THERMAL BEHAVIOR AND ENERGY USE HABITS OF RESIDENTS IN DIFFERENT CLIMATIC REGIONS OF TURKEY: IMPACTS ON BUILDING ENERGY CONSUMPTION

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ABSTRACT

THERMAL BEHAVIOR AND ENERGY USE HABITS OF RESIDENTS IN DIFFERENT CLIMATIC REGIONS OF TURKEY: IMPACTS ON BUILDING ENERGY CONSUMPTION

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Being in comfort thermally which is the most basic need in a built environment, is an important issue that pushes the occupants to interact with the built environment and encourages energy behavior, but also includes many factors that cause this behavior to diversify. This interaction is bidirectional, that is, occupants do not only affect but are also affected. This relation was conducted with a holistic literature review and field surveys but with limitations. Due to its complex structure, the factors were limited to the socio-economic and climate diversity of Turkey. The issue of energy use was evaluated in a cause-effect manner, supported by inferential statistical analyses. The residential building has been accepted as an indirect factor representing the socio-economic and climatic region of the occupants, and its thermos-physical quality has been obtained with the knowledge of the respondents in order to measure the energy behavior patterns and to evaluate the climatic thermal comfort preferences. Rather than examining the house structurally, diversifying the occupants within the context of this study's acceptances become a much more important issue. Since it provides a permanent physical environment as a housing structure, the dormitory building was selected to constitute the sample group of the study. It enabled to access a large number and variety of occupants in a single structure. In order to gather data a comprehensive field survey (questionnaire and self-report surveys) was conducted amongst university students residing in dormitories located in İstanbul, Ankara, Kars, Sivas, İzmir, and Balıkesir cities in Turkey and built after year 2009, during the time period covering the heating period. In addition, climatic parameters (temperature, humidity, mean radiant temperature and CO2) and occupant behavior patterns (window open/close state and occupant presence) were recorded by data loggers synchronously with self-report survey. This study contributed statistically to reveal the bidirectional interaction of the occupants with the built thermal environment regarding energy use manner with the context of thermal preferences diversified according to socio-economic factors and climate regions in Turkey, and contributed to keeping future studies with the obtained data.

Keywords: Thermal comfort, occupants' behavior, energy consumption, climate regions, Turkey

ÖZ

TÜRKİYENİN FARKLI İKLİM BÖLGELERİNDE KONUT KULLANICILARININ ISIL DAVRANIŞ VE ENERJİ KULLANIM ALIŞKANLIKLARININ BİNA ENERJİ TÜKETİMİNE ETKİLERİ

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Yapılı çevrede en temel ihtiyacı olan konforda olma durumu, kullanıcıyı yapılı çevresi ile etkileşime iten ve enerji davranışına sevk eden önemli bir konu olmasıyla birlikte bu davranışın çeşitlenmesine sebep birçok etkeni de ihtiva etmektedir. Bu etkileşim çift yönlüdür, yani binada oturanlar sadece etkilemekle kalmaz, aynı zamanda birçok etkenden etkilenirler. Bu sebeple bütüncül bir literatüre taraması yapılarak elde edilen bilgiler ışığında çalışmanın kabulleri Türkiye'deki sosyoekonomik etkenler olarak ve sınırları ise TS 825 iklim bölgeleri olarak belirlenmiştir. Bu kapsamda gerçek verilere ulaşabilmek için saha anket çalışmaları yürütülürken çevresel iklim verileri ve kullanıcı davranışları ile ilgili kayıtlar alınmıştır. Enerji kullanımı konusu, çıkarımsal istatistiksel analizlerle desteklenerek neden-sonuç ilişkisi içinde değerlendirilmiştir. Konut binası, anket katılımcısının sosyoekonomik ve geldiği iklim bölgesini temsil eden dolaylı bir faktör olarak kabul edilmiş ve termo-fiziksel niteliği ise daha çok kullanıcı davranışını ölçmek ve iklimsel ısıl konfor tercih değerlendirmesini yapmak amacıyla anket katılımcısının bilgisiyle elde edilmiştir. Bu sebeple konutu yapısal olarak incelemekten ziyade, anket katılımcısını çalışmanın kabulleri çerçevesinde çeşitlendirebilmek bu çalışmanın ana amaçlarındandır. Hem birey günlük yaşamında tercihlerini sürdürebilmesi ve süreklilik arz edebildiği fiziksel bir ortam sağlaması hem de tek bir yapıda çok sayıda ve çeşitlilikte kullanıcıya erişim imkânı vermesi, konut yapısını temsilen yurt binası sakinleri çalışmanın örnek grubu olarak seçilmiştir. Veri toplamak amacıyla İstanbul, Ankara, İzmir, Balıkesir, Sivas ve Kars illerinde 2009 yılı sonrası inşa edilmiş ve devlet üniversitesi bünyesinde hizmet veren yurt binalarında yaşayan üniversite öğrenciler ile ısıtma periyodu dönemini kapsayan zaman aralığında genel anket ve öz bildirim anketleri yapılmıştır. Ayrıca iç ve dış iklim parametreleri (sıcaklık, nem, ortalama ışıma sıcaklığı ve CO2) ile kullanıcıların davranışlar (pencere aç/kapa durumu ve kullanıcı doluluk) veri kaydediciler ile öz bildirim anketleri ile eş zamanlı kayıtlar alınmıştır. Bu çalışma, Türkiye'de farklı coğrafi ve iklim bölgeleri tarafından temsil edilen farklı sosyo-ekonomik geçmişe sahip hanelerin davranış kalıplarını ve termal tercihlerinin enerji kullanımı davranışında iki yönlü etkileşimini istatistiksel olarak ortaya koymuş ve aynı zamanda elde edilen veriler ile gelecek çalışmalara katkı sağlanmıştır.

Anahtar Kelimeler: Isıl konfor, kullanıcı davranışı, enerji kullanımı, iklim bölgeleri, Türkiye.

To my family

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CHAPTER 1

INTRODUCTION

This chapter has been structured under four subsections with the aim of introducing the problem, identifying the gap in the literature, posing the research questions and presenting the procedure of the study as well as the disposition of the dissertation.

1.1 Argument

The dilemma of the modern society is the increasing need for both energy resources and energy conservation at the same time (Wilhite, 2012). The individual is in fact not focused on consuming energy directly, but needs to use equipment and services that consume energy; such as lighting, heating and cooling equipment, house appliances for cleaning and cooking, etc (Horta, Wilhite, Schmidt & Bartiaux, 2014). As Lutzenhiser & Gossard (2000) point out, "Machines do not consume energy - people and machines [together] do". Hence, the behavior of building occupants plays an important role in the building's energy use (Carpino, C., Mora, D., Arcuri, N., Simone, M., 2017), as a parameter either effecting the surroundings or affected by the surroundings. Lutzenhiser & Gossard (2000) bring the importance of occupants' behavior into the picture by summarizing the way energy is used and pointing out to its role in energy consumption by defining energy efficiency as "…doing the same amount of work with less energy". In other words, various factors such as energy prices, household income, family structure, awareness on energy issues, socio-cultural attitude, perception and preferences of indoor environmental conditions shape the energy consumption patterns.

While Rapoport (1969) draws attention to the differently designed buildings in similar climates, similar but in a different perspective, Lutzenhiser (1993), a similar perspective but in a different way, states that differences in energy consumption have been observed in similar residential units occupied by demographically similar families located in the same region. The author argues that the diverse compositions of households with their unique activities, schedules, demographics and beliefs, which influence their “life-style”, have a direct relation with the varied energy use behavior in families. This diversity of lifestyle gives rise to different consumption requirements and the related environmental impacts; while the differences among individuals’ preferences result in varied adaptive behavior patterns or use of equipment controls, such as thermostats, temperature setting setbacks and opening/closing of windows and doors. On the other hand the regional energy consumption pattern in a country varies with such conditions as the quantity and accessibility of resources, technology options, and most importantly, the income level of households and affordability of energy resources (Ediger, & Kentmen, 2010; Faiers, Cook, & Neame, 2007).

The role of occupants on energy consumption has been overlooked or considered a minor priority even in studies based on the “physical-technical-economic model”, while the typical model assumes energy consumption analysis of buildings, and energy policy planning disregarding user behavior (Lutzenhiser, 1993). Fanger (1970) whose thermal equations are the basis of these analyses assumes all occupants from around the world as having similar thermal comfort preferences under similar conditions, i.e. clothing, activity, temperature, humidity and air velocity values are similar; although, the climate, living conditions and culture vary. On the other hand, Humphreys & Nicol (1998) argue that the building occupants with varied thermal perception and tolerance play an active role to achieve comfort by adjusting their behaviors, which make makes them accept a wider range of temperatures.

In its simplest form, energy efficiency aims to bring the building to a state where it does not need either heating or cooling at all or with the least amount of energy can attain the thermal comfort of the occupants (Fanger, 1970; Humphreys & Nicol, 1998). Pioneer studies which emphasize the importance of the interaction of the regional climatic characteristics with the structural form, prescribe the "Design with climate" approach that will provide climate-sensitive structural solutions and user thermal comfort with minimum energy use (Olgyay, 1963; Givoni, 1969). Within the context of this simplicity, the climatic characteristics of building's surroundings have primarily become a matter for researchers to evaluate the optimum approach to create the building from the point of view of energy use efficiency. The basic assumption of such studies is that buildings in the same region with similar climate and physical properties consume similar energy, and the people give similar responses thermally in similar thermal environments with similar structural forms (Smith, 1993). With this logic, the national and regional level studies in Turkey have been conducted to determine a practical guide for energy regulation and building design: the TS825 standard. This approach is criticized within the scope of the dissertation and can be identified as the first research problem being investigated here.

