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A Restoration Criticism of Historical Buildings According to Thermal Comfort Conditions through Ali Gav Madrasah

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Abstract

Thermal comfort studies have been a subject of research since the 1930s. Thermal comfort conditions which are of great importance for human health, are also important for energy. Today's due to climate changing and a decrease in energy resources, there is a change in indoor thermal comfort conditions in historic and contemporary buildings. Thermal comfort conditions are the most important factors affecting the use of buildings. So places and spaces where thermal comfort conditions aren't good are tried to improve to optimal.

The historical buildings constitute the majority of the city's building stock in addition to their original and aesthetic architectural qualities, the value for the city. From the planning to the construction process in historical buildings it is observed architectural plan schemes are shaped by considering various environmental and climatic factors such as sun and climate thus it can be said energy uses is taken into account. It is important to use historical structures and to re-function when they are

Keywords: *Ashrae standard 55, conservation of historic buildings, integrated restoration, thermal comfort*

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not available with their original function. With re-use, the new details and additional applications that are applied can affect the thermal comfort properties of the building positively or negatively.

This study focuses on the thermal comfort properties that come with the restoration of a historic building. In this context, Ali Gav Madrasah which is located in castle borders in the historical city center of Konya in Turkey and restored with a contemporary additional feature that is considered worthy of being examined in terms of thermal comfort. Thermal analysis of the reconstructed Ali Gav Madrasah, which has undergone restoration through integration based on historical documents and excavations and has a top cover made of modern materials, was carried out in August 2018 and January 2019. According to these analyzes, today's thermal conditions are inadequate for all places in Ali Gav Madrasah of thermal comfort conditions. Comments are made on the connection of this insufficient thermal comfort with the restoration/reconstruction. From this point of view, Before the restoration procedures for historical buildings, required feasibility studies and necessary solutions about buildings thermal conditions are investigated. And then architectural details should be produced for this.

INTRODUCTION

Thermal comfort, which has been the subject of scientific studies since the 1930s, is a very important term for architecture. In general, thermal comfort is a concept related to user satisfaction in buildings, use of the building, building health and energy consumption (Zomorodian, Tahsildoost, & Hafezi, 2016). Moreover because of global warming, increased carbon emissions and consumption of non-renewable energy sources, and many other factors, thermal comfort features are of great importance (Çalış, Kuru, & Alt, 2017).

When within the architectural discipline, it does not only cover modern buildings, the production of these structures causes huge energy losses, made with modern methods. Also, it covers surely historical buildings. At the same time, energy inputs have to be taken into account for structures with historical meaning and significance built by traditional methods, which have been re-functionalized or have not lost their original function.

When the historical buildings are examined without regard to the civil or monument structure, it is seen that if there is no other specific reason, the orientation of the building in plan schema is designed to take advantage of the sun. Looking at the wall surfaces of the buildings, it is observed that the walls store heat inside themselves as long as the sun is shining. And when the day is over, it is seen that the heat is released to the interior, thus increasing the ambient temperature. As a result, the wall surfaces that the sun directly reaches are getting warmer and the orientation



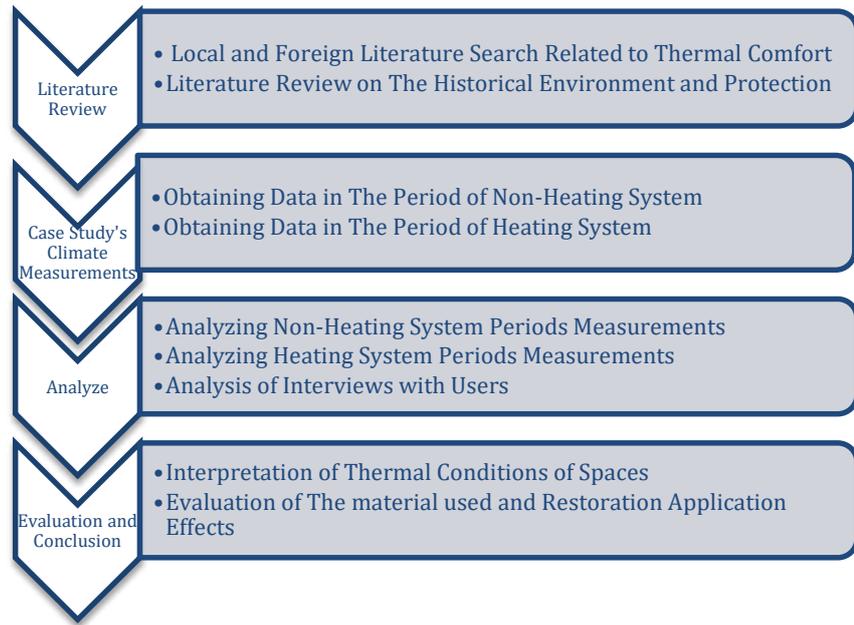
towards the sun can be considered a more accurate approach in terms of thermal comfort. But the restorations work carried out for the historic buildings to function and maintain their existence, in some way, affects these thermal states. From this point, In the scope of this study, Ali Gav Madrasah which is restored with reconstruction and a Seljuk's historic building located in Konya/Turkey is worth to be examined for evaluation of thermal climatic conditions and satisfaction levels of users in terms of the last restoration application.

