2	3	4	5	Total	Weighted Average
--	---	---	---	---	---	-------	------------------

						1							
Indoor temperature درجة الحرارة	17.0	6	14.2	5	26.7	0	21.4	8	20.4	8			
	9%	7	9%	6	9%	5	3%	4	1%	0	392		3.14
Indoor air quality (ventilation) جودة الهواء الداخلي (التهوية)		1				1							
	27.6	0	15.0	5	27.3	0	17.1	6	12.7	5			
	2%	8	9%	9	7%	7	4%	7	9%	0	391		2.72
Natural lighting الاضاءة الطبيعية						1							
	23.0	9	15.3	6	25.5	0	19.4	7	16.6	6			
	2%	0	5%	0	8%	0	4%	6	2%	5	391		2.91
Electric lighting الاضاءة الكهربائية										1			
	17.8	7	12.7	5	23.4	9	20.4	8	25.5	0			
	6%	0	6%	0	7%	2	1%	0	1%	0	392		3.23
acoustics	50.0		0.00		0.00		0.00		50.0				
	0%	1	%	0	%	0	%	0	0%	1	2		3
											Answ ered Skipp ed		393 1

My coworker accepts sharing the control over the following aspects: (with 1 being strongly not accept to 5 being strongly accept):
(يقبل زميلي في العمل مشاركة التحكم في الجوانب التالية: (مع اعتبار 1 عدم تقبل بشدة و 5 تقبل بشدة):

												Weighted
	1		2		3		4		5		Total	Average
thermostat settings اعدادات منظم الحرارة	1											
	13.7	5	10.9	4	32.6	2	21.6	8	20.9	8		
	8%	4	7%	3	5%	8	8%	5	2%	2	392	3.25
opening and closing the windows فتح أو غلق النوافذ	20.5	8	10.2	4	24.3	9	20.7	8	24.1	9		
	1%	0	6%	0	6%	5	7%	1	0%	4	390	3.18
electrical lighting الاضاءة الكهربائية	1											
	15.9	6	8.72	3	25.9	0	20.5	8	28.9	1		
	0%	2	%	4	0%	1	1%	0	7%	3	390	3.38
opening and closing blinds and shades فتح أو غلق الستائر	1											
	15.7	6	10.3	4	26.3	0	19.1	7	28.4	1		
	6%	1	4%	0	6%	2	2%	4	2%	0	387	3.34
											Answered	392
											Skipped	2

Number of people sharing the control over the following aspects: عدد الأشخاص الذين يتشاركون التحكم في الجوانب التالية:

	Sharing control										Total
	No access to control لا توجد وسيلة للتحكم				Sharing control with one other coworker		with Two coworkers تقاسم التحكم مع زميلين في العمل		Sharing control with Three or more coworkers تقاسم التحكم مع ثلاث زملاء أو أكثر		
	أنا Only me فقط		تقاسم التحكم مع زميل واحد في العمل								
thermostat منظم الحرارة	18.25%	71	11.57%	45	15.94%	62	14.91%	58	39.33%	153	38
opening and closing the windows فتح أو غلق النوافذ	26.05%	99	16.84%	64	16.05%	61	11.32%	43	29.74%	113	38
lights switches مفاتيح الاضواء	13.35%	51	17.02%	65	17.02%	65	12.57%	48	40.05%	153	38
opening and closing blinds and shades فتح أو غلق النوافذ	22.60%	87	15.32%	59	17.40%	67	14.29%	55	30.39%	117	38
	Answers Skipped										

Answered
Skipped

Are you sharing the office with another

هل تشارك المكتب مع جنس آخر?