The Energy Performance of Buildings Directive (EPBD) 2002/91/EC of the European Parliament and the European Council is related to the impact of energy consumption through buildings and the resulting CO2 emissions; while the aim of reducing or at least controlling CO2 emissions is addressed through protocols that have been enforced in some countries, e.g. the Kyoto protocol. After the implementation of EPBD, the CEN/TR 15615 standard have been developed as an umbrella document to explain the relationship between the various European Standards and the Directive and provide an outline of the calculation procedure for assessing the energy consumption of buildings. Since Turkey, as a country dependent on oil and gas imports, needs to reduce the increasing energy consumption, energy efficiency policies and legislations have been developing with the Energy Efficiency Law that came into force in 2007 (CSB); and the Turkish standard of Thermal Insulation Regulations in Buildings (TS 825) was revised. In the ongoing process, the Energy Performance of Buildings Directive with its building code TS825, Energy Performance Certificates for buildings and labeling household appliances were put into practice. The heat cost allocator and temperature control devices have become a necessity in residences. However, there is no process related to monitoring and evaluation of these measures in residences, instead, scenarios with forward-looking goals have been have been formulated for evaluation studies (WGB, 2015).

Two important aspects of the TS825 standard are criticized. The first is that it defines the highest allowable heating energy loss and prescribes thermal insulation applications in the building envelope (i.e. the maximum U-value of building components) according to five climatic regions. While, the only parameter used for this climatic region classification is the average number of heating degree-days in a year within the entire regional boundary; hence, cities located within these boundaries having different thermal conditions due to local geographical characteristics are evaluated within the same climatic region. The second criticism or weakness of the regional climate model is that the method for classifying energy performance of buildings neglects the varying thermal response and behaviors of households in diverse climatic regions. Hence, the need for an occupant-oriented study that evaluates whether or not the thermal perception and comfort preferences of households in different climate regions diversify in parallel to the defined climatic zones.

Schimschar, Boermans, Kretschmer, Offermann, & John (2016) who worked through the scenarios of energy efficiency improvement for the future emission reduction in the study of U-value map for Turkey pointed out to the influence of socio-economic differences of households on the significant difference between theoretical demand and actual consumption of energy. The physical-technical approach of theoretical estimations is based on the improvement interventions such as the heating system and insulation of the existing structure. Yet, socio-economically low-income households living in the colder regions of Turkey, who have limited financial means, behave differently than the energy evaluation assumptions. Instead of improving their home thermally, they usually resort to heating only parts of their homes and adapting to the thermal conditions in order to reduce the energy consumption. It should be noted that 57.1% of the households in Turkey still use stoves to heat their homes (TUİK, 2011).

The second major research problem is that although there are many studies in the literature focusing on energy consumption by households, the influence of occupants' behavior has been neglected. Therefore, there was a need to understand the thermal perceptions and preferences of households in different climatic regions of Turkey with respect to their varied socio economic conditions and energy use patterns; as well as the need to map the occupants' adaptive behavior when moving from one climatic zone to another.

1.2 Objectives

This research was conducted to evaluate the thermal perceptions and preferences of households in Turkey with respect to their varied socio economic conditions and climatic regions with a cause and effect manner. Climatic characteristics influence the occupants' thermal comfort as well as the building's energy consumption; and to produce energy efficient buildings there is a need to balance thermal comfort while decreasing energy consumption, concurrently. This double-sided interaction in residential buildings of Turkey needs to reveal.

Calculations for determining both thermal comfort in a building and the related energy consumption are made by considering the regional climatic characteristics as well as the characteristics of the building envelope; but the balance can be tipped by a third factor, i.e. the occupants' behavior due to their thermal perception and preferences.

Hence, the first aim of the this study is to critically evaluate the TS825 approach to improve the energy performance of housing in Turkey; which is based on the HDD related classification of five broadly identified "climatic" regions, each of which consists varying geographic conditions within their boundaries. This generalization neglects the thermal response variability of households in the diverse locations within these climatic regions.

The second aim is to analyze the influence of the socio-economic determinants of Turkish households represented by different geographical regions in the country (and not the designated climatic regions) on their perception and preferences with regard to their thermal environment.

For these aims, the objectives were comprised of the following;

- to analyze the relationship of households energy use pattern with demographic indicators such as gender, family size, city of birth (climatic region) etc.
- to explore the relationship between households energy use pattern and socio-economic indicators such as income, ownership, operating systems, energy bills, type and size of dwelling, thermophysical condition of dwelling, etc.
- to reveal the thermal comfort preferences of occupants from different climatic regions of Turkey, for comparison.
- to compare adaptive behavior patterns of occupants living in dormitories in different climatic conditions than those in their hometowns.
- to determine national awareness on domestic energy concerns.
- to get feedback about the influences of national regulations and legislation on the thermal perception of occupants

1.3 Procedure

In this study, the characteristics of the residential building have been accepted as indirect factors representing the socio-economic and climatic regions of the target population (users), and data on its thermophysical qualities have been obtained from the users/occupants, in order to measure the energy-use and occupant behavior patterns and to evaluate the thermal comfort preferences in different climates. Rather than examining the house structurally to ascertain the building's energy consumption in different climatic regions, diversifying the user to determine the energy consumption patterns became a much more important issue. Since it provides a permanent physical environment for individuals to maintain their preferences in daily life and enables the researcher to access a large number and variety of users in a single structure, the dormitory building constituted the sample group of the study as representing the housing structure. In order to understand the energy consumption patterns and user behavior as well as adaptive comfort strategies of the Turkish people the target population was selected from university students residing in dormitories. These students came from different parts of the country having different climatic conditions and were required to live in climatic regions that were sometimes quite different from their hometowns. Thus it was possible to assess the adaptive behavior of young people born or residing in different climate regions of Turkey who were living in the seven dormitories located in six cities representing belonging to five main climatic regions; cold and dry, cold and humid, cool, and hot and humid.

With these objectives in mind data was gathered in the following three stages.

1. Data and information on the building attributes of the selected dormitories (plans, occupant number, schedule rules, building construction, operating systems and utility bills) was gathered from the student housing administration in the universities.

2. Data related to indoor environmental conditions was recorded by deploying data loggers for temperature, humidity, CO2, lighting and ventilation conditions and occupant behavior (occupancy pattern, adjustment of temperature levels and operating the windows) by locating them in selected dormitories' rooms

3. Survey- based on two questionnaires were conducted to gather information from the dormitory residents about demographics such as age, gender, and family size; socio-economic profiles such as residential unit type, number of rooms and occupants, operating systems, income level, and energy bills, etc.; hometown characteristics such as, climate and dwelling type; current state information, such as occupancy duration in the current city, academic department, schedule of occupancy, visual comfort, thermal sensation, thermal preferences, thermal acceptability, adaptive behavior to adjust to the environmental condition, etc.)

4. First, to summarize and organize characteristics of the responses from the surveys, tables, bar charts, and scatter plots of descriptive statistics with the distribution of frequency, averages, and mostly tendencies or percentages were used. Then, inferential statistics were conducted by null-hypothesis significance testing.

Figure 1.1 presents a flow-chart of the research process followed in this study.

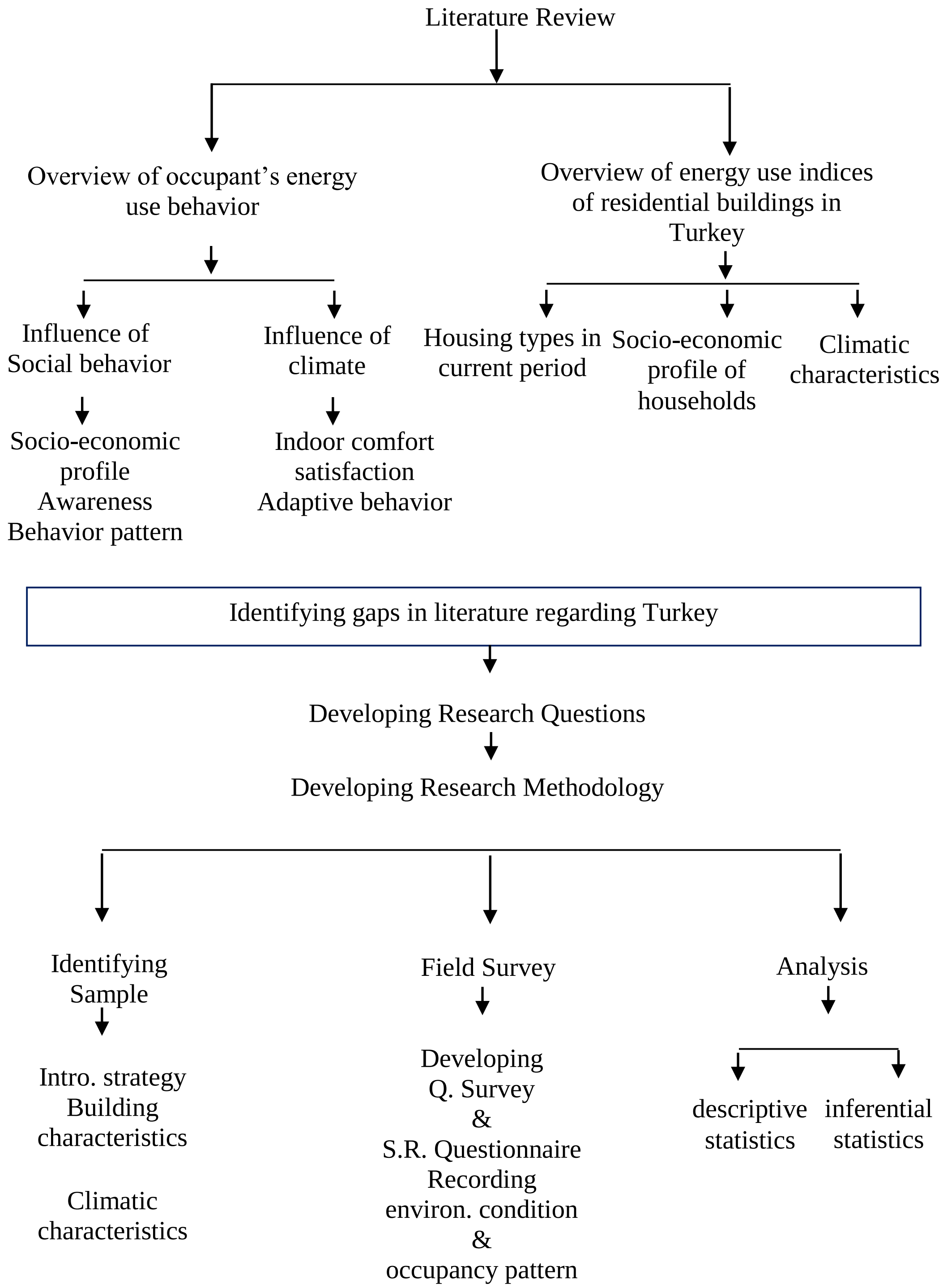

Figure 1.1. Overview of the study

1.4 Disposition

This, the first chapter presents the background of the research problem, the research objectives and the procedure adopted to reach these objectives.

