Examining the Impact of Environmental Quality in Architecture on Users' Thermal Perception

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Research Article

Abstract

This study examines the effects of environmental and physical factors on thermal comfort in educational buildings, focussing on Konya Food and Agriculture University. The quality of the indoor environment has a direct impact on the physical and mental health of the occupants as well as on the energy efficiency of the building. Since administrative and educational buildings contain a large number of people who spend a lot of time indoors, it is important to understand the relationship between environmental conditions and occupant comfort. This study hypothesises that in addition to climatic elements, other environmental and physical factors significantly influence people's thermal perceptions. The study utilised a mixed methods approach including a questionnaire, direct observation and climate data recording. 97 employees took part over five working days in August. The results show that indoor air temperature, relative humidity, window positioning and the view of the natural environment have a significant impact on thermal comfort. These results emphasise the importance of considering both environmental and physical components when designing buildings in order to improve occupant comfort and energy efficiency. The study emphasises the need for further research to develop adaptive design strategies that can improve thermal comfort in different building types and climates.

Keywords: Environmental components, physical components, relative humidity, thermal comfort, thermal perception

Mimaride Çevresel Kalitenin Kullanıcıların Termal Algısı Üzerindeki Etkisinin İncelenmesi

Özet

Bu araştırma, fiziksel ve çevresel faktörlerin eğitim binalarındaki termal konfor üzerindeki etkisini incelemektedir. İç mekanın kalitesi, binanın enerji verimliliğini ve kullanıcıların fiziksel ve zihinsel sağlığını doğrudan etkiler. İdari ve eğitim binaları, içinde uzun süre vakit geçiren bir kullanıcı kitlesine sahip olduğundan, çevresel koşullar ile kullanıcı konforu arasındaki ilişkiyi anlamak çok önemlidir. Bu çalışma, iklim ve diğer fiziksel ve çevresel faktörlerin insanların termal algılarını önemli ölçüde etkilediği hipotezini desteklemektedir. Araştırma, doğrudan gözlem, anket ve iklim verilerinin kaydedilmesi dahil olmak üzere çeşitli karma yöntemlerle yürütülmüştür. Bu araştırmanın gerçekleşmesinde, Konya Gıda ve Tarım Üniversitesi'nin 97 çalışanı, Ağustos ayında beş iş günü boyunca katılım sağlamıştır. Sonuçlar, iç hava sıcaklığının, bağıl nemin, pencere konumunun ve doğal çevrenin termal konfor üzerinde önemli bir etkiye sahip olduğunu göstermektedir. Bu sonuçlar, bina tasarımı sırasında hem çevresel hem de fiziksel öğelerin dikkate alınmasının, kullanıcıların konforunu ve enerji verimliliğini artırmak için çok önemli olduğunu göstermektedir. Çalışma, farklı iklimlerde ve bina türlerinde termal konforu artırmak için uyarlanabilir tasarım stratejilerinin geliştirilmesine yönelik daha fazla araştırma yapılması gerektiğini göstermektedir.

Anahtar Kelimeler: Çevresel bileşenler, fiziksel bileşenler, bağlı nem, termal knfor, termal algı.

1. INTRODUCTION

More than half of people's waking hours are spent indoors, with office buildings accounting for one-third of the total. Recently, due to the lack of attention paid to indoor environmental quality, in addition to architects and designers, this issue is followed by researchers and specialists in health disciplines. Indeed, interior spaces of official or residential buildings are rooted in the majority of health-related problems. In this regard, addressing the various aspects of user needs, including thermal, visual, and mental comfort facilitates the establishment of health-compatible

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quality environments (Antoniadou & Papadopoulos, 2017). Sick building syndrome (SBS), transmitted to occupants in unsuitable buildings, demonstrates the ineffectiveness of contemporary designs and has had an impact on human life improvement (Joshi, 2008). Conversely, the data from the World Energy Organization indicates that energy use in buildings is on the rise, while the optimization of energy usage progresses at a significantly slower rate (IEA, 2024). Consequently, an improvement in the situation can be anticipated, given the building sector's greater capacity to enhance efficiency compared to industry, commerce, and power facilities (Catrini et al., 2020). Therefore, the pressing necessity to mitigate the economic and environmental consequences of energy usage has garnered significant attention towards the issue of thermal comfort (Djamila, 2017).