Answer Choices	Responses	
Yes نعم	59.64%	235
No لا	40.36%	159
Answered		394
Skipped		0

I can freely speak about my indoor environment quality with my colleagues regardless the gender: (with 1 being strongly disagree to 5 being strongly agree):
يمكنني التحدث بحرية عن جودة بيئتي الداخلية مع زملائي بغض النظر عن جنسهم: (مع 1 اعتبار 1 لا أوافق بشدة و 5 موافق بشدة):

	1	2	3	4	5	Total	Weighted Average					
	3	3	8	7								
-	9.90%	9	9.39%	7	21.57%	5	19.29%	6	39.85%	157	394	3.7
	Answered											394
	Skipped											0

Sharing the office with other gender affect my indoor environment comfort within the space: (with 1 being strongly disagree to 5 being strongly agree):
مع اعتبار 1 لا :تؤثر مشاركة المكتب مع الجنس الآخر على راحة بيئتي الداخلية داخل المكتب: (بؤثر بشدة و 5 يؤثر بشدة):

	1		2		3		4		5		Total	Weighted Average
	7		4		10		6		10			
-	18.53%	3	11.93%	7	25.63%	1	16.50%	5	27.41%	8	394	3.22
											Answered	394
											Skipped	0

Setting closely to my colleague can affect my indoor environment comfort. (with 1 being strongly disagree to 5 being strongly agree): (مع اعتبار 1 لا يؤثر بشدة و 5 يؤثر بشدة):

	1	2	3	4	5	Total	Weighted Average
-	10.41%	10.91%	25.13%	21.83%	31.73%	394	3.54
	4	4	9	8	12		
	1	3	9	6	5		
						Answered	394
						Skipped	0

Working in a mixed environment (Including male & female) can disturb my indoor environment comfort. (with 1 being strongly disagree to 5 being strongly agree): (مع اعتبار 1 لا يؤثر بشدة و 5 يؤثر بشدة):

	1	2	3	4	5	Total	Weighted Average
-	16.50%	12.18%	29.19%	14.72%	27.41%	394	3.24
	6	4	11	5	10		
	5	8	5	8	8		
						Answered	394
						Skipped	0

I am able to express my feeling toward my indoor environment comfort. (with 1 being strongly disagree to 5 being strongly agree): (مع اعتبار 1 لا اوافق بشدة و 5 موافق بشدة):

	1	2	3	4	5	Total	Weighted Average
-	6.85%	8.38%	29.95%	25.38%	29.44%	394	3.62
	2	3	11	10	11		
	7	3	8	0	6		
						Answered	394
						Skipped	0

Inside the office, the opinion of the majority regarding the indoor environment is what matters; the minority opinion does not matter: (with 1 being strongly disagree to 5 being strongly agree): (مع اعتبار 1 لا اوافق بشدة و 5 موافق بشدة):