As a result, in this study, the thermal comfort conditions of a historical structure which is in a cold semi-dry climate are determined. And it has been observed how these comfort conditions change when the heating system operates and does not work. It has been determined that the additions and arrangements made in order to re-align with the changing world and living standards, have the effect of thermal comfort, which is felt by the structure in terms of the conditions of the new function brought which have survived despite the centuries of construction. Depending on all of this, it is determined how the users felt in this historical building and tried to understand the effect of the restoration.

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MATERIAL AND METHOD

In the context of the study, literature review about thermal comfort, historical environmental conservation, refunctioning and contemporary addition have been detailly examined. Within the scope of this literature review, studies on modern and historical buildings in various climate zones have been investigated. Moreover, the historic environment and conservation are mentioned briefly. Information about the existing structural features and socio-cultural status of Ali Gav Madrasah is provided. Maintenance and restorations of the madrasah structure from past to present are examined.

Table 1. Method of Research

Until the last restoration in 2013, Ali Gav Madrasah continues to exist with a different function than its original architectural structure and function. During the restoration of 2013, it includes cleaning, consolidation, renovation and integration, which is one of the interventions to the monuments. In general, it is observed that the original architectural structure is preserved and the functions that could cause problems are not given into the structure. After all these interventions thermal comfort determination of this structure is decided to be worth after it has been observed that the increasing temperature and humidity emerged very soon after, being in a disturbing level for the users, the presence of moisture-absorbing lens devices that are positioned in the courtyard and in the spaces around the courtyard to eliminate the humidity and the distortions that have started to occur on the surfaces. In addition, the modern building material used in restoration and the effect of modern construction techniques on this structure are also among the reasons to be selected.

In this research, thermal comfort properties are evaluated from obtained data which are measured by the climate devices from all cell rooms, iwans, main axle symmetry over the dome covered space and the indoor courtyard in the middle of the pool of Madrasah. In order to determine the measurement and evaluation method for the study, similar methods have been made use of (Çalış et al., 2017; Elwefati, 2007; Mıhlayanlar, Kartal, & Erten, 2017).



Ali Gav Madrasah climate measurements which are located between the buildings in Karatay District of Konya in the cold semi-arid climate zone has been carried out in two periods as winter and summer season, in which the heating system works and does not work. In both measurement periods, temperature, humidity and air velocity values are measured by means of measuring devices in each space, for 3 times a day in a week. Since the madrasah is used as a public education center, it is open every day of the week and between 07.00-18.00. Therefore, these measurements will be made at 7.00-8.00 in the morning, 12.45-13.45 in the afternoon, 17.00-18.00 in the evening, with the doors and windows closed in the center of each space. These measurements are considered as a standing person and are made from the centers of the ground, waist and head alignments. Besides, the courtyard, which has been closed for the contemporary addition, measured the temperature and humidity values by means of a data logger in both periods. The measurement dates of periods are between 06.08.2018-12.08.2018, 15.01.2019-21.01.2019 in the seven-day period.

The clo value used in the evaluation part of this study is determined according to ISO 7730 standard clo values. For the summer period when the heating period is not working, this value is calculated as 0,76 clo and for the winter period when the heating period is working, this value is calculated 1,42 clo.

The data collected for the evaluation is transferred to the computer and a graph is created in Excel program. In this way, differences in temperature, humidity and air speed factors are being formed within the madrasah structure, which has been restored and integrated with a contemporary addition. The data of these three factors are evaluated separately, as well as a combination of them. These data indicators are created separately for each room. Thermal comfort conditions are evaluated according to the standards and a restoration criticism is made by interpreting how these conditions affected the material durability and structural factors of the building.

Evaluating Method

The ANSI-ASHARE-55 standard, which was first published in 1966, will be used in the evaluation process. The standard was published in 1966 and re-published in 1974, 1981 and 1992. Since 2004, the standard is regularly updated every year and is published on the ANSI ASHARE website. The assessment can be carried out according to the standard values of ASHRAE 55 and ISO 7730 in the heating period and non-heating periods (Table 2.).

Table 2. Values in the standards for relative humidity and temperature (Çalış et al., 2017)

Standard	During Non-heating Period		During Heating Period	
	ASHRAE Standard 55	ISO 7730	ASHRAE Standard 55	ISO 7730
Indoor Temperature (°C)	22-24	20-24	22-24	20-24
Air Velocity (m/s)	-	0,19	-	0,16
Relative Humidity (%)	40-60	30-70	40-60	30-70
Operative Temperature (°C)	-	24,5±1,5	-	22±2,0

When evaluating, for the average radiation temperature (T_r , °C) developed depending on indoor air temperature (T_a , °C) = $0.99 \times T_a - 0.01$ Nagano and Mochida (2004)'s equation is used. In addition operative temperature for required to calculate PMV and PPD indices is figured with depending on indoor air temperature (T_a , °C) and mean radiant temperature (T_r , °C) $T_o = A \times T_a + (1 - A) \times T_r$ equation according to Ashrae Standard 55. In the equation A is a constant connection to the airflow rate (V_r) and the values in ASHRAE Standard 55 are used. According to this, A value can be thought based on $V_r < 0,2$; $0,2 < V_r < 0,6$ ve $0,6 < V_r < 1,0$ respectively 0,5; 0,6 ve 0,7. The "CBE thermal comfort tool - CBE (Center for the Built Environment) thermal comfort calculation tool" is used with ASHRAE standard 55 when calculating PMV and PPD indices (URL-1). In the assessment, environments in which PMV is between (-0.5) and (+0.5) ranges in standard Ashrae 55-2013 and ISO 7730 accepted considered thermally comfortable (Çalış et al., 2017).