Thermal comfort is a component of indoor environmental quality, as referenced in the EN15251 standard (Albatayneh et al., 2018). In a good quality environment, a individuals' mental health is supported by physical, mental, and emotional states (Salonen et al., 2013). Today, it is widely known that people's thermal perception differs due to physiological variances or changes in their lifestyle and behavior (Lenzholzer & de Vries, 2020; Yang et al., 2019). Thermal adaptation in environments where people spend a lot of time may be influenced by other factors. Therefore, it is important to understand what other factors besides environmental conditions (temperature and humidity) influence thermal perception and ultimately thermal comfort. The main idea is that behavioral adaptations and changes in physical characteristics enable part of a person's thermal adaptability. Identifying these variables can assist designers select the best ideas to enable compatible behaviors. More crucially, a predictive model will be available to determine each person's thermal perception based on physical and environmental factors as well as take action to provide comfortable settings. In this context, the study hypothesizes that both environmental components (e.g. temperature, humidity) and physical components (e.g. window conditions, ventilation systems) significantly influence the thermal perception and comfort of users. This hypothesis is investigated through field studies conducted in the administrative building of Konya Food and Agriculture University. By integrating questionnaire data, environmental measurements and observations, the study aims to quantify these influences and propose evidence-based recommendations for architectural design and building management.

2. THEORETICAL FRAMEWORK

2.1. Environmental Quality in Architecture and Thermal Comfort

The intensity of light entering indoor spaces varies according to the angle of sunlight in different climatic zones. The change in the angle of sunlight entering the interior changes the depth and amount of light penetration. The strong fluctuation of light disturbs the comfort of users in an architectural space (Fan et al., 2023). Interior lighting in architecture and ensuring thermal comfort are crucial for the efficient utilization of solar energy. A variety of solar rays enter the building interior through the windows, while the evenly distributed daylight increases comfort and approaches the perfect conditions for the occupants. Various studies (Liu, 2023; Wang et al., 2023; Ahmad et al., 2020; Hraska, 2015) have shown that daylight can save energy, increase productivity, provide amenity and thermal comfort, and fulfil people's physiological and psychological needs. Thermal comfort is evaluated in terms of thermal balance. This balance is initially influenced by environmental characteristics such as air temperature, radiant temperature, relative air velocity and humidity (Gao, 2017). Subsequently, human factors such as age, activity level, the body's metabolic rate and the thermal resistance of clothing influence the level of thermal comfort (Zhang et al., 2024; Luo et al., 2018).

Thermal comfort, one of the most important aspects of environmental quality, is determined by a number of factors. These include the appropriate design of the building envelope, the amount of heat exchange with the outside environment, natural or mechanical ventilation and effective control of solar radiation. In an ideal building, these factors are designed and modified to minimize internal temperature fluctuations while maintaining a thermal balance between the human body and the environment (Zhang & Ma 2022). Indicators such as effective temperature, the rate of heat exchange by convection, conduction and radiation, and the volume of air movement all play an important role in creating optimal thermal conditions. For example, the use of high thermal capacity materials in walls and ceilings can help to avoid temperature fluctuations indoors, allowing users to maintain thermal comfort while requiring less air conditioning or heating. Closed openings, the use of untested new building materials, various types of furniture and office equipment such as printers and computers can all contribute to sick building syndrome (Wu et al., 2022).

2.2. Environmental Components Affecting Thermal Comfort

Satisfaction with environmental warmth is a complex subjective reaction that is influenced by various factors and their interactions. In other words, it is not possible to give a specific and definitive standard for thermal comfort at a glance. In general, comfort is achieved when fluctuations in body temperature are limited, wetness on the skin surface is minimal and physiological reactions are minimized (Wagner et al., 2007). Comfort, on the other hand, is determined by behavioral responses, such as changing clothes, changing the type of activity, changing position or circumstances, adjusting the temperature of cooling or heating systems, opening windows, expressing discomfort and leaving the place. Various studies have shown that the adaptation of users' behavior to their environment is influenced by a variety of factors. Some of these include: climatic components such as temperature, wind speed and direction, humidity, radiation intensity, carbon dioxide content of the environment, contextual components (building characteristics, orientation, type of heating and ventilation system, season, occupancy pattern and time), psychological components (expectations, habits, perceptions, economic and environmental concerns, lifestyle), physiological components (age, gender, type of clothing, type of activity, diet) and social components (Psomas et al., 2024; Vellei et al., 2021; Schweiker et al., 2018; Wang et al., 2018).

Knez and Thorsson (2008) demonstrate that geographical attributes and place characteristics also influence an individual's perception of thermal comfort. They preferred place over space because it encompasses not only the physical aspects of the area, but also psychological attributes, spatial dimensions and structures. They argue that a place is determined by its physical foundations, its climatic conditions and its functional elements. Physical foundations are non-thermal characteristics that are also related to economic considerations, such as form, materials, naturalness (the ratio of artificial to natural environment) and location. Physical and social activities have a significant impact on spatial performance. Physical elements in an office workplace, such as the visual and auditory quality as well as the quality of the indoor environment, can contribute to feelings of dissatisfaction with the environment. However, a person's social, economic and psychological skills can enable them to adapt to physical situations (Cansino, 2024). The pattern of space use by users, the degree of access and control over the space, the number of people using the space individually or collectively, the pattern of entry and exit, and the duration of users' presence in the space are all components that influence thermal comfort (Arowoiya et al., 2024; Lee et al., 2013). In addition, this context takes into account factors such as the degree of control over the environment, access to the type of control, the complexity and transparency of automatic, electrical or mechanical systems for different people, visibility and communication with the outside space, past experience and the ability to predict the future, awareness of the level of energy consumption and constraints (Zou et al., 2018; Heydarian et al., 2015).