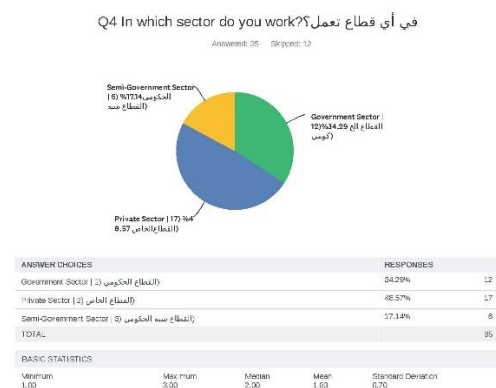
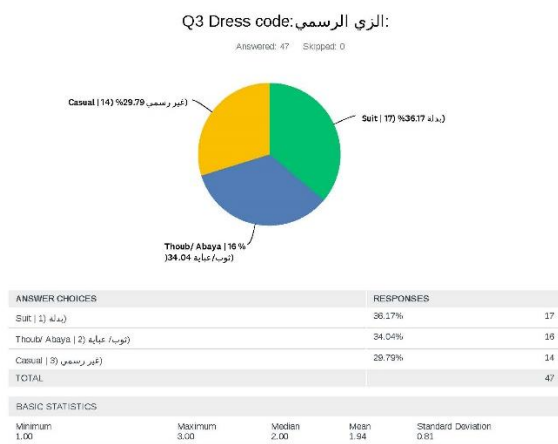
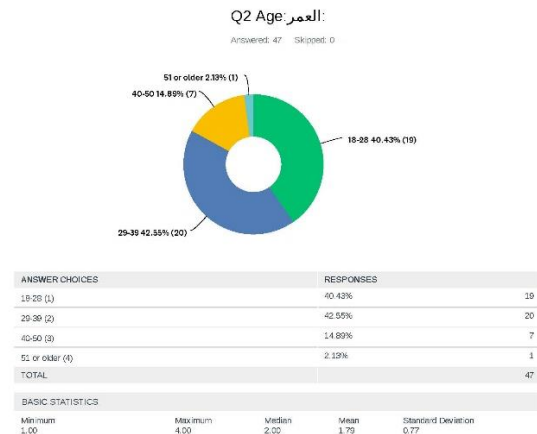
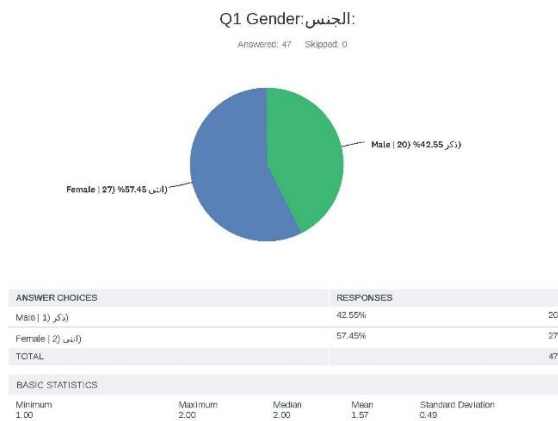
	1	2	3	4	5	Total	Weighted Average
-	16.75%	14.97%	34.52%	18.53%	15.23%	394	3.01
	6	5	13	7	6		
	6	9	6	3	0		
						Answered	394
						Skipped	0

Communicating with the same gender regarding the indoor environment is more effortless than the other gender: (with 1 being strongly disagree to 5 being strongly agree): (مع اعتبار 1 لا اوافق بشدة و 5 موافق بشدة):

	1	2	3	4	5	Total	Weighted Average
-	11.93%	9.14%	26.65%	22.59%	29.70%	394	3.49
	47	36	105	89	117		

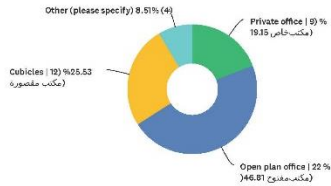
Appendix 2:

Question 12: Data filter of Q12 (1 being very uncomfortable):



Q7 Your office type is: نوع مكتبك هو:

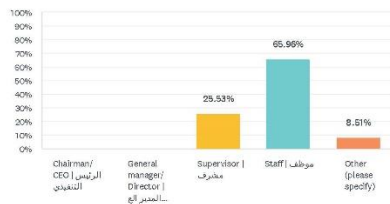
Answered: 47 Skipped: 0



ANSWER CHOICES		RESPONSES	
Private office (1) (مكتب خاص)		19.15%	9
Open plan office (2) (مكتب مفتوح)		46.81%	22
Cubicles (3) (مكتب مقصورة)		25.53%	12
Other (please specify) (4)		8.51%	4
TOTAL			47
BASIC STATISTICS			
Minimum	Maximum	Median	Mean
1.00	4.00	2.00	2.23
			Standard Deviation
			0.96

Q8 Your work position is: منصبك في العمل هو:

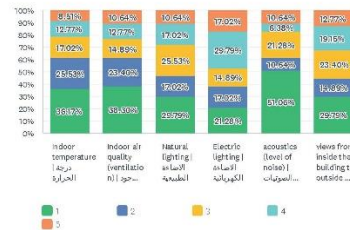
Answered: 47 Skipped: 0



ANSWER CHOICES		RESPONSES		
Chairman/ CEO 1	(الرئيس التنفيذي)	0.00%	0	
General manager/ Director 2	(المدير العام/ مدير)	0.00%	0	
Supervisor 3	(مُشرف)	25.53%	12	
Staff 4	(موظف)	65.96%	31	
Other (please specify) 5		8.51%	4	
TOTAL			47	
BASIC STATISTICS				
Minimum 3.00	Maximum 5.00	Median 4.00	Mean 3.83	Standard Deviation 0.56