It has been shown that the data, which is concremented by measurements, is perceived by different user typologies, whether by teachers, students, administrators and other employees who use this structure continuously or for a short time. Measurements and verbal/written interviews are conducted simultaneously with this method. Then, the thermal comfort measurement part of the study was completed by comparing the thermal comfort conditions of summer and winter period. Finally, the effect of the restoration applications and the re-functionalization on thermal comfort are evaluated by comparing the original parts with the evaluation of the thermal comfort analyzes in summer and winter periods via Ali Gav Madrasah.

that may cause problems, later on, are not given. As a result of the investigations and interviews, it is seen that the amount of moisture in the structure causes problems in the disturbing level and the problem is tried to be solved with moisture devices. It is known that a humidity device is located in each room and four devices in the courtyard, can collect a maximum of 50 liters of moisture and it is used to eliminate moisture at night even though it is not used for daytime because of their loud. These devices are usually operated when fewer users exist and employees say at least once a day the moisture collection's tank is filled. After all these interventions are made, it is worth to determine the thermal comfort of the building due to the obtrusive temperature and humidity by the users, the presence of dehumidifying devices which bring the additional energy cost and the deterioration of the surfaces. In addition, the modern building material used in the last restoration and the effect of modern construction techniques on this structure are also among the reasons to be selected.

THERMAL COMFORT

The definition of the comfort zone was first introduced by Prof. John Sheppard in 1913-1923. In 1923, Houghten and Yaglou used the concept of effective temperature (et) by combining dry thermometer temperature and relative humidity in a single index. The comfort chart was first mentioned in 1924, and the climate-conditioned comfort was mentioned in 1938 in the Ashare report (Altıntaş, 2008). The comfort zone is defined in terms of the average radiation temperature and the thermal conditions accepted by the users or combinations of the range of average thermal temperatures suitable.

In Turkey, it is seen that work related to thermal comfort starts at the end of 1960. In 1969, Berköz focused on a method for determining the appropriate ceiling height in terms of bioclimatic comfort. In 1980, Sungur conducted a study with the Turks found the optimum temperature values for Turks. These values are 16.7 - 24.7 °C, but found that these values are subjective. Koçman, in his study in 1991, defined the effective temperature values for our country as 17.0 - 24.9 ° C. Topay and Yılmaz (2004) prepared bioclimatic comfort maps for the first time in 2004 with a study on the opportunities to utilize GIS in the determination and mapping of areas with bioclimatic comfort (Çetin, Topay, Kaya, & Yılmaz, 2010). Relative humidity should be between 30% and 70%, wind speed should be less than 6 m/s. These three factors are dependent on each other and it should be handled together (Güçlü, 2008).



Thermal comfort is defined at different times by various standards and people working on this subject. The definition of thermal comfort according to ASHRAE 55 standard is defined as a subjective moment when a man feels comfortable with the thermal environment (American Society of Heating, 2010). Fanger refers to the person's 'condition of being thermally neutral' as an environment in which the person 'does not want to be cooler or warmer'. Givoni's thermal comfort is not anger or discomfort due to temperature or coldness and as a matter of contentment (Yaşa, 2010). Thermal comfort can be viewed as the most dynamic feeling and harmony with the environment. The comfort values created by these ambient conditions vary from person to person. This can be explained by the fact that psychological and physical comfort conditions change from one person to another and each person cannot feel happy at the same time, frame and space so that the environmental conditions required for comfort cannot be the same for everyone. From this point of view, it is natural that people spend most of their time indoors and demand to the comfort level of climatic characteristics of these areas. People feel comfortable, fit and healthy if they are in good weather conditions and so they produce more efficient work (Daneshkadeh, 2013).

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Nicol and Humphreys (2002) explain why thermal comfort is important as simply three main factors. These include providing satisfactory ambient conditions for users, controlling energy consumption, setting and recommending standards (Salur, 2016). When the thermal comfort conditions are not at the appropriate values, dissatisfaction and discomfort begin and "patient building syndrome" or "building-related illness" occurs (Balkaş, 2005; Salur, 2016). In addition, the decrease in the level of thermal comfort causes not only physical and biological but also mental activities to be limited.

Thermal Comfort Factors

Some factors are used to evaluate the thermal comfort conditions in buildings. The ASHRAE Standard is said to be basically six factors affecting thermal comfort. These factors are metabolic rate, clothing insulation, air temperature, radiant temperature, air velocity and humidity. It is also stated that other secondary factors may affect comfort conditions in some cases (American Society of Heating, 2010). According to Carpenter et al. (1975), four climatic factors influence human comfort. These are air temperature, air movement, or wind, humidity and solar radiation constitute factors. According to Marsh (1991), 5 climatic factors affect climate comfort. These are air temperature, humidity, solar radiation, wind and air pollutants (Güngör & Polat, 2012).