3. METHODOLOGY

The present study employs a mixed methods approach combining field studies (surveys) and empirical studies (observations) to answer the questions posed. The field study generally sought to assess the relationship between environmental variables such as temperature, radiation, airflow and humidity and users' subjective responses to cold and heat sensations and their preference for cooler or warmer conditions, recording people's thermal responses in real-life conditions. The aim of the empirical study was to record climate data and assess its influence on indoor temperature fluctuations. For this purpose, the education administration building of Konya Food and Agriculture University was used as a case study in the hot season in August 2024. According to thermal maps, temperatures in the central areas of Konya have risen significantly in recent years. This problem has a direct impact on the micro level of the climate and increases the need for cooling and heating systems in buildings in the city centre. For this reason, the building under consideration was selected at a crucial thermal point. The building in question is located in the central part of the city (37°52'29 "N - 32°28'19 "E). It is built of concrete, has three floors and is organised in a central design pattern. The façade of the building is made of 5 cm thick concrete with silica, lubricant and fibres. A metal casing is provided under the concrete, and foam is filled in for thermal insulation. The cooling and heating system is powered by a central machine room with a fan coil unit. To regulate the temperature, a separate thermostat is installed at each location for the users. In summer, the cooling unit is switched on at 7.00 am and switched off again at 7.00 pm. The building can be ventilated and receives natural light. However, due to the circular shape of the building, there are openings and windows on the north, east, south and west sides so that the amount of light and ventilation varies throughout the day and year. The window frames are made of flexible aluminium and the glass used is double-glazed. The lighting system consists of fluorescent tubes, linear lamps, compact fluorescent tubes and LED lamps.

3.1. Experiment 1, Survey

To examine the thermal perception of users, a survey was developed based on the content mentioned in the theoretical framework of the research, covering parameters such as thermal sensation, thermal comfort, thermal satisfaction, thermal preference, humidity preference, airflow preference, radiation preference, thermal acceptance and overall thermal comfort. Because the purpose was to quantify the influence of environmental components, individual, physiological, social, and psychological factors were not included in this regard. For the thermal evaluation of users, the overall satisfaction with thermal conditions was assessed in three ways. Thermal and overall comfort were evaluated using the seven-point ASHRAE 55 (2013) scale (hot, warm, slightly warm, neutral, slightly cool, cool, cold). The purpose of using this standard was to identify alternative combinations of indoor thermal environmental parameters and personal variables that provide acceptable thermal conditions for most people in a given space. Thermal satisfaction was measured using a seven-point Likert scale, while thermal preference was categorised using a three-point McIntyre (1980) scale (cooler, no change, warmer). The use of mean values was in fact primarily intended to provide a summarised measure of thermal satisfaction and perception. This approach is consistent with practise in similar studies where mean scores are used to convey overall trends in subjective responses. To ensure clarity, the percentage distributions of responses have also been provided in key sections to complement the mean scores and provide a more comprehensive picture of user perceptions. The McIntyre temperature preference scale complements the thermal preference scale by analysing people's desire for a change in the thermal conditions of their environment. This scale is designed to assess a person's tendency to change the temperature. Thermal acceptability was determined using the following methods: indirect tests using a seven-point scale to quantify thermal sensation and a three-point thermal preference scale with a "no change" option considered an acceptable baseline.

The questionnaire was distributed to 97 (45 men: 20 academic staff, 5 administrative staff, 20 students and researchers; 52 women: 37 academic staff, 5 administrative staff, 10 students and researchers) volunteers on five working days in August, from 10:00-17:30, in different areas of the building. The average time to answer the questions was 5 minutes. As the building studied has three floors and three different sides, each floor has unique technical and operational characteristics. Thus, the circumstances of the employees were taken into account. Due to the workload of the employees, which was based on the number of customers in the different working hours, the floors were not evaluated in a regular order and the participants were instructed to stay in the research environment so as not to disturb their working conditions. At the beginning of the distribution of the questionnaires, a brief description of the aim of the survey and the method of answering was given. In order to avoid bias and prejudice, it was agreed to select an approximately equal number of people from both gender groups. To comply with the ethical guidelines of the study, each participant was also asked to confirm their participation in the study with the first question of the questionnaire. In addition, users were informed that they could refuse to continue the study if they were dissatisfied at any point during the response process.