Q10 How would you rank your overall comfort of these following aspects: (with 1 being very uncomfortable to 5 being very comfortable). كيف تقيم راحتك العامة من هذه الجوانب التالية؟ (مع اعتبار 1 غير مريح للغاية و 5 مريح للغاية):

Answered: 47 Skipped: 0



Q9 Does the office meet your comfort needs in general? (with 1 being not meet at all to 5 being highly meet): هل المكتب يلبي احتياجات راحتك بشكل: (مع 1 لا يلبي على الإطلاق و 5 يلبي بشكل كبير):

Answered: 47 Skipped: 0



1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	TOTAL	WEIGHTED AVERAGE
17.02%	34.04%	27.66%	14.89%	6.38%	47	2.60
BASIC STATISTICS						
Minimum	1.00	Maximum	5.00	Median	2.00	Mean
					2.60	Standard Deviation
						1.12

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	TOTAL	WEIGHTED AVERAGE
Indoor temperature درجة الحرارة	36.17%	25.53%	17.02%	12.77%	8.51%	47	2.32
Indoor air quality (ventilation) جودة الهواء الداخلي (التهوية)	36.30%	23.40%	14.89%	12.77%	10.64%	47	2.54
Natural lighting الامضاء الطبيعية	29.79%	17.02%	25.53%	17.02%	10.64%	47	2.62
Electric lighting الامضاء الكهربائية	21.20%	17.02%	14.89%	29.79%	17.02%	47	3.04
Acoustics (level of noise) الصوتيات (مستوى الضوضاء)	51.06%	10.64%	21.20%	6.38%	10.64%	47	2.15
Views from inside the building to outside المنظر من داخل المبنى إلى خارجه	29.79%	14.89%	23.40%	19.15%	12.77%	47	2.70

Q11 I think the following aspects influence my comfort at work: (with 1 being no influence at all to 5 being highly influenced):
اعتقد أن الجوانب التالية: (مع اعتبار 1 ليس له تأثير على الإطلاق و 5 يؤثر
تؤثر على راحتي في العمل):



BASIC STATISTICS					
	MINIMUM	MAXIMUM	MEDIAN	MEAN	STANDARD DEVIATION
Indoor temperature	1.00	5.00	2.00	2.32	1.31
Indoor air quality	1.00	5.00	2.00	2.34	1.37
Natural lighting	1.00	5.00	3.00	2.62	1.35
Electric lighting	1.00	5.00	3.00	2.04	1.41
Acoustics	1.00	5.00	1.00	2.15	1.38
views from inside the building to outside	1.00	5.00	3.00	2.70	1.40

Q12 How would you describe the indoor air temperature in the summer?
(with 1 being very uncomfortable to 5 being very comfortable):
كيف تصف: درجة الحرارة داخل المكتب في الصيف؟ (مع اعتبار 1 غير مريح للغاية و 5 مريح للغاية):

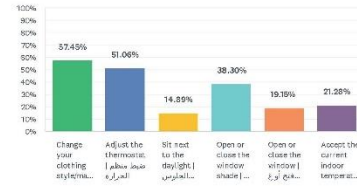


Q13 How would you describe the indoor air temperature in the winter?
(with 1 being very uncomfortable to 5 being very comfortable):
كيف تصف: درجة الحرارة داخل المكتب في الشتاء؟ (مع اعتبار 1 غير مريح للغاية و 5 مريح للغاية):



Q15 How do you usually adjust your indoor temperature in the office? (you can choose more than one answer) كيف تقوم عادة بضبط درجة الحرارة في المكتب؟ (يمكنك اختيار أكثر من إجابة واحدة)