The second chapter contains a thorough literature review on human factors and energy concerns in residential buildings; the development of residential buildings in Turkey; socio-economic and demographic profile of households in Turkey; the role of residential buildings in national energy use of Turkey; and the critiques of the relationship between climatic region and residential building energy conservation studies in Turkey.

The third chapter consists of the material and method of research. The fourth one presents the results and their discussion, while the fifth chapter rounds off the dissertation by presenting conclusions of the research and recommendations regarding national regulations and legislation based on the research findings.

CHAPTER 2

LITERATURE REVIEW

This chapter presents a literature review on issues that influence the energy requirements of a country; namely, human factors, building characteristics and the climate; as well as their interactions. According to the problem statement, the residential building is taken as a physical environment that influences user behavior, rather than as a physical structure. For this reason, the influence of occupants' behavior on energy consumption was studied in the first section of the literature review. The literature search was carried out through the electronic resources search engine of METU Library that allows students to access online databases of Scopus, Science Direct, etc. The terms "house building", "occupant behavior/pattern", "energy efficient/efficiency", and "energy consumption" were considered as the research key words. To limit the number of articles the followings criteria were used:

- published in peer reviewed journals
- focused on the impact of the climatic conditions on occupants' behavior and households' energy consumption
- overviewed the most influential and commonly cited occupant behaviors
- contributed to energy efficiency studies

In the second part, it is desired to create a national framework within the scope of the aim of the study. Published studies evaluating the effect of household behavior on residential energy consumption in Turkey are very few, therefore, this part was constructed obtaining data about Turkey's climate characteristics and socio-economic diversity in the context of their relation with residential energy consumption, as well as the quantitative and qualitative status of today's housing structure and its importance in national energy consumption sources. Therefore, this literature survey helps to evaluate the user-housing-energy relationship on a national scale within the scope of the study by providing information for the research conducted herein.

2.1 Human factors and energy concerns in residential buildings

After the oil embargo crisis, the term energy 'conservation' became the important issue concentrating on how to encourage households to reduce their energy consumption. Therefore, many studies have focused on the national real energy use of the houses. Over the past several decades research on the impact of occupants' behavior on the actual energy consumption of buildings has been carried out to validate actual schedule of occupancy patterns and peak demand of heating and cooling systems, or just to investigate occupant's interactions with lighting system, electrical appliances, hot water supply and window use for ventilation. With interdisciplinary approach to this research area, the context of the issue has been enlarged by exploring the reasons of occupant interventions in achieving environmental comfort, such as social and economic profile and awareness on energy savings.

The influence of behavioral variables on the energy consumption trend of the building, whether domestic or non-domestic is generally defined by the demand for space heating and cooling, appliances used, lighting and domestic hot water. However, the impact ratio of these on energy consumption is varied depending on building type. Levine et al. (2007) present the end-use energy in buildings in the United States and China. In comparison to the residential building with non-domestic building sector in China, the most important difference is the appliance use, lighting load and space-cooling load. While commercial buildings consume cooling energy, houses are preferred to be ventilated naturally. Moreover, there is no appliance use in commercial buildings, while lighting load is more significant in these buildings. Yet, space heating and heating water have same contribution in both building types. Although, in the U.S. lighting load has same trend as in China, but the other energy load factors have similar influence for both building sectors in contrast to China. In order to understand the reason of these varied end-use energy profiles in different countries and in different types of building sectors, their study emphasized the importance of behavioral characteristics of occupants to be the primary factor. Since the success of this concept depends on the availability of information on occupant behavior, there are several studies discussing the overall framework of the theories related to energy issues of residential sector. The review study by Delzendeh, Wu, Lee & Zhou in 2017 identifies the percentage of residential building type as 36.44 % used as case studies in the reviewed papers, which is the highest ratio among other type of buildings. On the other hand, the study published in 2021 (Chen, Zhang, Xia, Chen, Setunge & Shi, 2021) shows that work on office buildings has increased and it has reached 45%, thus outnumbering studies on residential buildings (Figure 2.1). Another change experience until 2021 is the subject of interest about occupants' interactions with energy use according to review papers. The issue of electricity use behavior has transferred its importance to subject of occupancy shown as in Figure 2.2.

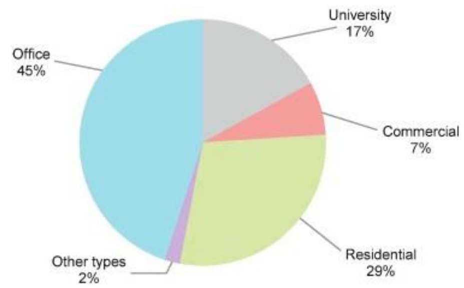

Figure 2.1. Building types used in case studies. (Source: Chen et al., 2021)

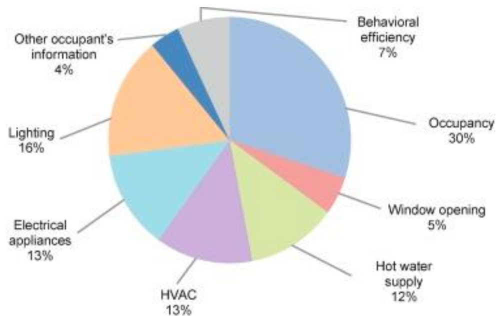

Figure 2.2 Types of occupant behaviors (Source: Chen et al., 2021)

What interventions of occupant manipulate the assumed energy use in dwellings become main concern of these studies. Once a dwelling is occupied, the interactions manipulate end-use energy profile within different demands. Culture, aesthetic norm, attitudes, and comfort as well as economic and social variables influence energy use behavior of a dweller (Wilhite, Nakagami, Masuda, Yamaga & Haneda, 1996). In the light of the complexities such as financial, education, country profile, occupancy patterns, occupant awareness on energy savings, occupant preferences and interventions in achieving environmental comfort and occupant adaptation, have been considered in several studies to understand whether representing occupants in a more realistic way in analyses of energy profile in residential buildings is crucial or not.

Some authors (Webster, Tomalty and Korteling, 2009; Diamond, 2001; Fuller & Crawford, 2011) argue that family life and urban development influence residential preferences of occupants and thereby typical housing type of countries have been formed which informs a general view of energy load profile. For example, single-family dwelling is the representative dwelling type in Canada in contrast to apartment and row house type, and that type of dwelling was found to consume more energy than the others, and is used to characterize the energy load of residential stock of the country (Webster, Tomalty and Korteling, 2009). In Europe, the typical dwelling is the single-family house type, which is about 64% while apartment blocks constitute 36% (Buildings Performance Institute Europe, 2011). Similarly, in the

U.S. single-family house is around 73% of other single and multi-family apartment houses (Diamond, 2001). Furthermore, in Turkey, an apartment block with 3 rooms is the predominant building type as reported by Turkish Statistical Institute (TUIK,2017). In Australia, Fuller and Crawford (2011) emphasize the importance of urban development in Melbourne to guide occupants in their residential choices about size and type, and corresponding energy loads. Australian cities have grown outwards from previous centers, so they have supported the demand for low-density housing with large sizes. Consequently, detached house style is more common and correspondingly increases the energy use in the country.

The studies on relation between the price of electricity and energy use pattern confirm that the use of air ventilation and space heating systems are affected relatively. For instance, the high cost of electric power in Japan influences the households to use air conditioner in a controlled manner, while in Kuwait electricity use is free; therefore occupants do not turn the lights off during the night even if the rooms are not used. Also, during the daytime lights are left switched on. On the other hand high electricity rate in Japan forces the occupant to use non-electrical space heating devices and consequently increase the environmental impact of buildings (Iwashita & Akasaka, 1997; Al-Mumin, Khattab & Sridhar 2003; Yu, Haghighat, Fung, Morofsky & Yoshino, 2011).