Participants were given no limits in answering the questions and were free to change their environment. In order to adapt the person to the circumstances of the internal environment, fieldwork began early in the morning each day, one hour later than the start of working hours. The acquired data were analyzed with the program SPSS 26. The analyzes were divided into two parts: descriptive statistics and inferential statistics, depending on the type of variable in question. The independent and simultaneous effects of the analyzed components were measured using minimum and maximum values, mean values, standard deviations and simple ($p < 0.05$) and multiple linear regression coefficients. The Pearson correlation test was also used to examine the correlation between the factors. The validity of the questionnaire was confirmed by a pilot study with 16 participants (8 women and 8 men). Confirmatory factor analysis was performed using structural equation modeling. The Cronbach's alpha coefficient of 0.83, which is regarded satisfactory, ensures the reliability and feasibility of the questionnaire. The type of relationship analysis included the Pearson correlation coefficient to examine the strength and direction of associations between continuous variables such as temperature and humidity. Multiple linear regression analysis was used to investigate the simultaneous effects of environmental and physical components on thermal perception, as it helped to understand the combined effect of multiple factors on users' thermal perception.

3.2. Experiment 2, Observation and Climatic Data Recording

This phase was completed in two stages. The weather conditions at the study site were identified as the main environmental elements influencing users' thermal perception. Indeed, in this part, an attempt was made to determine the users' thermal perception based on the current temperature and humidity conditions. Therefore, as a first step, a data logger was used to collect meteorological data such as air temperature, relative humidity, dry bulb temperature (DBGT) and wet bulb temperature (WBGT). At the same time, the temperature and relative humidity of the outside air were determined from the nearest meteorological station, which was one kilometer away from the facility. As the data were collected during the summer season, the airflow was extremely low (less than 0.6); this result is consistent with the results reported in studies of other areas with mechanical ventilation. With this explanation, the airflow was considered constant in all areas. In the next step, the author documented the physical characteristics of the ceiling-mounted cooling units, such as the location of the doors and windows, the view of the surroundings and the distance to the users. The device for measuring temperature and humidity (data logger) was placed in accordance with the ISO 7726 standard within a radius of 1 meter around the subject and away from the cooling system at a height of 1.1 meters, which is considered to be the body's center of gravity. The two steps of Experiment 2were carried out of five days a week, during which the participants answered the survey questions. They were asked to rate the physical components of the room they were in, such as the condition of the heating system, doors and windows, the person's location, the view of the surroundings and the floors of the building.