Answered: 47 Skipped: 0

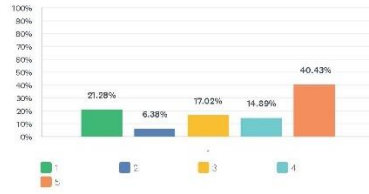


ANSWER CHOICES	RESPONSES
Change your clothing style/material (تغير نمط/ نوع الملابس الخاصة بك 1)	57.45% 27
Adjust the thermostat (ضبط منظم الحرارة 2)	51.06% 24
Sit next to the day/light (الجلوس بجانب ضوء النهار 3)	14.89% 7
Open or close the window/shade (فتح أو غلق النافذة 4)	38.30% 18
Open or close the window (فتح أو غلق النافذة 5)	19.15% 9
Accept the current indoor temperature without changing it (تقبل درجة الحرارة الحالية بدون تغييرها 6)	21.28% 10
Total Responses: 47	

BASIC STATISTICS	Minimum	Maximum	Median	Mean	Standard Deviation
	1.00	6.00	2.00	2.67	1.70

Q14 I think the way I dress can affect my thermal comfort: (with 1 being strongly disagree to 5 being strongly agree) أعتقد أن الطريقة التي أرتدي بها: (مع 1 لا أوافق بشدة و 5 ملابسي يمكن أن تؤثر على راحة درجة الحرارة: (مع اعتبار 1 لا أوافق بشدة و 5 موافق بشدة):

Answered: 47 Skipped: 0

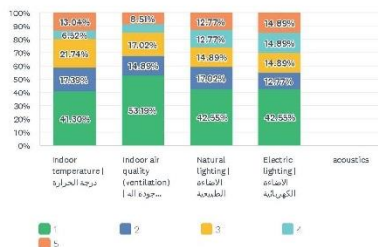


	1 (0)	2 (0)	3 (0)	4 (4)	5 (6)	TOTAL	WEIGHTED AVERAGE
	21.28%	6.38%	17.02%	14.89%	40.43%	47	3.47

BASIC STATISTICS	Minimum	Maximum	Median	Mean	Standard Deviation
	1.00	5.00	4.00	3.47	1.57

Q16 How much control do you have over the following aspects of the office? (with 1 being no control at all and 5 being complete control): ما مقدار التحكم الذي تتمتع به على الجوانب التالية في المكتب؟ (مع اعتبار 1 لا (تتحكم على الإطلاق و 5 هو تحكم كامل):

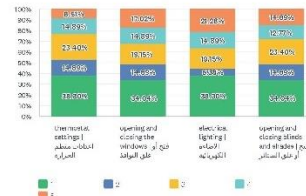
Answered: 47 Skipped: 0



	1 (1)	2 (2)	3 (3)	4 (4)	5 (6)	TOTAL	WEIGHTED AVERAGE
Indoor temperature درجة الحرارة	41.30%	17.39%	21.74%	6.52%	13.04%	47	2.40
Indoor air quality جودة الهواء الداخلي (التهوية)	53.19%	14.89%	17.02%	6.38%	8.51%	47	2.66
Natural lighting الإضاءة الطبيعية	42.55%	17.02%	14.89%	12.77%	12.77%	47	2.74
Electric lighting الإضاءة الكهربائية	42.55%	12.77%	14.89%	14.89%	14.89%	47	2.60
acoustics	0.00%	0.00%	0.00%	0.00%	0.00%	0	0.00

Q17 My coworker accepts sharing the control over the following aspects: (with 1 being strongly not accept to 5 being strongly accept): يقلل زميلي في العمل مشاركة التحكم في الجوانب التالية: (مع اعتبار 1 عدم تقبل بشدة و 5 تقبل بشدة):