In short, thermal comfort evaluations also have two main indicators, depending on the climate and depending on the user. Indicators linked to the user are the clothing factors, the metabolic temperatures of the users, subcutaneous fat ratios, age and gender factors. Indicators related to climatic factors are temperature, humidity, mean radiant heat (MRT) and air velocity. While the climate-related ones can be controlled by design methods, only the clothing factor can be controlled by human factors.

Standards are published in various time frames for different needs or in order to update another version. In the literature, there is a wide range of studies and classifications related to these standards. According to Markov (2002), standards are direct thermal comfort and standards for the thermal environment in which it is located (ASHRAE 55, ISO 7730, ISO 7993), standards related to the design of the interior (ASHRAE 62, CR 1752), standards covering the measurement of indoor thermal environment parameters (ASHRAE 55, ASHRAE 113, ISO 7726) classifies into four groups as standard (ISO 8996, ISO 9920) for determining personal factors.

Looking at the Ashrae 55 standards considered in this study accepted environment is comfortable if 80% of the users are undisturbed. According to Ashrae 55, combinations of personal and environmental factors are affected by thermal comfort. This standard takes into account environmental factors such as thermal radiation, humidity and air velocity, as well as personal factors such as clothing and activity, and is not interested in physical chemical and biological factors that may affect air quality, lighting, comfort, acoustic or health. The measurement period is more than 15 minutes according to the standard (Altıntaş, 2008; American Society of Heating, 2010).

The other considered standard in this study ISO 7730 standard aims to estimate the thermal sensitivity value and to determine the degree of disorientation of a person in a moderate thermal environment by determining acceptable thermal conditions. PMV and PPD calculation formulas are used when determining these grades (ISOEN7730, 2006).

Thermal Comfort in Historic Buildings

Climate refers to the entire of all kinds of weather events observed over many years of a region. Despite the long years of accumulation of data, the climate has a constantly changing and transforming structure (Çalışkan, 2012). Climate change, one of the most important issues of our day is investigated climate scientists, as well as ecologists, biochemists, botanists, biologists,



environmental engineers, Foresters, hydrologists and geologists, are examined by scientists in other areas of expertise. Climate change is caused by the change of climate factors such as temperature, humidity, precipitation and wind. From this point of view, the interventions to adapt the spaces used to the changing climatic factors should be made and comfort conditions should be improved (Nikolakis, 2007).

Users ask to be at the comfort level of the indoor air quality without noticing any issues such as using a building with traditional or contemporary construction techniques and different construction functions. As a result of interviews with users living in buildings built with traditional building material and literature studies on thermal performance, it seems that user satisfaction comes to the fore in the context of thermal comfort (Asadi, Fakhari, & Sendi, 2016; Elwefati, 2007; Georgescu, Ochinciuc, Georgescu, & Colda, 2017; Samuel, Dharmasastha, Nagendra, & Maiya, 2017; Timur, Başaran, & İpekoğlu, 2017).

To protect historic buildings with a different function or their original function, thermal behavior analysis should be done before the interventions are performed. In addition to shaping the interventions to be carried out with these analysis studies, it provides design data in a wide perspective for the energy infrastructure planning to be developed in historical environments. Moreover, the intervention methods prepared for thermal behavior analysis should be considered in such a way as to require minimal changes and interventions in historical buildings, so that historical buildings should be changed and architectural heritage should not lose value (Timur et al., 2017).

In the regions with similar climatic conditions, it is observed that the aforementioned factors such as typology, material and so on are similar in historical buildings. When we look at the historic buildings today, we can clearly see that they are in a rare group of buildings in which active systems are not used regardless they are civil or monumental architecture. Active systems produce many negative effects such as mold, fungi, dust, noise, stress and thus create factors that disturb human comfort. Therefore, it is necessary to avoid the factors that could impair the preservation of the present situation of historical buildings.

Form of the structure, where it is located; material affects the level of thermal comfort (Asadi et al., 2016). In addition, the location of the building is important for climatic factors such as air temperature, solar radiation affecting energy expenditure, humidity, as well as microclimate conditions that affect the energy

efficiency of the building (Yilmaz, 2006). In this respect, while looking at historical buildings, it is observed that the regions were formed according to climatic factors and material selection. Also, many factors such as orientation, location solutions, façade characteristics, material selection are shaped according to the climatic factors of the region.

CONSERVATION OF HISTORICAL BUILDINGS

The rules related to the concept of historical environmental protection are based on The Upanishads (Brahma Laws 800-400 BC), which includes the protection of cultural heritage (Öz, Aydin, & Güner, 2013). Later, the idea of conservation evolved into stylistic reconstruction, romantic vision, historical restoration and contemporary restoration theories, and is in a constant change and development and took its present position (Kuban, 2001).