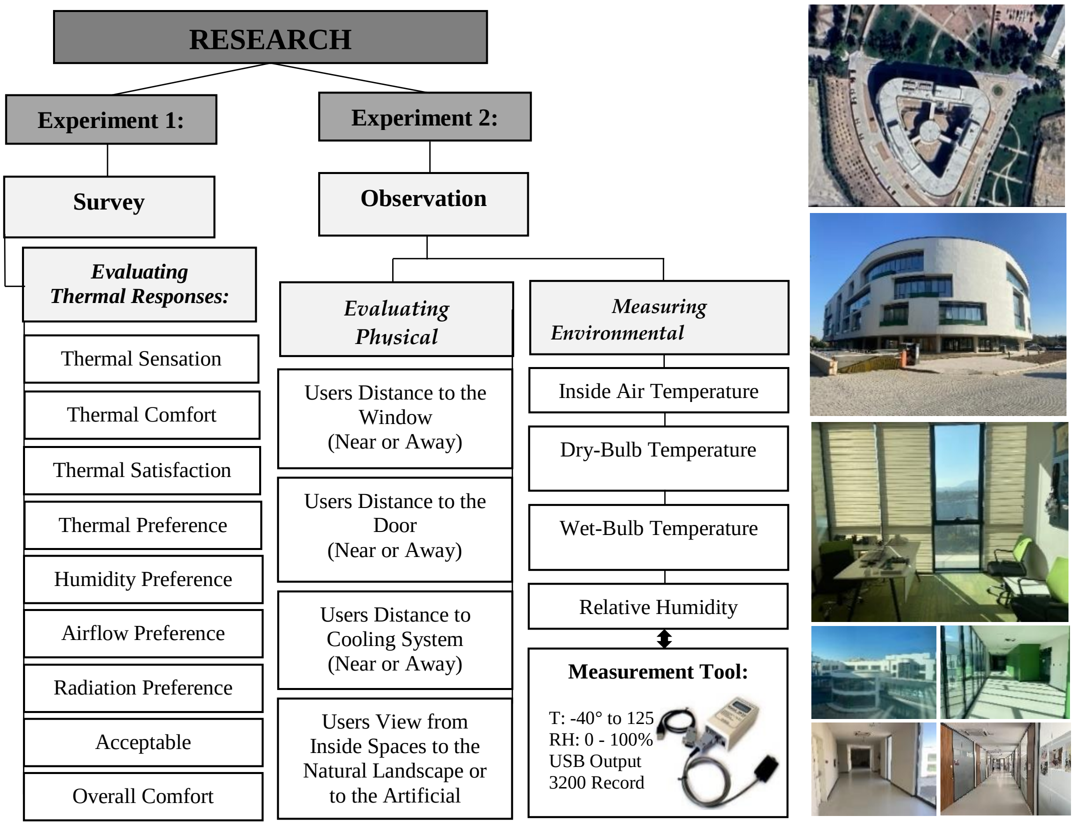


Figure 1. Methodology steps and measured components

4. RESULTS AND DISCUSSION

The research findings were classified into three groups. The first part described people's temperature perception, which was measured using nine distinct scales. In the second and third sections, while delivering a report on the condition of the physical and environmental components of the tested sample, the correlations between temperature perception and the aforementioned components were investigated:

4.1. Users' Thermal Perception

In conjunction with the thermal assessment of users, overall satisfaction with the thermal conditions was surveyed in three ways. Thermal comfort and overall comfort were measured using the seven-point ASHRAE 55 scale, while thermal satisfaction was measured using the seven-point Likert scale. Their responses were queried using nine scales, as can be seen in Figure 1. Accordingly, the group studied had an average thermal sensation of M=0.85, an average thermal comfort of M=7.54, a thermal satisfaction of M=6.39, a temperature preference of M=0.05, a humidity preference of M=0.21, an airflow preference of M=0.02, a radiation preference of M=0.04, an acceptable temperature of M=1.52 and an overall thermal comfort of M=5.77. As can be seen in Figure 2, based on the ASHRAE 55 standard, all three levels of the building are rated as hot on a 7-point scale, with people being thermally dissatisfied. Thermal preference was measured using McIntyre's 3-point scale. In terms of temperature preference, 86.51% of users preferred a situation that tended to be colder (cooler), 12.23% preferred the temperature to stay the same (no change) and 1.26% wanted the temperature to rise (warmer). In terms of humidity preference, 16.27% of users wanted the humidity to be higher. 67.93% of users requested an increase in air flow. In terms of radiation preference, 9.81% of users wanted more sunlight on the north side (see Figure 2-B).

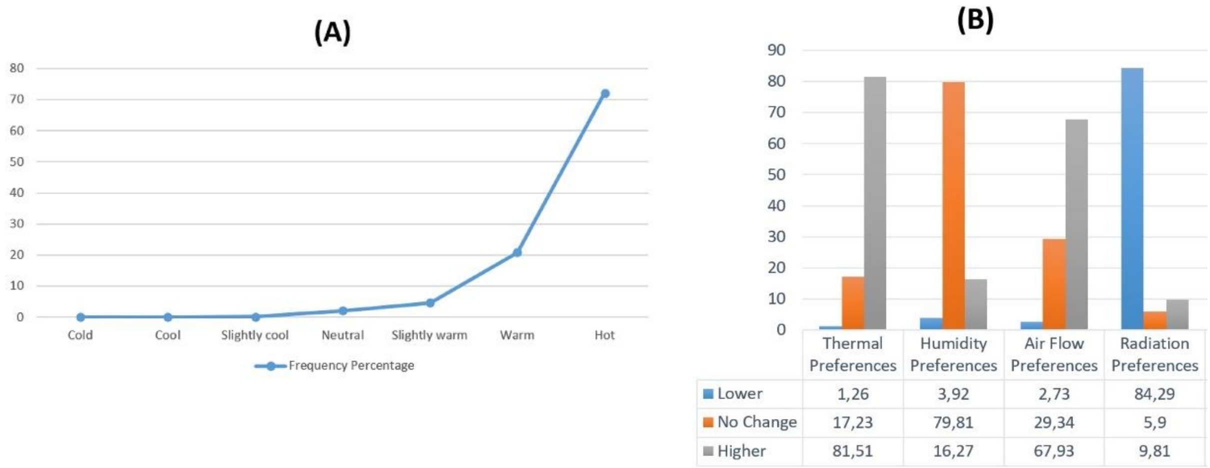
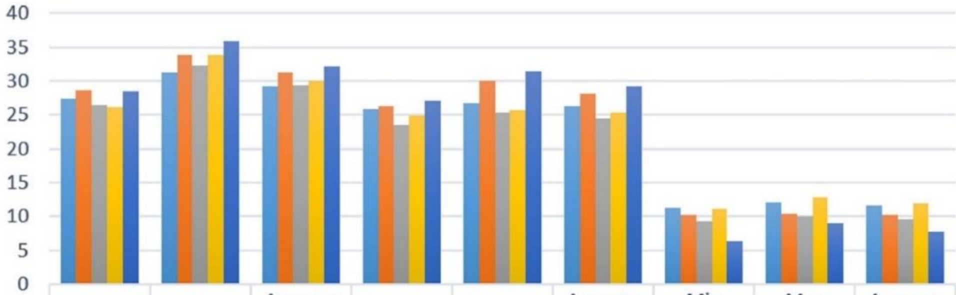