Answered: 47 Skipped: 0



	1 (1)	2 (2)	3 (3)	4 (4)	5 (6)	TOTAL	WEIGHTED AVERAGE
thermostat settings إعدادات منظم الحرارة	35.43%	14.89%	21.74%	14.89%	8.51%	47	2.40
opening and closing the windows فتح أو غلق النوافذ	35.43%	14.89%	19.15%	14.89%	17.02%	47	2.66
electric light إضاءة كهربائية	35.43%	8.51%	19.15%	14.89%	21.28%	47	2.74
opening and closing blinds and shades فتح أو غلق أشرطة أو ستائر	34.04%	14.89%	23.02%	12.77%	14.89%	47	2.60

BASIC STATISTICS	Minimum	Maximum	Median	Mean	Standard Deviation
thermostat settings إعدادات منظم الحرارة	1.00	5.00	2.00	2.40	1.35
opening and closing the windows فتح أو غلق النوافذ	1.00	5.00	3.00	2.66	1.40
electric light إضاءة كهربائية	1.00	5.00	3.00	2.74	1.56
opening and closing blinds and shades فتح أو غلق أشرطة أو ستائر	1.00	5.00	3.00	2.60	1.44

Q18 Number of people sharing the control over the following aspects: عدد الأشخاص الذين يشاركون التحكم في الجوانب التالية:

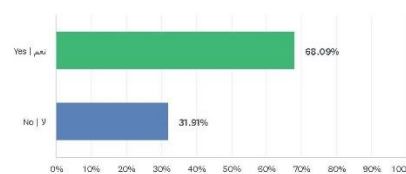
Answered: 47 Skipped: 0



	NO ACCESS (0) لا وصول	ONLY ME (1) فقط أنا	SHARING CONTROL WITH ONE COWORKER (2) مشاركة التحكم مع زميل واحد في المكتب	SHARING CONTROL WITH TWO COWORKERS (3) مشاركة التحكم مع زميلين في المكتب	SHARING CONTROL WITH THREE OR MORE COWORKERS (4) مشاركة التحكم مع ثلاثة أو أكثر	TOTAL	WEIGHTED AVERAGE
thermostat settings إعدادات منظم الحرارة	13.04%	8.51%	12.77%	12.77%	45.81%	47	3.50
opening and closing the windows فتح أو غلق النوافذ	13.04%	17.02%	14.89%	12.77%	44.88%	47	3.04
lights switches مفاتيح الإضاءة	15.24%	13.22%	15.24%	10.67%	43.40%	46	3.52
opening and closing blinds and shades فتح أو غلق الستائر	9.70%	13.04%	17.36%	19.22%	45.55%	46	3.26

Q19 Are you sharing the office with another gender? هل تشارك المكتب مع جنس آخر؟

Answered: 47 Skipped: 0



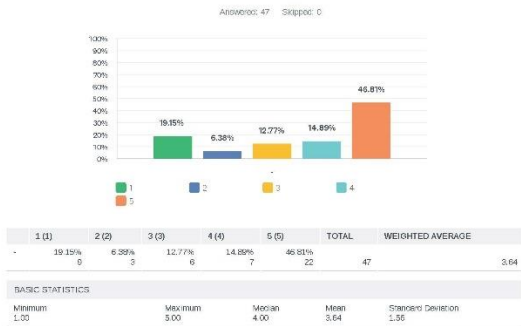
ANSWER CHOICES	RESPONSES
Yes (نعم 1)	68.09% 32
No (لا 2)	31.91% 15
TOTAL	47

BASIC STATISTICS	Minimum	Maximum	Median	Mean	Standard Deviation
	1.00	2.00	1.00	1.32	0.47

Q20 I can freely speak about my indoor environment quality with my colleagues regardless the gender: (with 1 being strongly disagree to 5 being strongly agree)
يمكنني التحدث بحرية عن جودة بيئتي الداخلية مع زملائي بعض: (مع اعتبار 1 لا أوافق بشدة و 5 موافق بشدة)
(النظر عن جنسهم):