The concept of protection, even if there are constant values and rules in shaping applications; decision-making and implementation processes are effective in relation to the cultural, political, social and economic structure of each region, rather than scientific definitions, search for methods, international principles, theoretical frameworks, and ideas (Altınöz, 2010). Today, intervention to historical monuments is realized with two different approaches. The first is the model of conservation, namely restoration, renovation, reconstruction, and the second is the participatory planning model, which enables reintegration and utilization into the city (Tanrıseven, Saraç, & Aydoğdu, 2016).

To integrate damaged or destroyed structures or elements of buildings today, modern methods and materials are now used and completed with it. Factors causing integration; aesthetic, functional or structural balance can be caused by the anxiety and another element of the structure as a need for integration and completion occurs (Zeren, 2010).

The method of integration is a method that is considered for structures since the birth of conservation theory. Related to this topic Venice charter's 13. article states that " Additions may only be allowed if the structure does not suffer damage to its traditional location, composition, balance and connection to its surroundings.". from this point, according to Ahunbay (2017), The contemporary additions should be as compatible as possible on the surroundings. In addition, applying a different material and construction technique will be good for separating the design from the original.



The roof is an element of the outer shell in the horizontal direction that formally completes the structure and protects it from the external environment. It is appropriate to gather the required characteristics of the roof systems under four main headings. The first of these; it is that prevent factors that will adversely affect the structure such as heat, wind, water or stopping these existing factors. The second factor is that the structure brings the interior environment to a certain comfort condition and that it controls the sustainability of these conditions. As a third factor, it is to carry its weight, snow load coming to buildings, wind load, and transfer them to the carrier system. The fourth and last factor is aesthetics. In other words, it is expected to be aesthetic because it symbolizes and defines the end of the shell in the vertical direction regardless of being a directly visible element (Coşkun, 2006; Yazıcıoğlu, 2014).

ALİ GAV MADRASAH

The building is located in the district of Selçuklu, one of the central regions of Konya province in Turkey in the archaeological site of III. degree (KonyaKentRehberi, 2013). In 1982, the madrasah was registered officially as the first group building by the Konya Regional Committee for the protection of Cultural Assets. The property is currently located on the Konya Metropolitan Municipality as a public building. The madrasah is located inside the main road and is not visible from the road as it is below the buildings and road level (Figure 2.). The entrance to the madrasa building can be accessed from the northern façade by descending the stairs from the Karatay Street on the west side. The garden wall forms the border between the high school building in the south of the madrasah. There are generally residential apartments, commercial spaces and school buildings around the madrasah. The structure is in a state of being stuck and isolated.



Figure 2. Ali Gav Madrasah's Location in Konya (URL-4)

Ali Gav Madrasah has no foundation showing the construction date, archive document, the construction site and the architect. All the restorations have been altered by the remains of the excavations during the repair and maintenance process and have been made according to the founts (Yaldız, 2003). When the madrasah is compared with the other madrasah structures, it is right to date one of the works of the early Anatolian Turkish Architecture, namely to the last period of the Seljuk State, the end of the 12th century and the first quarter of the 13th century (Kuran, 1969). This shows that the example of the first closed courtyard madrasah in Konya is the Ali Gav madrasah.

Although there is no definite evidence for the madrasah, the building was built as the Bektashi zawiya when it was first built, but it was closed by the governor of Konya Ferid Pasha of 1896-1902 and it was given to Hodja Mehmed Vehbi ibn Hüseyin. In 1901, with the support of the governor, he has made the renovations with the money collected by the philanthropists and opened as a madrasah (Konyalı, 2007; Kuran, 1969; Sözen, 1970). As a result of the arrangements made in education together with the proclamation of the Republic of Turkey, it was closed as in all other madrasahs. The madrasah, which was later transferred to the Ministry of National Education, began to function as a children's library. Then, in 1983, the building was used as a bookbinding office of the provincial public library. In the same year, it was asked by the Konya Folklore Research Association to be a presidential building, but his request was turned down that it was not appropriate to use it for commercial purposes because it is thought by directorate general of foundations madrasah is located in an important district and between the Street (T.R. directorate general of foundations archive).

Many excavations have been made to find a trace of the building until the present day, and they have undergone repair, maintenance and restoration and have many different functions. As a result of the excavations carried out in 2009, The madrasah is revealed the main plan scheme of the madrasah which is an example of a madrasah with a closed courtyard. So the integration method was applied within the scope of restoration work. The ruined building walls were completed with the rectification proposal suggested in the restoration in accordance with its original form and material such as rubble stone. The upper cover of the spaces on both sides of the entrance is covered with a flat roof, the portico of the courtyard is covered with a brick material as a vault and the central area is covered with a tempered glass geodesic dome. Date of 14.12.2010, the directorate general of foundations leased to the Konya Metropolitan Municipality. After its restoration in 2013 (figure 3. and 4.), KOMEK (Konya Metropolitan Municipality Vocational Courses) started to serve as a public education center with darülhuffaz, music and traditional handicraft courses (T. R. Konya General Directorate of Cultural Heritage Archives).



Figure 3. Top Cover Of The Courtyard



Figure 4. Madrasah Before and After Restoration-(Aynur Yilmaz's Archive)

FINDINGS

As a result of the thermal comfort analysis of the Ali Gav Madrasah, the comfort features of a closed courtyard building with integrated contemporary features are revealed. Thus, this kind of integration is aimed at modern technical, repair and restoration works in cold climate regions, both for energy cost

reduction and to ensure user satisfaction. The data taken during the periods when the heating system is operating and not operating is shown in the diagram according to the space names shown in the schematic plan (Figure 5).