The income level of the residents is the other concern of the studies. Results show that the higher income level leads the occupants to consume more electricity than others, because, they have larger homes with great number of occupants and more appliances used more frequently. However, it does not have any significant relation with comfort temperature settings (Yohans, Mondol, Wright & Norton, 2008; Steemers & Yun, 2009). On the other hand the expectations for higher standard of living have increased electric energy use continually for each year (Ouyang & Hokao, 2009). Having air conditioners and appliances even though not needed is an indication of well-being and status of households. Moreover, life style influences luminary selection and hot water usage pattern, and turning off the thermostat and lights when leaving is a matter of habits. (Wilhite et al., 1996)

The influence of occupants' awareness on energy use pattern is dealt with to achieve decreasing energy consumption without additional infrastructure. For this purpose, many studies examine different methods to raise the users' awareness on energy consuming habits. One of them is educating occupants to become more aware of energy savings, which can help to decrease energy use by more than 10% (Ouyang et al. 2009). The other one is the awareness of seasonal energy costs, which makes the occupants to be thrifty and reduces heating and cooling consumption (Wilhite, et al., 1996). Awareness of health impact of mechanical air conditioning is the other approach, which encourages occupants to use more natural ventilation (Iwashita et al., 1997)

Because the impact of user behavior is difficult to quantify for methodological reasons, the influential parameters of occupants' energy-use behavior are considered in different perspectives in the studies. Each study has its own occupancy scenarios due to their conceptual differences. Buildings science evaluates the occupant's role on the actual energy consumption with the scenario with regard to the defined occupant behavior (Brahme et al. (2009). The studies (Santin, Itard and Visscher, 2009; Gillott, Holland, Riffat & Fitchett, 2013; Johansson, Bagge & Lindstrii, 2011; Al-Mumin et al. 2003; Richardson, Thomson & Infield, 2008; Yohans et al. 2008; Ouyang et al. 2009; Yu, Fungb, Haghighata, Yoshinoc & Morofskyd, 2011; Johansson et al. 2011) at the scale of a building's thermal envelope accept the occupant passive interaction with the building (occupant's metabolic heat as a gain, occupant profile and presence), and the occupancy factor is often defined as occupancy schedule or occupancy pattern. Other studies (Al-Mumin et al. 2003; Han et al. 2007; Hwang, Cheng, Lin, & Ho, 2009; Etzion, Portnov, Erell, Meir & Pearlmutter, 2001; Andersen, Toftum, Ndersen and Olesen 2009) defining the acceptable indoor thermal comfort boundaries and propagating their use have focused on occupants' thermal perception and preferences, while others (Iwashita et al. 1997; Han et al. 2007; Park & Kim 2012; Shin et al. 2013; Etzion et al. 2001; Karahan, 2016;) integrating user control of the building operational systems uses the occupancy factor actively (managing heating system and heated area, adjusting, shading and window, use of domestic electrical appliances, lighting and hot water) and define it often as the occupants' behavioral pattern or adaptive behavior. Each approach depends on its own assumptions and determines its own limits; it is inevitable that studies often ignore an important behavioral component of energy demand. These gaps determine the topics of the next studies to be done.

The occupancy pattern is one of the main issues for the studies intending to accurately determine the energy simulation results by using real time occupancy data. The number and location of households as well as duration of stay in residential buildings and correspondingly its influences on the energy use pattern are the focus in these studies. Gillott, Holland, Riffat and Fitchett (2013) focused on the room use pattern by emphasizing that the larger floor area the room has, the more time it is occupied, with the exception of service areas such as a laundry. In addition to the occupancy time, other studies examine the time varying impact of occupant activities such as the use of appliances, lighting, heating, cooling and domestic hot water varying considerably. It means that it depends not only on the number of people living on a property but also on whether they are at home and active. For example, Santin, Itard and Visscher, (2009) emphasized that the temperature setting as an important parameter to determine energy use and is more related to role of occupant than the thermal quality of the building. In another study, mechanically ventilated dwellings designed for maximum occupation are observed to be over-ventilated because the accepted occupation level is not the case during all hours of the year (Johansson, Bagge & Lindstrii, 2011).

Apart from the presence of user, the demographic characteristics of people in different type of dwellings as well as in different countries are studied and it was revealed that building users get used to different activity levels in different time periods, which are important identifier of energy use pattern. For example; in cold climatic region, occupancy leads to consuming 34% more heating energy in evening than during the day, while this increased heating energy is decreased 2 % during the night (Al-Mumin et al. 2003; Richardson, Thomson & Infield, 2008; Yohans et al.

2008; Ouyang et al. 2009; Yu, Fungb, Haghighata, Yoshinoc & Morofskyd, 2011; Johansson et al. 2011).

Occupants' satisfaction with the indoor environmental conditions depends on their thermal, visual and acoustic comfort as well as the indoor air quality (IAQ). Accordingly, studies in different climatic zone focus on the investigation of occupant thermal perception at the national level. In view of occupant preferences and interventions in achieving environmental comfort, studies mostly have dealt with the thermal comfort of users so as to examine the relationship between thermal sensation of occupants and building envelope properties and to compare international standards of thermal comfort levels to thermal sensation ranges of occupants in hot climatic regions.

Some authors (Al-Mumin et al. 2003; Han et al. 2007; Hwang, Cheng, Lin, & Ho, 2009) reveal that in hot climate regions, occupants' thermal perception differs from those in cold climates. Neutral thermal sensation scale shifts to slightly cool, namely occupants in hot climate region prefer cooler indoor temperature than the scale defined in ISO 7730. Within the context of the relation between building envelope and thermal comfort, some adaptive behaviors help occupants to acclimatize thermally, such as; maintaining a pleasant breeze by shading the building envelope in hot climatic regions (Etzion, Portnov, Erell, Meir & Pearlmutter, 2001). From a different view point Andersen, Toftum, Ndersen and Olesen (2009) claim that there is no statistically significant relation between thermal sensation of users and window opening behavior and found that window opening behavior is linked to the outdoor temperature in cold climatic region.

Besides thermal comfort, visual comfort is the other focus of studies to investigate the influence of occupant patterns on lighting use intensity and to examine visual perception of occupants. The periods being at home and activity regime in different spaces of house varies according to different demographic characteristics and lifestyle in different countries. Accordingly, illumination level inside of the dwelling is perceived differently depending on the duration of sunshine and intensity of daylight outside. All these factors influence the period of benefit from daylight and the use frequency of artificial lighting, and consequently vary the energy use intensity (Al-Mumin et al. 2003; Ouyang et al. 2009; Andersen et al. 2009; Shin, Kim & Kim 2013; Gillott et al 2013). The other variable of occupant preferences is the luminaire selections influenced by cultural differences, which differs the energy demand (Wilhite et al. 1996)

Indoor air quality is considered as a parameter based on different factors; e.g. removal of pollutants and moisture, supply of fresh air, occupants' activities and preferences as well as construction and operation of building systems. Especially the matter of energy conservation in buildings after 1970s makes thermal insulation and air tightness of building skins popular in minimizing infiltration of outside air. Because of air tightness, indoor air pollution emitted from the human body or building materials in a room becomes important problem. With regard to occupant pattern, indoor air quality issue is mostly conducted on influence of user on ventilation pattern in dwellings and consequently comparison between actual ventilation pattern and assumed amount of air change in order to examine energy efficiency interventions. The studies emphasize that the measured actual total ventilation rate is five times more than that calculated for the summer period in hot climatic region. (Iwashita et al. 1997). However, this differences between actual and assumed rates varies according to ventilation type (naturally or mechanical) and climatic region. Ventilating a house naturally is the most preferred behavioral pattern, which increases heat tolerance of occupants (Han et al. 2007). On the other hand, use of mechanical ventilation in hot climates increases the thermal comfort demand (Han et al. 2007). Nevertheless, occupants need mechanical ventilation during heating season, if the building envelope is airtight. When used for more than 4 hours per day, which is needed period to improve occupant acceptability of the indoor air, energy use increases by 31% (Iwashita et al. 1997; Park & Kim 2012).

Adaptive attitudes of users have been studied depending on climatic region and type of building. Accordingly in hot climatic region, adaptive approaches are explained to be dependent on socio-economic profile. Such that, adjusting behaviors vary from conditioning mechanically to operating windows as well as using air fans, changing clothes and washing face, which also influences the thermal tolerance of body as a thermos-physiological adaptation. (Iwashita et al. 1997; Hwang et al. 2009). Besides, in order to avoid overheating and glare problem as well as getting pleasant breeze, the other adaptive responses are clarified as occupant's preference to add shading elements, use blinds or to plant vegetation (Shin et al. 2013; Etzion et al. 2001). On the other hand in cold climatic region, studies focus on heating season and correspondingly habits on adjusting indoor temperature suggest that using thermostat is preferred more than controlling valves to increase the indoor temperatures, which raise the energy consumption (Santin et al. 2009). The second issue is that the building type influences the adaptive approaches and some studies show that turning on the air-conditioner is the most used intervention in work places (57%), while the highest percentage in residence belongs to the window opening behavior (33%) (Hwang et al.2009). On the other hand, another field study focusing on window opening patterns and its related factors reveals that the frequency of windows opening varies according to outdoor environmental variables (Karahan, 2016)

One of the common results is that the building characteristics and climatic conditions is thought to be much more important for indoor conditions, studies of occupancy scenarios show that there could be a feasibly important relationship between occupants and energy consumption level. Because the studies have shown that the actual energy use in residences was different from the calculated energy consumption. Studies have also shown that occupants might play an important role in the variation in energy consumption even in a built environment having similar characteristics.

The studies in the countries which have high heating loads focus on the influence of infiltration rate in dwellings on the indoor air quality associated with occupants' behavior pattern regarding ventilation interventions during heating period. Moreover, in order to decrease energy, use during heating season, the occupants' daily activities such as electricity use patterns; time being at home, occupancy level, habits of air conditioner use, become the research matter of the studies. Accordingly, standardize occupancy pattern is revealed as an important input for the countries in cold climatic region. Furthermore, as occupants increase the energy consumption when they have control of the temperature set points in winter, district heating management is confirmed as the most useful system.

On the other hand, the studies in hot climatic locations mostly deal with thermal comfort studies. They argue that the international standards have been developed according to people who live in cold climatic region. However, as the climatic diversity influences the thermal perception and correspondingly actual thermal comfort range of the indoor spaces in hot climatic region, they aim to improve national adaptive comfort band by conducting field studies. The other important issue is the ventilation use pattern during cooling period, in contrast to the cold regions.

2.2 The development of residential buildings in Turkey

The purpose of this section was to consider the studies focused on chronological examinations of different housing formations in Turkey to understand the causality of these different formations and to find their quantitative counterparts. Especially considering that one of the main purposes of user-based studies is to reach real energy consumption, it is important that the built environment is equally up-to-date and local. The quantitative data on residential buildings was reached via TUIK's website. Housing type densities according to regions, use of building envelope materials, and the current status of the Energy Performance Certificate application in housing were examined. In the last part, the studies on the number and size of the rooms in the house and the total areas of the dwellings were considered. The contribution of this section to the existing literature is to bring together the studies on housing formation in Turkey and the demographic, socioeconomic, and thermal comfort preferences mentioned in the following sections, so as to relate occupants' behaviors within the framework of representative housing.