Q22 Setting closely to my colleague can affect my indoor environment comfort. (with 1 being strongly disagree to 5 being strongly agree)
الجلوس عن قرب شديد من زميلي يمكن أن يؤثر على راحة بيئتي الداخلية: (مع اعتبار 1 لا يؤثر بشدة و 5 يؤثر بشدة)
(يؤثر بشدة و 5 يؤثر بشدة)



Q21 Sharing the office with other gender affect my indoor environment comfort within the space: (with 1 being strongly disagree to 5 being strongly agree)
تؤثر مشاركة المكتب مع الجنس الآخر على راحة بيئتي الداخلية: (مع اعتبار 1 لا يؤثر بشدة و 5 يؤثر بشدة)
(داخل المكتب):



Q23 Working in a mixed environment (including male & female) can disturb my indoor environment comfort. (with 1 being strongly disagree to 5 being strongly agree)
العمل في بيئة مختلطة (بما في ذلك الذكور والإناث) يمكن أن يزعج راحة بيئتي الداخلية: (مع اعتبار 1 لا أوافق بشدة و 5 أوافق بشدة)



I. Abstract

Numerous research studied factors influencing indoor environment quality (IEQ) aspects, but most of them were focusing on each factor separately. Thus, there is a lack of research on the factors that affect IEQ as a whole. Studying these variables while considering social and cultural issues is crucial in the Middle East and Bahrain. Therefore, this research aims to investigate the relationship between occupants' satisfaction and IEQ inside an office building in Bahrain and evaluate the social and cultural aspects of IEQ. The research focused on users' satisfaction with the overall aspects (i.e., thermal comfort, natural lighting, electrical lighting, air quality, and acoustic) and their overall work comfort within the office space itself. It assesses the connection between the variables and the hypothesis, as well as the role of personal control and determining IEQ factors in an office building.

To offer a basis for this research, a quantitative method that established an online questionnaire was distributed randomly among users of selected office buildings, sectors, and office types in Bahrain. The questionnaire was conducted over eight months, starting with a pilot study in September 2021 and ending with the final questionnaire, and data collection was done in April 2022. Effects of indoor environmental quality on user comfort in office buildings surveys had 508 participants who answered 26 questions. The estimated completion time for the survey was 8 minutes, with an estimated completion rate of 81%. The total number of individuals with complete responses was 393.

This research aimed to investigate the connections between occupants' satisfaction with IEQ criteria, contentment with the facility as a whole, and overall work performance and satisfaction in an office building. Two out of four hypotheses (H1 and H2) were confirmed, and two were not confirmed (H3, H4). The key results and implications summarize that Males show more levels of satisfaction when compared to females. The age variable has a significant impact on IEQ comfort level. The study concluded that age, years of experience, office type, and position are the factors that affect IEQ. However, clothing type, working sector, and working hours do not significantly affect a user's comfort level. Furthermore, Users with total control over indoor air quality feel more comfortable in their workplace environment. The study found that people who are not sharing the office with another gender have a higher comfort level than those who share the office with another gender. This study's statistical data and results provide various insights. This involves evaluating design strategies that allow objective-driven decision-making, as well as emphasizing the need of cooperating across different professions. Different settings enhance the understanding of the quality and comfort of the indoor environment. While it would be great for offering a broad variety of architectural solutions to improve the overall quality of the indoor environment, this research adds to the design process by highlighting the most critical features.

II. الملخص:

درست العديد من الأبحاث العوامل التي تؤثر على جوانب جودة البيئة الداخلية، ولكن معظمها كان يركز على كل عامل على حدة. وبالتالي، هناك نقص في البحث حول العوامل التي تؤثر على جودة البيئة الداخلية ككل. تعتبر دراسة هذه المتغيرات مع مراعاة القضايا الاجتماعية والثقافية أمراً بالغ الأهمية في منطقة الشرق الأوسط والبحرين. لذلك، يهدف هذا البحث إلى التحقق من العلاقة بين رضا المستخدمين و جودة البيئة الداخلية داخل مبنى مكتبي في البحرين وتقييم الجوانب الاجتماعية والثقافية للبيئة الداخلية. ركز البحث على رضا المستخدمين في الجوانب العامة (الراحة الحرارية، والإضاءة الطبيعية، والإضاءة الكهربائية، وجودة الهواء والصوت) وراحة العمل بشكل عام داخل مساحة المكتب نفسها. يقوم البحث بتقييم العلاقة بين المتغيرات والفرضية، وكذلك دور التحكم الشخصي وتحديد عوامل جودة البيئة الداخلية في المباني المكتبية.