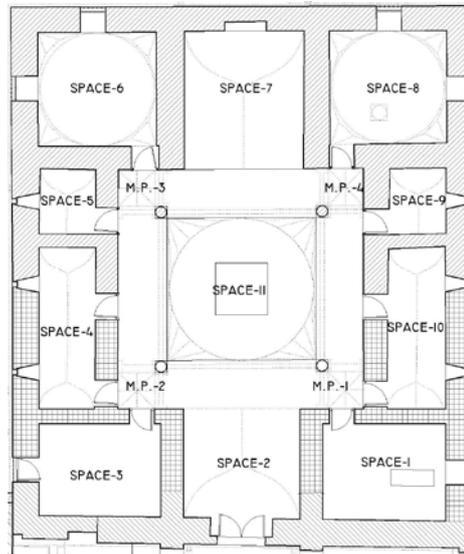


Figure 5. Madrasah's Plan Schema and Place Names (Ceray Architecture Restoration, Konya Metropolitan Municipality)

When a general evaluation is made, it can be said that the parameters affecting the thermal comfort especially in summer are proportional to the external environment data. During the measurements, temperature and humidity changes are observed according to the height of the instrument. This change occurs as the height of the tool increases in the space and there is not much change in the temperature value but there is an increase in the amount of moisture is observed. Air velocity factor (wind), which is one of the factors affecting thermal comfort, is measured in both measurement periods. But no airflow is observed in any of the interiors. Therefore, there is no positive or negative effect of the air velocity factor.

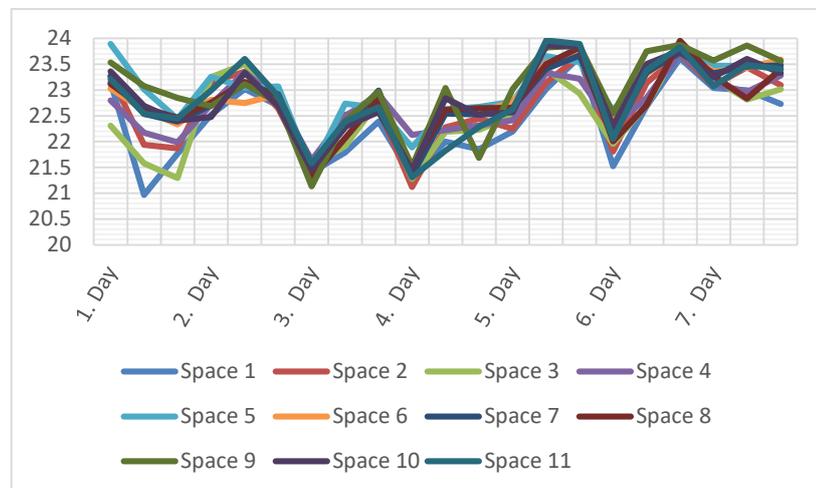


Figure 6. Heating System works Period's Temperature Diagram of Places (Şenalp, 2019)

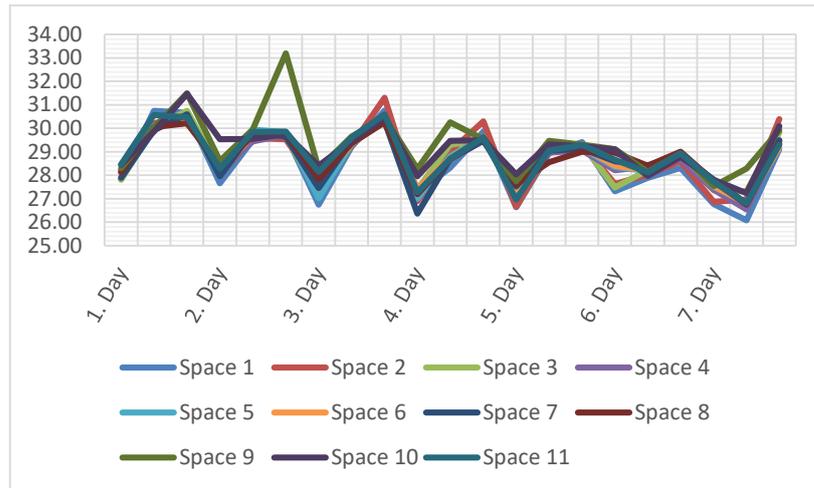


Figure 7. Heating System does not work Period's Temperature Diagram of Places (Şenalp, 2019)

As a result of the measurements made, the temperature value for the period (summer period) without heating system exceeds the ideal level due to the high ambient temperature. Since the temperature can be adjusted manually in the period when the heating system is running (winter period), the temperature value is generally constant and it is also thermally positive.