Along with the economic, political, technological, sociological and cultural changes, residential spaces also change or transform to adapt to the needs and preferences of the users. Changing social norms and values, family structure, economic structure, material use and construction techniques, zoning laws, regulations and political decisions, together create diversity in examining housing production from different perspectives. The subjects that have been emphasized a lot in housing articles for Turkey were the housing production from the republic to the present until the 2000s or the examination of traditional and rural housing. During the 20th century, important events like the 1st and 2nd World Wars, the Industrial Revolution, Modernization movements and the establishment of the Republic of Turkey gave birth to the current housing production approaches, together with the housing styles. Tekeli (2009) classifies in general terms like planned-unplanned, collective-individual or rental-private residential units, or in specific terms with more detailed categorization. Author also mentions seven different types of housing in the Turkish housing supply sector: Individual houses, housing cooperatives, build-and-sell housing, mass housing projects, local government organized housing with building cooperative unions, self-built slum housing, semi-organized slum production. On the other hand, the Turkish statistical institution was used as a source of quantitative data about houses classifying them according to the number of independent sections and the number of floors[1] or by type of investor such as public sector, private sector and construction cooperative. Along with these classifications, in this section, studies that evaluated the commonly used housing types[2] and their quantitative state during and after the 20th century when urbanization was spreading, have been included.

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[1] Terms and their explanations used in numeric data tables created with TUIK data: Flat was used to refer a single residential unit. This term was used to define number of residential unit in a building.

[2] The terms used to define the different forms of residential buildings are as follows; Apartments: a separate building or in a apartment complexes, which have more than 2 floors and more than 1 residential unit. Flat: a single residential unit in an apartments. Dublex flat: in apartments building

Bektaş (2013) discusses the traditional Turkish House (Türk evi) type, which dominates the architecture of large areas in Central Anatolia, and points out to the changes in the Turkish house that came about with the evolution of the living spaces to respond to the changing conditions as a natural result of cultural interaction and westernization process. Since most of the studies examining housing typology, from the twentieth century to the present, make evaluations in parallel with social, political, cultural, economic and social developments, they generally deal with big cities (Cengizkan, 2010; Kaprol, 2010; Tapan, 1998). Especially from the beginning of the urban planning activities that started after the proclamation of the Republic until present times, we come across different discourses as traditionalist and modern evaluation of housing in the architectural realm (Çetin, 2010). The modern approach summarizes the general characteristics of housing as follows (Çetin, 2010; Batur, 1998); high demand for the apartment-type housing, curved corners of the prismatic masses, long horizontal windows, continuous balconies along the facade, wide glass surfaces, day and night use distinction with the spaces arranged at different levels, the use of cylindrical mass, making the spatial use functional and flexible by using reinforced concrete structures. The traditionalist approach is summarized as having a symmetrical plan, overwhelming use of scale, rhythmic rectangular windows, monumental scale stairways and entrances, wide eaves, horizontal roofline, and brick decorations.

Especially after 1950, modernization, rapid population growth, immigration, legal regulations and incentives (build-and-sell system, cooperatives), economic developments and natural disasters, also caused the change in spatial order and formal differentiation of rapidly increasing housing in time (Bektaş, 2013). Due to

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having 2 floors. One storey detached house: a stand-alone house having only one floor. Multi-storey detached house: a stand-alone house for only one family with having more than one floor. Shanty house: an illegal or unauthorized house building. Country house: single storey family house in villages. State residences: apartment complexes built with participation of government.

the increase in building demand, faster and cheaper production became desirable (Batur, 1998). Thus, typical designs and commonplace structures became the order of the day. Intensive urban development activities, especially in cities like Istanbul, increased the demand for unskilled workers in the construction sector. In parallel, big cities started to receive internal migration as high as 11% in this period (Tapan, 1998). Due to the urbanization process, increased migration and growing slums became the primary and fundamental issue. After 1960, especially as a result of increasing sanitation and migration to cities, shanty settlements started to affect the city silhouette. This problem, which continued to increase until the 1980s, changed the term slum housing into “illegal construction” because apartments or villas which were built without obtaining building permits or licenses, could find a place in the real estate market and be sold at a profit (Ekinci, 1998). The growth in other big cities was similar to that in Istanbul, which still consists of 65% unplanned development zones. Parallel to these developments, the “condominium law”, which came into force in 1965, spread the apartment buildings (Erman, 1998). This law made it possible to sell the individual units in the apartment building to different owners, and thus increased the economic value of the property, which in turn gave birth to a system called build-and-sell. Accordingly, owners of illegal structures in the city periphery started to acquire flats and shops by trading in their illegal housing plots, and the outward expansion of the city became wider. Repetitive contractor-style apartment buildings, in which rapid production and commercial concern were at the forefront, started to become widespread. In addition to the increase in low-income housing stock, the number of luxury apartments and residences increased in parallel with economic developments in the country (Sey, 1998). Apart from individual solutions to the housing demand, the state's collective housing policies aimed at reducing the stratification in housing and closing the gap between them. These policies are chronologically examined by some authors (Seyi, 1998; Alkışer & Yürekli, 2004); and summarized as follows: The state residences of the early Republic period were few in number but were considered to be of good quality. The reason was that the architectural approaches of this period rejected the apartment building format and the houses were generally small in size, up to 180 m2, detached or in rows having one or two storeys and gardens. However, the demand for housing cooperatives increased in 1945 due to the criticism that this understanding is outside the social housing standard and does not meet the increasing housing deficit of the workers and civil servants in the cities. With Turkey Real Estate Credit Bank, the opportunity to buy a house on installments increased the sales that resulted in mass housing initiatives. Large housing projects with multi-storey apartment blocks instead of single-storey residences were started. However, in the 60s, the tradition of constructing spacious housing units continued in the residential buildings also, which increased their cost to the point that only the upper income group could afford them This approach brought the housing problem back on the agenda, and the state had to adopt the social housing approach, which prioritizes the needs of low-income families, as a policy. Cooperatives were encouraged to start mass housing projects. The process of constructing apartment buildings, which lasted until the late 1960s, started to develop from a single block with multiple flats to large-scale housing production in the 1970s. In his article titled Cooperatives and Housing Production, Özüekren (1996) states that mass housing projects consisting of multiple apartment blocks came to the forefront in addition to the production of individual apartment buildings, especially in housing production according to the "Cooperatives Law" indicates the formation of a building culture. With the use of rapid production systems in the construction sector, such as prefabrication and tunnel formwork, mass housing was produced by such cooperatives and a sizeable stock was accumulated in the 1980s. Under the influence of the cooperative culture, the new housing concept of clustered apartment blocks on the periphery of the cities began to prevail, replacing the flats that were built separately on individual parcels and lined up side by side along the roads (Bilgin, 1998). In particular, the increase in employment with increasing industrialization and economic growth, and most importantly, the increase in social housing supply as in the aftermath of natural disasters was effective in the establishment of the Mass Housing and Public Partnership Administration in 1984 (https://www.toki.gov.tr/kuruulus--ve-tarihce). In the 2000s, the Mass Housing

Administration (TOKİ) became the most dominant actor in urban space production in Turkey, due to the legal authorities it was granted and the treasury lands transferred to this semi –governmental organization. However, in the 21st century, similar multi-storey blocks, where the user profile and the environmental characteristics of the region are not considered as a design input, form the residential identity of the cities that receive immigration (Koca, 2012). At the same time, during this period contrasting concepts such as studio flats, high-rise residential buildings with modern amenities and smart homes also made their debut on the housing scene by diversifying the service concept along with user expectations (Görgülü, 2016).

Regarding the quantitative change of housing in parallel with the qualitative change data is continually being collected by public institutions and organizations, local governments, and infrastructure services such as natural gas, water, electricity, and telecommunication. However, each institution produces data within its own system which is closed to external access (Sarıoğlu, 2007). For this reason, one of the important sources for housing data in Turkey is the Turkish Statistical Institute (TUIK), which allows access to data on the number of family members, housing property status, number of rooms and demographic structure. Comprehensive studies on housing stock surveys conducted to date are the building census data report written in 2000 (TUIK, 2001) and the TUIK (2011) "Population and Housing Research" reports produced in 2011. Within the scope of the geographical and annual statistical studies on residential buildings in 2017, it is possible to reach data on the building count according to the building construction permits, building occupancy permits, and data on single-storey and double-storey buildings (Table 2.1.). The statistical data according to building permits issued shows that of the total building stock in Turkey 86% is housing, according to the intended use. While the number of single flat residential building is 19%, the rate of 2 or more flat residential building is around 81%. The density of housing by provinces (Figure 2.3.) increases towards cities where industry, labor, and population are dense. Bursa, İzmir, Ankara and Istanbul, which are in the same housing density group with the rates of 5%, 6%, 7%, and 19% respectively, differ from other provinces that are also in the same group with these provinces but have rates of 2% to 3%.