Figure 2. A) Frequency Percentage of Thermal Sensation; B) Frequency Percentage of Thermal Preferences

To determine thermal acceptability, the following methods were used: indirect testing using a seven-point scale for thermal sensation and using a three-point scale for thermal preference with the option "no change" (Schweiker et al., 2017), which is considered the basis for acceptable conditions. The result is that 72.14% of individuals have experienced extremely high temperatures and consider such conditions to be unacceptable. In the second method of determining acceptable conditions, the no change option for temperature preference is 17.23%, humidity preference is 79.81%, airflow preference is 29.34% and radiation preference is 5.90%. The conditions cannot therefore be classified as acceptable on the thermal preference scale. This means that users need to adjust their physical conditions.

4.2. The Impact of Environmental Components on Users' Thermal Perception

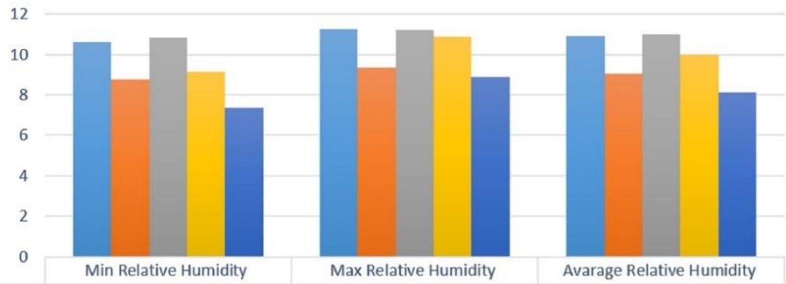
The weather conditions in the study area are considered to be the most important environmental conditions influencing the thermal perception of the users. Therefore, the temperature inside the building was measured using a data logger. In this section, an attempt was made to determine the thermal sensation of the users based on the current temperature and humidity conditions. This experiment was conducted on five different days within a week. Four variables - air temperature, relative humidity, dry bulb temperature (DBGT) and wet bulb temperature (WBGT) - were recorded for real-time measurement using the device mentioned in Figure 1 and during the time of questionnaire distribution for each person. Figure 3 shows the average minimum and maximum air temperature, the dry bulb temperature and the wet bulb temperature. It shows that the average air temperature on the first, second, third and fifth day is almost identical, but on the fifth day the average temperature (M=31.12) was higher. A similar change can be observed in the dry bulb and the wet bulb temperature. It seems that the reason for this is either the higher temperature on that day or the measurement on the south and west sides of the building, which are exposed to direct sunlight.



	Min Temp	Max Temp	Avarage Temp	Min DBGT	Max DBGT	Avarage DBGT	Min WBGT	Max WBGT	Avarage WBGT
Day 1	27.33	31.21	29.27	25.75	26.75	26.25	11.27	12.02	11.65
Day 2	28.66	33.89	31.28	26.34	29.97	28.15	10.14	10.28	10.21
Day 3	26.41	32.29	29.35	23.51	25.36	24.44	9.22	10.02	9.62
Day 4	26.13	33.86	30	24.91	25.68	25.29	11.12	12.78	11.95
Day 5	28.36	35.88	32.12	27.12	31.42	29.27	6.27	9.01	7.64

Figure 3. The mean minimum and maximum air temperature, dry-bulb temperature, and wet-bulb temperature

Overall, the average temperature during the study days is M=30.40, the average dry-bulb temperature (DBGT) is M=26.68, the average wet-bulb temperature (WBGT) is M=10.21, and the average relative humidity is calculated as M=14.14 using Figure 4, which depicts the changes in relative humidity during the study days. The third and fifth days show a greater difference in relative humidity due to the low temperature of the cooling system, the presence of plants in the workplace, the position of the windows, the number of people in the room, the passage of time and an increase in air density.