Figure 8. Heating System works Period's Relative Humidity Diagram of Places (Şenalp, 2019)

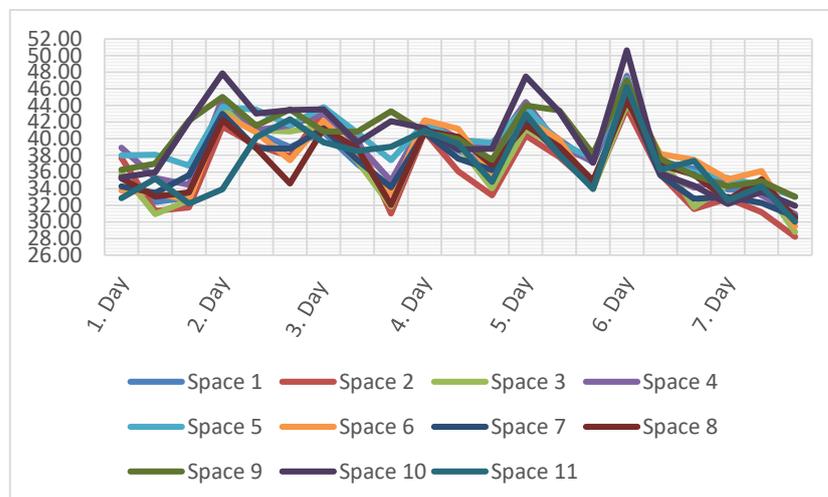


Figure 9. Heating System does not work Period's Relative Humidity Diagram of Places (Şenalp, 2019)

Moisture factor is determined as the main reason for the lack of thermal comfort in the measurements made during the period when the heating system is running and is not. The other two factors based on the measurements are sufficient to provide ideal conditions especially during the operation of the heating system, while the comfort level in the structure falls back due to the high amount of humidity in the indoor environment.

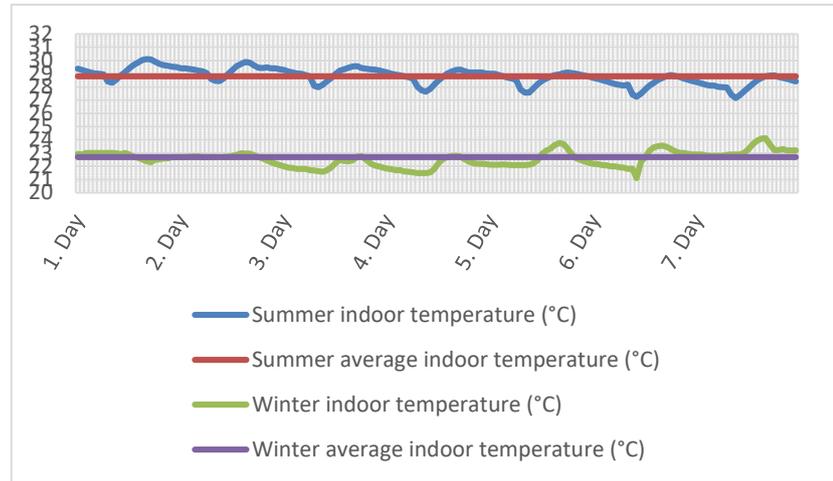


Figure 10. Datalogger's Temperature diagram (Şenalp, 2019)

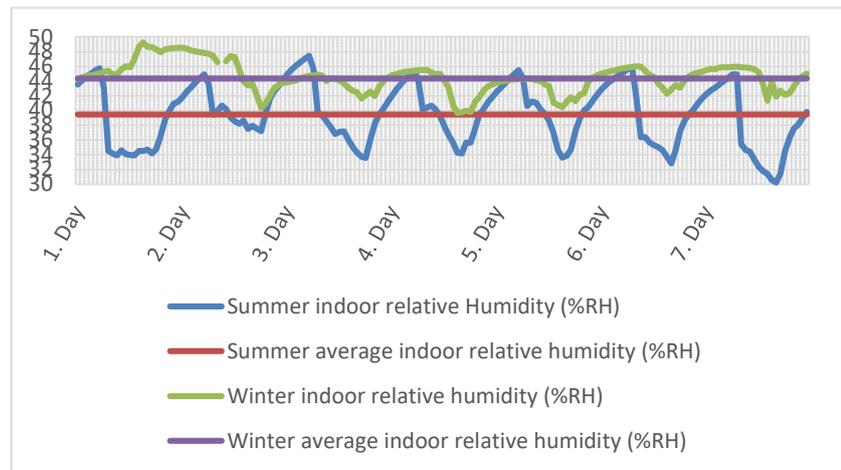


Figure 11. Datalogger's relative humidity diagram (Şenalp, 2019)

The users who use the madrasah continuously during the summer and winter periods and managers express that they feel extremely uncomfortable in the interior. Personnel say that they have been working for a long time and that their health is disrupted by many reasons such as pain in their knees, breathing during breathing and many others. Users who stay at certain time intervals and only some days in the summer period say they don't feel well inside the place and they haven't mentioned a problem in their health. Every user of madrasah state that they feel themselves overwhelming and stifling in the time periods they use.