Table 2.1 Number of buildings in 2017, for which permits are granted according to building type (Source: TUIK, https://data.tuik.gov.tr/)

Building Occupancy Permit for 2017		Building License Certificate	Building Use Permit	Building Permit Area (m2)
Residence	Number of residential buildings	125,855	104,442	228253100
	Number of flats* for residence purpose	1,397,778	830,297	
	Number of single flat residential building	25,669	19,944	5759488
	Number of 2 or more flat residential building	1,485,975	894,528	221237910
Total	Total number of buildings (public residence, public entertainment, education, hospital or care establishments)	161,921	118,802	287333966
	Total number of flats	1,405,447	833,517	
*a single residential unit				

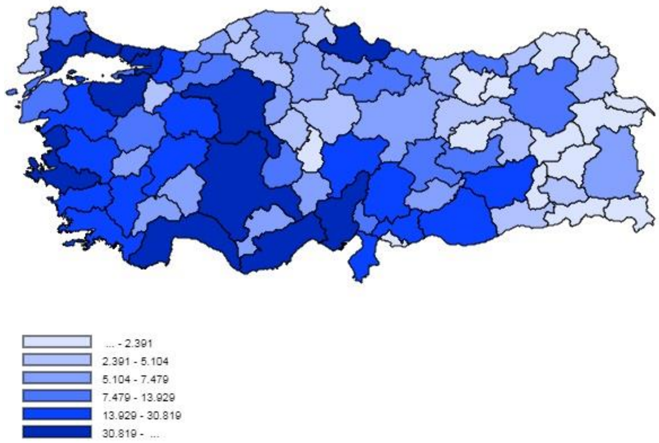


Figure 2.3 Housing density by province (Source: https://biruni.tuik.gov.tr/ilgosterge/?locale=tr)

According to the 2011 statistical report (TUIK, 2011), Ardahan, Ağrı and Iğdır are the provinces with the highest proportion of households residing in single-storey houses, i.e. 78.9%, 76.8% and 73.2%, respectively. On the other hand, Istanbul, Ankara and Kayseri are the provinces with the highest ratio of households residing in buildings with 6 or more floors, i.e. 41.7%, 39.5% and 38.8%. One of the available data in the building stock study published in 2001 (TUIK) is the classification of building material use in residences (Figure 2.4). According to this classification, the most preferred material is brick with a ratio of about 80%. The use of local materials against industrial materials is relatively low. However, when local materials such as stone, wood and adobe are compared to the total housing stock on a provincial basis, the use of local materials in the provinces but in mostly rural areas , which characterize the regional climatic characteristics, is not to be underestimated according to the 2001 report. For example, in Çankırı and Çorum 41.96% and 39.43% of the construction material used is mudbrick; in Bitlis and Ardahan 44.10% and 26.19% of construction material is stone; Bolu and Kastamonu are the provinces where 23.14% and 9.64% of construction material used in residential buildings is wood.

Material of building by use of building, 2000

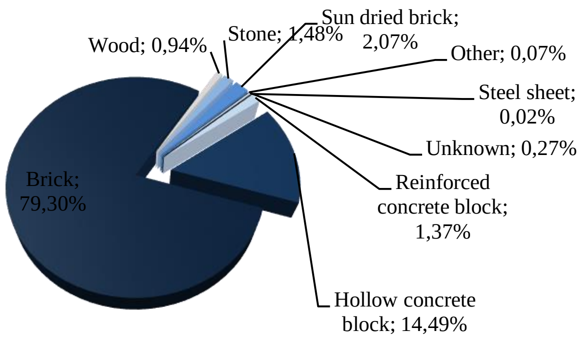


Figure 2.4 Material of building by use of building, 2000 (Source: TUİK Building Census 2000)

Projects such as the Turkish National Geographical Data Portal and the Energy Efficiency in Buildings (BEP-TR) carried out within the scope of the duties of the Ministry of Environment and Urbanization is also considered as resources within the scope of the building inventory (Toybıyık, 2017). According to Table 2.2 given in this source, 11% of the 477,373 residential buildings are detached houses and 0.5% are residences, while the majority (82%) are apartment building type. BEP-TR accepts buildings that have a construction permit after 2011 as new buildings. For this reason, the number of new buildings stated represents the number of buildings that received a building permit after 2011 with the Energy identification document (*Enerji Kimlik Belgesi - EKB*).

Table 2.2 Percentages of buildings that have received an Energy Performance Certificate by building type (Source: Toybıyık, 2017)

Building type		Number of Old Building (EKB)		Number of New Building (EKB)		Total Number (EKB)	
House	Detached house	4.051	1.37	53.121	0.80	57.172	11,27
	Apartments	36.427	83.07	381.173	82.26	417.600	82,33
	Résidence	64	0.15	2.537	0.55	2.601	0,51
Commercial	Office	1.281	2.92	16.813	3.63	18.094	3,57
Others	Hospital	271	0.62	604	0.13	875	0,17
	Education	975	2.22	3.746	0.81	4.721	0,93
	Hotel	601	1.37	3.694	0.80	4.295	0,85
	Shopping Mall	179	0.41	1.673	0,36	1.852	0,37
Total		43.849	100	463.361	100	507.210	100

Furthermore, studies are carried out to determine the minimum values, for each functional space in order to meet the diversified physical, physiological and psychological needs of the household at the comfort level at home (Table 2.3.). With the Planned Areas Zoning Regulation of the Ministry of Environment and Urbanization (*Çevre ve Şehircilik Bakanlığı (ÇŞB) Planlı Alanlar İmar Yönetmeliği*), the minimum square meters area of the spaces required in the houses have been determined. Studies are carried out on spatial standards in order to meet the user requests and needs of these determined standards and to encourage the selection of standards that prevent losing space while designing. When these studies are examined in the context of the real space usage and changes made in the current housing stock, it is possible to see the changes in the dimensions of different spaces over the years according to the behavioral patterns of the household. Evaluations have been made that each activity area has increased in parallel with the change of equipment over the years (Geçkin, 1995; Annex, 2012), on the other hand, it is seen that more economical and functional housing spaces arising from contemporary urban life and changing lifestyles lead the user to prefer smaller housing and spaces, if possible. In his study, Özcan (2013) states that according to TUIK 2010 data, the net area sizes of the houses in Turkey are mostly between 71-110 m2 and have 3 to 4 rooms (Table 2.4., Table 2.5.). Studies on middle class housing interiors, indicate that the apartment size of 100 to 120 m2 is preferred by the families as the most suitable, and as the number of family members increase, the number of rooms in the houses also tend to increase; this is also seen in the housing statistics (Arslan, 2006).

Table 2.3 Minimum measurements of the areas in an apartment

Areas	Planned Areas Zoning Regulation of ÇŞB	Sources: Geçkin, 1995; Ek, 2012, Arslan2006, Yıldırım,1999
Living room	12.00 m2	12-14 m2
Bed room (parents)	9.00 m2	12 m2
Bed room (children)		10-13 m2
Kitchen or cooking place	3.30 m2	10-12 m2
Bath or washing place	3.00 m2	4-5 m2
WC	1.20 m2	2 m2
Living room (Salon)		20 -28 m2

Table 2.4 Net area size and numerical distribution of residences according to TUIK (Source: Özcan, 2013)

Net area size of the residence (m2)	Number of residences
0 to 50	645.510
51 to 70	1.711.048
71 to 90	5.211.123
91 to 110	5.376.699
111 to 140	4.216.166
141 and above	1.647.626
Total	18.808.172

Table 2.5 Number of rooms and numerical distribution of residences according to TUIK data (Source:Özcan 2013)

	Number of residences by number of rooms

Total residential building	1	2	3	4	5+
18.808.172	189.967	1.502.750	7.480.946	8.444.14	1.190.494

2.3 Socio-economic and demographic profile of households in Turkey

It is possible to evaluate that the demographic structure of the user and the quantitative situation of the dwelling do not have a homogeneous distribution throughout Turkey and that it has regional characteristics. According to TUIK data, the population density per square kilometer decreases from west and south to east and north, and in parallel, the number of residences and the total number of households decrease in the same direction (Appendix A.). However, the average household size (Appendix A.) decreases in the opposite direction. According to the number of family members data in TUIK 2017, while the household size in Turkey is 3.4 persons, Şırnak province has the most crowded families with an average of 6.4 persons, on the contrary, it drops to 2.7 persons in Çanakakale, Tunceli and Eskisehir. Besides of size of family, their socio-economic profiles were also regarding the indicators such as population, employment, education level, income distribution, health facilities, industry and agriculture, and geographical location (Albayrak, 2003; Çakır 2008; Şen, Çemrek, Özaydın 2006). Considering the effect of all these variables, the regional distribution studies of socio-economic development in Turkey indicate the level increases from East to West and from North to South (Figure 2.5). In contrast to the socio-economic level distribution, the number of households published by TUIK (2017) gets crowded towards to east and southeast.

Figure 2.5 Spatial distribution of socio-economic differentiation (Source: Çakır, 2008)

Another economic indicator is the property state distribution of households. TUIK with its distribution report in 2011 states that the province with the highest rate of people living in their own homes is Ardahan with 84.3% of the ownership, while the province with the highest number of rented residences is Istanbul with 31.5% of tenants. Totally in Turkey, 67.3% of the households live in their own houses, which is similar to the trend on a provincial basis (Figure 2.6).

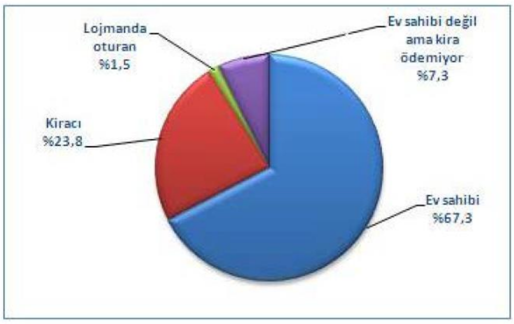


Figure 2.6 Household Ownership status in the residence (Source: TUİK, 2011)

In the research conducted by Küçükkural (2013) for the Istanbul region regarding income, it was concluded that in 70% of the household only 1 person contributed to their livelihood and the average monthly income entering the households in 2012 was 3000 TL (857$), on average. In a study on the distribution of equivalent household disposable income in 2017, according to TUIK data the monthly income of 47% households was 4260 TL (1217$) on average. Looking at the regional income distribution, it shows that the lowest income of an individual in the east and southeast of Turkey was 1700 TL (485$) per month.

In order to understand the effect of the socio-economic and demographic differences in Turkey according to the residential electricity consumption by regions, data collected on the amount of electricity used according to the geographical regions in 2017 by EPDK was compared for the west and south regions, and it was seen that the residential electricity consumption and the number of persons varied according to the socio-economic development of the region; and an increase in residential electricity consumption per person was determined (Figure 2.7).