	Min Relative Humidity	Max Relative Humidity	Avarage Relative Humidity
Day 1	10.63	11.23	10.93
Day 2	8.78	9.33	9.05
Day 3	10.83	11.19	11.01
Day 4	9.13	10.86	9.99
Day 5	7.36	8.88	8.12

Figure 4. The changes in the relative humidity of indoor spaces

Table 1 reveals the relationships between thermal reactions and environmental components. The result is that thermal sensation is strongly related to indoor air temperature (r=0.170; P<0.05). Indoor temperature is also significantly related to thermal comfort (r=0.167; P<0.05) and overall comfort (r=0.129; P<0.05). In contrast to temperature preference (r=0.149; P<0.05) and radiation preference (r=0.158; P<0.05), thermal satisfaction had no strong correlation with any of the environmental components. A higher correlation was found between indoor relative humidity and thermal comfort (r=0.185; P<0.05), humidity preference (r=0.172; P<0.05), airflow preference (r=0.197; P<0.05), radiation preference (r=0.217; P<0.05) and overall comfort (r=0.233; P<0.05). For airflow preference, there is an inverse relationship between indoor relative humidity and the need for airflow (r=-0.433; P<0.05), meaning that the cooling system becomes less active as the outdoor temperature rises, leading to air condensation and a greater need for ventilation. Regarding acceptable temperature conditions, the correlation coefficient Eta (η) shows moderate correlations with indoor air temperature (r=0.109; P<0.05), DBGT (r=0.111; P<0.05), WBGT (r=0.104; P<0.05) and a strong link with indoor relative humidity (r=0.108; P<0.05). Given the minimal correlation values, it can be concluded that people's thermal perception is not only dependent on environmental components and weather conditions and that the influence of other factors should be investigated. On the other hand, the component of acceptable temperature has been shown to correlate highly with indoor relative humidity, which means that most office spaces face the problem of increasing air density and lack of adequate environmental quality. Air density was assessed based on people's thermal preferences in terms of temperature fluctuations, humidity, airflow and radiation.

Table 1. Relationships between thermal reactions and environmental components

Environmental Component	Temperature (Inside)	DBGT	WBGT	RH (Inside)	Coefficient
Thermal Sensation	**0.170**	0.190	0.174	0.049	Eta (η)
Thermal Comfort	**0.167**	0.142	-0.051	**0.185**	
Thermal Satisfaction	-0.014	-0.210	-0.121	-0.129	
Thermal Preference	**0.149**	-0.016	-0.184	0.062	
Humidity Preference	0.011	0.214	-0.048	**0.172**	
Airflow Preference	-0.123	-0.417	-0.067	-0.433*	
Radiation Preference	**0.158**	-0.042	-0.011	-0.28	
Acceptable Temperature	0.109	0.111	0.104	**0.408**	
Overall Comfort	**0.129**	-0.310	-0.012	**0.233**	

4.3. The Impact of Physical Components on Users' Thermal Perception

The participants measured the physical components, including the condition of the heating system, doors and windows, the person's location, the condition of the surrounding view, and the floors of the building. About the cooling system, the data showed that 65% of the system conditions were active, while 35% were inactive due to the automatic system being activated or the user shutting it off. In comparison to all participants, the room door was open in 69.2% of the total conditions, and 30.8% of the total door was closed during the measurement. Of all the individuals in the space, 74% were positioned near the window, 3.26% were under the cooling system located on the ceiling, and 22.74% were near the room's door. 59.15% of all users had a view to the natural environment outside, while 40.85% had a view to the artificial environment. To study the relationship between thermal responses and environmental components, correlation coefficients were calculated based on the type of scale used for each variable. The thermal sensation is associated with both open and closed condition of the window using the Cramer's V coefficient, which has an intensity of M=5.10 and M=5.87. According to Cramer's V coefficient, humidity preference with visibility over the natural environment has a magnitude of M=3.25. Using the Contingency coefficient, the overall thermal comfort is correlated with view to the natural environment an intensity of M=4.01, airflow preference is related to proximity to a window with an intensity of M=4.09, as well as the position relative to the cooling system with the intensity of M=3.33. Thermal comfort, thermal preference, acceptable temperature, thermal satisfaction, and radiation preference show no significant association with physical components. The averages in Table 3 demonstrate that physical components influence users' thermal perception.

Table 2. The average of thermal reactions to physical components

Component	Near Window	Away Window	Near Cooling System	Away Cooling System	Near Door	Away Door	Natural View	Artificial View
Thermal Sensation	**5.10**	**5.87**	2.21	1.04	2.41	1.71	-0.98	-0.55
Thermal Comfort	0.11	0.12	1.03	1.97	-0.29	0.61	1.26	1.54
Thermal Satisfaction	2.04	2.31	1.02	2.09	1.10	-0.86	2.14	1.94
Thermal Preference	-0.27	-0.31	1.40	-0.92	-0.67	1.69	-0.79	0.98
Humidity Preference	0.91	-0.71	1.29	-0.22	2.77	2.02	**3.25**	2.10
Airflow Preference	**4.09**	2.16	**3.33**	1.36	-0.63	-0.81	1.25	0.05
Radiation Preference	-0.23	-0.85	-0.29	1.14	2.04	1.11	0.31	-0.34
Acceptable Temperature	1.42	1.36	1.62	-0.30	0.26	1.73	0.66	-0.87
Overall Comfort	-0.199	1.24	-0.129	-0.81	1.19	2.14	**4.01**	2.01