لتقديم أساس لهذا البحث، تم توزيع طريقة كمية لإنشاء استبيان عبر الإنترنت بشكل عشوائي بين مستخدمي المباني المكتبية والقطاعات وأنواع المكاتب المختارة في البحرين. تم إجراء الاستبيان على مدار ثمانية أشهر ، بدءاً بدراسة تجريبية في سبتمبر 2021 وانتهاءً بالاستبيان النهائي، وتم جمع البيانات في أبريل 2022. وكان تأثير جودة البيئة الداخلية على راحة المستخدم في استطلاعات المباني المكتبية يشمل 508 مشاركاً أجابوا على 26 سؤال. الوقت المقدر لاستكمال الاستبيان هو 8 دقائق، مع معدل إكمال يقدر بـ 81٪. كان العدد الإجمالي للأفراد الذين لديهم أجوبة كاملة 393.

يهدف هذا البحث إلى التحقق من الروابط بين رضا المستخدمين عن معايير جودة البيئة الداخلية، والرضا عن المنشأة ككل، وأداء العمل العام والرضا في المباني المكتبية. تم تأكيد اثنتين من أربع فرضيات (الفرضية الأولى و الثانية)، ولم يتم تأكيد اثنتين (الفرضية الثالثة و الرابعة). تلخص النتائج والآثار الرئيسية أن الذكور يظهرون مستويات أعلى من الرضا عند مقارنتهم بالإناث. متغير العمر له تأثير كبير على مستوى راحة جودة البيئة الداخلية. الدراسة آلت إلى أن العمر وسنوات الخبرة ونوع المكتب والوظيفة هي العوامل التي تؤثر على جودة البيئة الداخلية. ومع ذلك، لا يؤثر نوع الملابس وقطاع العمل وساعات العمل بشكل كبير على مستوى راحة المستخدم. علاوة على ذلك، يشعر المستخدمون الذين يتمتعون بالتحكم الكامل في جودة الهواء الداخلي بمزيد من الراحة في بيئة مكان العمل. وجدت الدراسة أن الأشخاص الذين لا يتشاركون المكتب مع جنس آخر يتمتعون بمستوى راحة أعلى من أولئك الذين يتشاركون المكتب مع جنس آخر.

توفر البيانات والنتائج الإحصائية لهذه الدراسة رؤى مختلفة. يتضمن ذلك تقييم استراتيجيات التصميم التي تسمح باتخاذ القرار الذي يحركه الهدف، بالإضافة إلى التأكيد على الحاجة إلى التعاون عبر المهن المختلفة. تعمل الإعدادات المختلفة على تحسين فهم جودة البيئة الداخلية وراحتها. في حين أنه سيكون من الرائع تقديم مجموعة متنوعة من الحلول المعمارية لتحسين الجودة الشاملة للبيئة الداخلية، فإن هذا البحث يضيف إلى عملية التصميم من خلال تسليط الضوء على أهم الميزات.



تأثير جودة البيئة الداخلية على راحة المستخدم في المباني المكتبية مع أخذ اعتبار الجوانب الاجتماعية والثقافية في البحرين

مخطط بحث لاستكمال متطلبات الحصول على درجة الماجستير في العمارة "العمارة الداخلية"

إعداد:

بيان عبدالحسين محمد ابورويس

إشراف:

د. هناء الجودر

أستاذ مساعد

جامعة البحرين

مملكة البحرين

فبراير، 2023