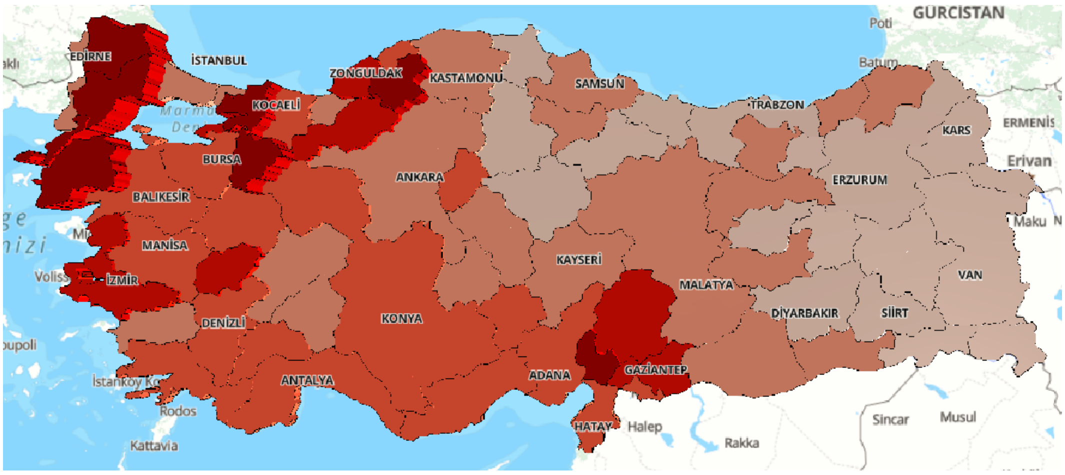


Figure 2.7 Electricity consumption per person kWh (Source TUIK: https://cip.tuik.gov.tr/

In a study conducted to see the effect of energy efficiency developments on energy consumption in Turkey, it was also shown that increasing income and urbanization increase electricity consumption as important determinants of electricity demand, while electricity prices decrease (Topallı, 2012). Similarly, studies investigating the relationship between household electricity consumption and socio-economic and demographic variables in detail show that the number and type of electrical household appliances, the number of family members, the size of the house and the increase in income increase consumption, but natural gas use and house ownership have a negative effect on electricity consumption. (Arı, E., Aydın, N., Karacan, S. & Saraclı, S., 2016; Çalmaşur & İnan, 2018).

Most of the spatial studies examining the relationship between the demographic and socio-economic profile of the household and the use of housing were carried out in big city centers due to the location of mass housing projects constructed to solve the housing deficit, and the change in family structures that started with the migration to the big cities. For this reason, the literature review is generally based on the evaluations of studies carried out in big city centers such as Istanbul, Ankara and Izmit.

Although socio-economic variables vary according to the arguments of the studies, data on the demographic structure such as the number of family members, education and occupational status, spatial characteristics of the residence, belongings of the users and income level are used within the scope of housing studies. In the light of these data, studies are conducted on the choice of residence in or outside the city center, room size and number, satisfaction level, and thermal comfort condition preferences (İmamoğlu, 1993; Aslan, 2000; Dügeroğlu, 1993; Polat, 1883; Yılmaz & Özgünler, 1993).

The issue of the household population, it is inevitable to experience the change in socio-economic life with the spread of the nuclear family structure and the change in the professional activities of the family. The increase in the population of working women has changed the family life style and expectations from the house. Again, despite the shrinking family structure with the increase in individualization in the society, it is seen that the number of private spaces in residences has increased (Zorlu & Sağsöz, 2010). Polat (1993), in his research conducted in 4 different city centers where high, middle and low income groups live in the Istanbul region, states that he has reached a similar percentage of family members in all income groups. The Istanbul Chamber of Commerce (Küçükkural, 2013), which conducted a research on the housing tendency of the people of Istanbul in 2013, concluded that the households are based on the nuclear family structure of 4 people on average. Another research in Izmit region, Aslan (2000) concludes that the nuclear family structure represents today's family structure, especially in the city centers, and therefore, the residential plan schemes are standardized by accepting the user as having no particular regional identity; whereas the general trend is to live in a 3 bedrooms and a living room or 2 bedrooms and a living room housing units. Dülgeroğlu (1993), on the other hand, mentions the dissatisfaction of the users with the number and size of the rooms was expressed in the satisfaction survey he conducted with the residents. It was revealed that the upper income group complained about the insufficient number of rooms, and the low income group was dissatisfied with the smallness of the rooms. Another study (İmamoğlu, 1993) shows that the size of the residential area increases as the socio-economic level increases. It explains that while the lower income group lives in houses of 50-90 square meter area, the middle and upper income groups live in houses of 100 square meters and above. The family population, on the other hand, showed that in this study, contrary to the size of the house, it increased as the income level decreased, but did not change the nature of the nuclear family. Küçükkural (2013) states that 48.5% of Istanbul residences have an area below 100 m2. When the demographic family structure variables and the implications of housing use are evaluated (Polat, 1993), it can be seen that as the income level increases, the level of education increases and the social interaction in the living spaces decreases due to the increase in professional activities. In the same study, it was concluded that the tendency to use the house all day, that is the occupancy rate, increases as the income level decreases. The reason is that as the income level of the family members decreases, the rate of housewives and retirees among residential users increases. In his study, Küçükkural (2013), which looks at the education level and housing typology, concluded that the education level of those living in slums and detached houses is lower than the users of apartments and mass housing, and that those living in slums are usually of rural origins. Yılmaz & Özgünler (1993) stated that in the indoor thermal comfort research, the occupants accept the comfort temperature range between 19-25 °C and that they adapt to the indoor temperatures, which change according to the heating system, buildings thermal insulation, building orientation and double glazing in windows, by changing their clothing. He concluded that while the thermal insulation level of clothing in the high-income group is 0.69 clo, the preference of the low-income user is 1.11 clo. Küçükkural (2013) states that 23% of the houses are heated with stoves, 86.7% of the households have no complaints about the house they live in, and a small percentage of the complaints are about the smallness and old age of the house. The research, which covers the preference for housing in the city center and outside the city in terms of the concept of site and neighborhood according to the socio-economic profile of the occupants, has shown that as the income level increases, the preference for urban housing increases, while low-income families prefer the city center (İmamoğlu, 1993). In a study conducted in 2012 (Küçükkural, 2013), it was seen that around 93% of residential users do not like large apartment-style buildings, 72% of them want to live in low-rise houses and 22% of them want to live in traditional neighborhoods.

2.4 Human factors and energy concerns in residential buildings in Turkey

Academic studies show that there has been extensive progress on the building physics aspects of energy performance, using various methodologies in Turkey. However, importance given to the occupancy dimension is still low as a measurement criterion. In the1980s, human comfort was a part of the measurement criteria for energy consumption in the context of participation in design process or controlling the thermal comfort. In 1990s the matter of human comfort was the least preferable topic. Currently, the human dimension in view of energy concerns has been paid more attention to than the previous decades. Some models of relationship between occupancy and building performance have been constructed to develop algorithms as a function of energy tools for simulating manual control of window-blinds, providing methods to increase efficiency of HVAC systems for saving energy, conducting an appropriate indoor air quality simulation and defining the influence of natural ventilation on human comfort. Meanwhile, the occupancy issue has been studied as a post-occupancy evaluation model to get feedback from user and determine the quality of life in the buildings by investigating user participation and satisfaction on comfort and spatial quality.

When the relationship between residential energy consumption and climate characteristics is evaluated in the context of the user, one of the main principles is to provide the user thermal comfort at an optimum level. For this purpose, scientific studies focusing on user-oriented thermal comfort studies have gained importance. While the effect of environmental parameters on comfort can be determined by measuring or calculating with measurable parameters or from a psychometric diagram, the determination of personal parameters is more complex and difficult (Yagloglou, 1923; Winslow et al. 1938; Gagge et al., 1971; Givoni 1969) and the thermal comfort level of the society (Fanger, 1970; Humphreys & Nicol, 1998; Olgyay, 1963) has been diversified by different disciplines. Standards have been established on the international platform with scientific studies from the past to the present. If the ASHRAE Standard 55 (Thermal Environmental Conditions for Human Occupancy) and ISO 7730 (Ergonomics of the thermal environment) standards accept the environment as uniform in this context, and if there is a 90% an imbalanced thermal environment, it determines the climatic conditions to be in the comfort zone for 80% occupants. It is possible to talk about two different approaches for the aforementioned social comfort level studies, with the limitations and acceptances they bring. The first of these is the heat balance approach, which accepts steady-state conditions known by Fanger (1970) studies, and the other is the adaptive approach (Humphreys & Nicol, 1998). In his studies, Fanger states that although the climate, living conditions and culture vary around the world, the comfort temperature preferences of individuals are similar in conditions where clothing, activity, humidity and air velocity values are similar. This static model does not take into account the physiological, behavioral and psychological responses of the user. As personal factors, activity level and clothing are considered as variables. With the mathematical model it creates together with environmental factors, it reveals the PMV (the predictive mean vote) value, which is a parameter related to how people perceive the environment. It also calculates the PDD (the predicted percentage of dissatisfied) value of the people in the steady-state environment with the PMV value, and reveals what percentage of them are satisfied with the thermal environment. This method recommends that the rate of dissatisfied people should not exceed 10% for the accepted comfort range and therefore PMV values should remain within ±0.5 values. The physiological, behavioral and psychological responses of the users to adapt themselves to the climatic conditions they are exposed to, form the basis of the adaptive model. While the adaptive approach model is a method recommended for the determination of thermal comfort in buildings with natural ventilation in ASHRAE 55 and EN 15251 standards, the static model is based on the examination of thermal comfort in buildings with air conditioning systems, in all standards (Nicol, Humphreys, & Roaf, 2012).