5. CONCLUSIONS AND RECOMMENDATIONS

Although laboratory studies are crucial in the field of thermal comfort, the observation and recording of user dissatisfaction in diverse settings has underlined the need for field studies. This method is used to investigate the effects of numerous factors on thermal perception and to determine the most suitable area for thermal comfort. Several studies have identified and evaluated different components as useful variables for thermal comfort. This study was conducted to explore the effects of physical and environmental components. For this purpose, a field study was designed and carried out in the educational-administrative building of Konya Food and Agriculture University. In this context, 97 administrative staff and faculty members were interviewed about their thermal perception. The researcher recorded physical, climatic and environmental factors before presenting and statistically analysing the results. Because the goal of current thermal comfort models is to develop personalized models and make people completely happy, the degree of dissatisfaction should also be carefully considered. This is also reflected in the thermal preference scale, as people are still sensitive to changes in temperature, humidity, air movement or ambient radiation, even if they have a neutral thermal experience or are in a comfortable thermal environment.

The results of the study show that, in addition to environmental temperature and humidity, other elements also influence the thermal comfort and perception of users. In terms of personal preferences, one of the most common wishes of users was better air circulation. In such spaces, where the building services are commissioned before the occupants enter, the accumulation of heated air in summer leads to air congestion, which can cause dissatisfaction if adequate ventilation is not provided. This problem is particularly evident in buildings with thermal insulation but without air inlets. Air humidity is also cited as one of the criteria required by users; due to the low level of humidity, Konya city requires humidification in various places, particularly during the summer season. Increasing humidity can be accomplished mechanically by utilising humidifier equipment or by incorporating vegetation into the interior. Of course, this issue should be addressed in such a way that an increase in humidity does not cause further problems in areas with a large density of people and students. The analysis of thermal reactions revealed that user discontent increases in the afternoon and evening hours, indicating that additional air flow is required during these times. Humidity is also cited as one of the criteria required by users. Due to the low humidity, the city of Konya needs to be humidified in various places, especially during the summer months. An increase in humidity can be achieved mechanically using humidifiers or by installing plants indoors. Of course, this problem should be addressed in such a way that increasing humidity in areas with a high density of people and students does not cause further problems. Analysis of thermal responses revealed that user dissatisfaction increases in the afternoon and evening hours, suggesting that additional airflow is required at these times. Regarding the temperature conditions, the difference between the wet-bulb temperature and the dry-bulb temperature was found to be very small, and users could clearly feel the dryness of the air. In terms of correlations, indoor air temperature and relative humidity have a stronger influence on user responses and thermal requirements. In terms of physical components, the condition of openings and windows has been shown to influence thermal sensation and airflow. This point is completely insufficient in terms of thermal comfort and satisfaction.

In general, in addition to the environmental components, physical components can also be used to predict people's comfort and thermal perception. Consequently, these elements need to be considered more carefully in the architectural design phase. Therefore, based on this study hypothesis, it can be concluded that to overcome these challenges, architectural designs should prioritize the flexibility and adaptability of environmental controls. This is based on the hypothesis that adaptive systems can significantly improve thermal comfort and user satisfaction while meeting different climate needs. This approach gives users the opportunity to shape the indoor climate according to their preferences and supports energy efficiency and sustainable practices. In this regard, adaptive ventilation systems should dynamically adjust to fluctuations in occupancy and external environmental conditions. These systems could include sensors to monitor air quality and temperature, ensuring optimal distribution of airflow and reducing instances of air stagnation or overload. Incorporating advanced humidity control mechanisms, such as automatic humidifiers and strategically placed plants, can help regulate indoor humidity levels. In dry climates, vegetation not only helps regulate humidity, but also improves air quality and creates a more comfortable indoor environment that provides psychological benefits to occupants. In addition, spaces should be equipped with features such as adjustable windows, modular partitions and local cooling/heating systems. These elements allow occupants to create micro-environments within larger spaces that accommodate individual thermal preferences while maintaining overall energy efficiency. This flexibility can be particularly valuable in shared environments such as offices or educational facilities. Regular and comprehensive monitoring of thermal conditions through IoT-enabled devices and data analysis can also identify emerging problems and trends. This proactive approach allows for timely intervention to minimize user discomfort and ensure the long-term functionality of environmental systems. While the study provides valuable insights, its limitations such as its focus on a single climate zone, and reliance on short-term data highlight the need for more comprehensive research. Future studies should further investigate the hypothesis by examining different building types, including longer observation periods to capture seasonal variations, and conducting comparative analyzes across multiple climate zones. Such efforts would facilitate the development of universally applicable models of thermal comfort that consider the differentiated needs of different environments and populations. In addition, integrating behavioural and cultural factors into these models could provide deeper insights into the way users perceive and interact with their environment, supporting the design of spaces that are more responsive to people's needs.

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