CONCLUSION AND RECOMMENDATIONS

As a result of the research, thermal comfort conditions are thought to affect both human health and efficiency as well as structure and energy cost. If the thermal comfort is at the optimum level for the users, their desire to work and the efficiency of the people increase and he/she feels psychologically better. While looking at the factors affecting the comfort conditions structurally, it is observed that the orientation of a building, the material and the openings in the structure differentiate these conditions. In addition, it is possible to improve the comfort of the interior with various devices and machines in places that do not have this comfort condition. For this reason, the structures which are not suitable for this comfort condition increase the cost in terms of energy and raw material expenditures. In this context, it is observed that there are some problems in terms of thermal comfort conditions in the madrasah structure which was completed in 2013 within the scope of restoration.

In the Madrasah, spaces, which are opened to a common indoor courtyard, the doors opening to the courtyard, are permanently opened except for special times. There is continuous air circulation between courtyard and spaces. As a result, there is no difference between the comfort conditions of the rooms. So there is a lack of thermal comfort in the madrasah's entire spaces.

During the measurements it seems that; The climate devices located in various parts of the building contribute normalization of thermal comfort conditions. In addition, due to the warm weather conditions during the summer period, doors and windows opened for ventilation for long periods can easily be ensured by balancing the thermal comfort with the external environment and it seems that temperature and especially humidity increase rapidly after the closing of the madrasah in the evenings.

As a result of the measurements made in summer and winter, it seems that the heat conditions of the spaces are similar to each other regardless of the size, number of openings and the direction they look at. The differences are formed due to the direction, a number of openings, usage conditions and many other structural factors, and these differences are minimal. The reason for this situation is the opening of all the spaces into a common area of the courtyard.

In the oral interviews conducted during the periods, the users mentioned that in the winter period when the heating system is

running, the building's atmosphere is generally more humid and disturbing. But the result of the measurements and analyzes, it is observed that the windows and doors are kept open and the humidity is removed by the interaction with the external environment during the summer period. As proof of this situation, the summer period's night data and winter humidity rates are similar with the humidity rates during the summer period after the course center is closed in the summer period, it is shown that the humidity increased in the evenings but there is no such difference between the day and night humidity in winter. However, since there is no such situation during the winter, moisture remains indoors. Thus, the perception that the madrasah in winter is more humid is formed. But this is not a spatial situation which is a result of external factors.

As a result of the study, thermal comfort analysis of the Ali Gav Madrasah, which has a wide variety of user typologies, is carried out also the effects of the restoration and its newly gained functions on these comfort conditions is revealed. It is thought that this study will provide a basis for how to do the preliminary research on how this intervention will affect the thermal comfort in the structure before the modern restoration applications such as the contemporary additions and materials.

When we look at the applications of restoration in Turkey, it can be said that thermal effect, thermal comfort that will occur before and after restoration is completely ignored. Today, examined restoration, reconstruction and recommendation studies show that contemporary additions and top cover applications are increasing. In general, the restoration applications made with modern materials, buildings are negatively affected by the thermal aspect according to observations and interviews. It can be said that this is mostly due to the greenhouse effect caused by the transparent/glass steel top and wall coverings made by ignoring the climatic and structural features. The importance of this issue emerges in this context. From this point of view, it's necessity arises to increase and deepen these research on historic structures.

The restoration, maintenance, repair and restoration activities which will be carried out for the use of historic buildings in order to use the existing building stock, which is a very important phenomenon, are of great importance not only to protect the historic work and the culture it reflects but also to use the existing building stock by means of economic and temporal factors. For this purpose, necessary feasibility studies should be carried out before the procedures and applications to be carried out,



determination of the thermal effect, investigation and analysis will be required. And so it should be carried out to produce detail to solve the problems that occur in the determination.

It seems that the problem that is the subject of the research constitutes a problem in the interviews and detailed investigations with the users of the structure before restoration/reconstruction. From this point of view, as a result of verbal and written interviews conducted in Madrasah and objective climatic measurements, it is concluded that this problem rises neither due to the geodesic tempered glass dome of the top cover of the courtyard nor Ali Gav Madrasah's restoration-reconstruction application. In fact, it can be said that the problem originates from the external factors such as the location of the building, the soil characteristics, or the internal factors such as the use of bad workmanship and detail due to the first construction.

Restoration Interpretation in terms of Used Material and Application

- The presence of moisture and hence water in the madrasah not only affects the users but also affects the structure and material. The interior and exterior walls of the building and floor of interior surfaces have deteriorated the effects arising from water/moisture like salinity, color change. In addition, cracking, breakage and spills are observed on some wall surfaces.
- Thermal comfort, thermal behavior analysis revealed that the building does not enough in terms of thermal. However, before and after the reconstruction/integration process, the oral interviews with the trainees taking part in this structure show that this amount of moisture felt in the structure is much more overwhelming. It is said that the amount of depressing moisture decreases day by day. Prior to restoration studies, no preliminary studies are made concerning any problems existing except the determination of the planning scheme. Therefore, the thermal problems that existed before the restoration application continued after the integration.
- In order to solve the problem, it is tried to find temporary solutions by using climate devices, air conditioners and ventilation systems. However, none of these solutions can be seen as a method to eliminate the problem radically.
- Based on this, restoration studies should not be started before the necessary feasibility studies such as problem detection and search for ways to reach. However, when we look at the applications, it is seen that there are

deficiencies in the preparation of the preliminary studies. In this case, it is seen that it does not constitute a healthy application for historical structures and users.

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Resume

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