Doubtlessly, all these ongoing basic interdisciplinary studies on thermal comfort are reflected in scientific studies in Turkey also. Some studies that have carried out research on the effect of individual preference in thermal comfort on the building-energy relationship are conducted to design hospital and office buildings that are easily accessible to the user, and where HVAC systems are actively used, in order to design the automatic control elements / systems appropriately (Turhan, 2018) and to optimize the existing system (Caner, 2020). These authors evaluated the thermal preferences of the users by choosing a working area, which were compiled through a questionnaire survey, and a comparative evaluation was made with the PMV thermal comfort range in the standards. The survey was conducted with a limited number of users, and data such as activity level, clothing, age and gender regarding the participants were included in the evaluation as well as their thermal preferences. In addition to these studies, which are based on the determination of the user's responses to the thermal environment, in order to understand the effect of the thermal comfort parameters mentioned in the climatized environment on human comfort, studies were conducted with a limited number of subjects with thermal interaction balance models (Atmaca, 2006).With this study, the author concluded that the indoor temperature should not fall below 24 C and the air velocity should not exceed 0.2 m/s for the physical health of the active subjects. The other conclusion of a limited number of study conducted with the shopping center user profile, using the thermal interaction balance model is that the heat radiated by the lighting elements negatively affects the thermal comfort of the user and the response to the same thermal environment varies from person to person (Arslanoğlu, 2015). These studies show that building energy performance is not only a result of geography, climate and structural inputs, but also that the residential user profile and comfort satisfaction are also an important factor affecting the energy loads. In particular, the user and family profile that distinguishes the residential building typology from other buildings makes the duration of use of the volumes and the diversity of actions to have drawn on the subject of user behavior.

Methodology studies have been conducted for the quantitative evaluation of plan layouts by observing the behavioral interpretations given by the user to the functional qualities of the indoor spaces by the user movement tracking method (Başarır, 2018). On the other hand, in Atabay (1982)'s residential area planning study, which Akın (2001) included in his research, he emphasizes the importance of user behavior in the direction and volumetric plan decisions of the house for energy conservation with quantitative approaches such as behavioral tendency and space usage density in the houses of the users (Table 2.6)

Table 2.6 Space density of use in residences. (Source: Akın, 2001)

Nuclear family of 5 people space density %	**HOUR**						
Space	**07:00-19:00** 50 %	**19:00**	**20:00**	**21:00**	**22:00**	**23:00**	**23:00-07:00**
Kitchen							
Living room				65-70 %			
Parent room						90-100 %	
Children's room	50 %				90-100 %		

Specifically, the study evaluates alternative spatial planning approaches that can be adjusted by natural light and heat gain, and heating regime. Sümengen (2015), on the other hand, examines the effect of national behavior such as user profile, space usage and visual comfort preference on artificial lighting energy and evaluates it in order to determine the lighting energy saving potential. For this purpose, he develops scenarios with the Housing-User-Space Model and fuzzy rule-based variables system including user behaviors and space usage. Three different family profiles are classified in order to present the lighting energy requirement in Turkish residential buildings in a realistic way. Author used the occupancy hours' data included in the "Energy Consumption in Residences" research conducted jointly by TURKSTAT (TUİK) and the State Planning Organization (SPO) (Table 2.7). Between 08.00-18.00, which is accepted as working hours during the day, it has shown the rate of use of housing on the basis of geographical province centers depending on the number of people. This data shows that at least 1 or 2 people use the house during the day, and the percentage of vacancy varies at a low rate between 1 and 8 percent.

Table 2.7 Number of people in the residence between hours 08.00-18.00 (Source: Sumengen, 2015)

Geographic Region / City center	Number of residence	Number of people in the residence %					
		0	1	2	3	4	5+
Ankara	782,810	8 %	24 %	30 %	24 %	9 %	5 %
Antalya	183.512	5 %	30 %	37 %	18 %	5 %	5 %
Erzurum	64.014	0.82 %	18 %	23 %	23 %	16 %	19 %
GaziAntep	151.998	1,5 %	15 %	24 %	22 %	17 %	20 %
İstanbul	2.113.488	6 %	24 %	31 %	21 %	12 %	5 %
İzmir	630.992	6 %	30 %	35 %	17 %	7 %	5 %
Toplam	11.549.759	4 %	22 %	30 %	21 %	12 %	9 %

Another study conducted to reveal the sensitivity of occupant behavior on energy consumption in the house is the number of users and frequency of use, heating (thermostat control or radiator control), ventilation (frequency of opening windows and mechanical systems) and lighting and other energy consuming equipment. A simple decision support tool for the designer and the user was created by collecting data such as “frequency of use of the equipment” from the sample houses produced within TOKİ and grading the effect of the defined behavior patterns on the residential thermal energy (Ulukavak Harputlugil, G. & Harputlugil T, 2016). Besides studies focusing on the influence of variable occupant behavior on energy use in the similar typology of the structural environment, Karahan (2016) reveals that structural differences in housing typology cause behavioral differences in energy consumption trends. The author examines comparatively occupants’ behavioral tendencies in order to optimize their thermal comfort in vernacular housing and contemporary residence. The results show that while the user habits are influenced by the structural feature, the demographic and socio-economic characteristics effect the energy consumption behavior. In parallel with the developing technology and economic growth over time, studies are also carried out showing the tendency of households to use household appliances in their residential energy consumption. These studies show the ‘time-dependent’ change in household electricity usage habits and offer suggestions for creating necessary energy saving policies (Çalmaşur & İnan, 2018).

Again, studies on the user and family profile and the spatial comfort of the house, especially in the period when the state's housing policies and mass housing production started to take an important place in Turkey's housing approach, evaluations with the post-occupancy evaluation (POE) method took its place in the literature. It evaluates the building performance and user satisfaction in the building use phase with many measurable criteria (thermal, acoustic, visual comfort, etc.). At the same time, it accepts the changes that the user needs in this process as adaptive behaviors and guides the final design decisions for optimum comfort with these observations (Kacel, 2019). In these studies, with the concept of comfort, it is determined to what extent the housing needs and expectations of the user from the house are reflected on the finished product and to guide the new production process with tangible suggestions. In the light of these studies, the goal of energy concerns can be summarized as reducing energy costs, reducing the environmental impact, and supporting the comfort, health, and safety of building occupants.

In order to have an idea of occupant-oriented energy consumption pattern in the residential buildings in Turkey, considering that the diversity of climate characteristics and socio-economic profile provides an opportunity for a comparative evaluation, related studies were reviewed. This literature review also helps to provide data for methodology of the study.

2.5 The role of residential buildings in national energy use of Turkey

The electricity market sector report published by the Energy Market Regulatory Authority (*Enerji Piyasası Düzenleme Kurulunun EPDK, 2017*) states that the residential sector accounts for 24.99% of the total electricity consumption and ranks 3rd according to the distribution of billed electricity consumption on the basis of consumer type (Figure 2.8). Again, the amount and percentage distribution of electricity used by geographical regions reveal it gradually decreases towards the east and north of the country (Table 2.8.), when the country-wide rate of residential electricity use is considered. The space heating, regarding both climatic conditions and energy use pattern of households in our country, The Department of Energy Efficiency and Environment (YEGM, www.yegm.gov.tr) states that 82 % of the energy consumption in buildings is used for heating and this amount constitutes 26 % of the total energy consumed in our country.

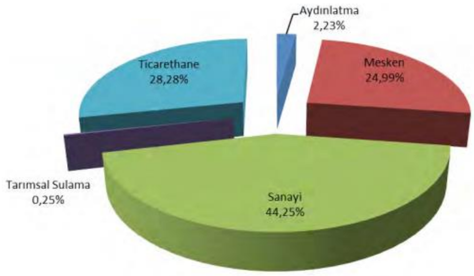


Figure 2.8 Distribution of invoiced electricity consumption by type of consumer (Source: EPDK, 2017)

Table 2.8 Electricity usage amount by geographical regions in 2017 (Source: EPDK, 2017)

Region	**Percentage Distribution %**	**Region**	**Percentage Distribution %**
Mediterranean	15.61%	Central Anatolia	15.37%
Eastern Anatolia	4.10%	Black Sea	8.19%
Aegean	15.21%	Marmara	33.41%
Southeast Anatolia	8.11%	Total	100.00%

The Department of Energy Efficiency and Environment (YEGM, www.yegm.gov.tr) states a family of 4 people who live in an area of 120 square meter housing unit equipped with standard household appliances and lighting consumes 6000 kWh electrical energy per year. On the other side, the report about the electricity and natural gas sector published by EPDK (2017) reveals a household in Turkey consumes approximately 4128 kWh of electricity annually on average, regardless of the size of the house. That report shows that 25.75% of the total natural gas consumption by sector is in residential buildings (Figure 2.9). Another output of the report is related to the consumption pattern of the residents, and it shows that 80% of the natural gas in the house is used by the combination boiler and stove; i.e for heating and cooking (Figure 2.10). Again, varied the annual natural gas consumption per housing unit in 2017 in the report (EPDK, 2017) is remarked between minimum of 576 Sm3 (Sinop) to a maximum of 158579 Sm3 (Ağrı). This results provide how important it is to examine regional climate and family structure diversity.

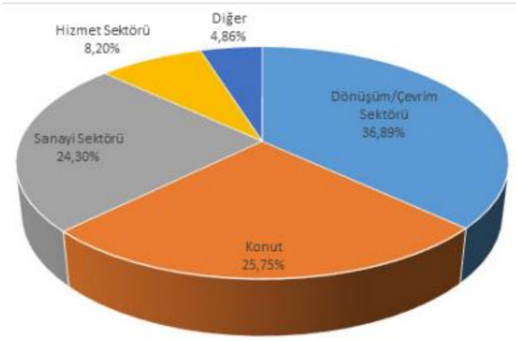


Figure 2.9 Natural gas sectoral consumption distribution (Source: EPDK, 2017)

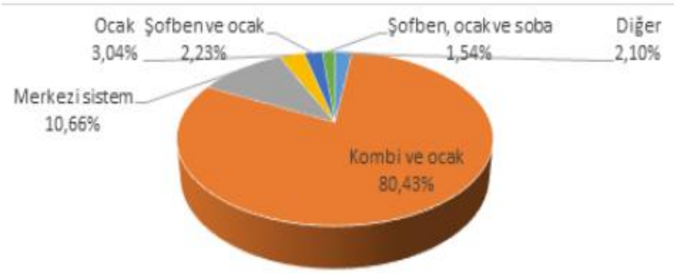


Figure 2.10 Distribution of gas consumption of residential users by type of use (EPDK,2017)

The data on the price of electricity and natural gas for domestic consumers in 2017 is respectively reported as 41.3 kuruş/kWh (11.8$) (TUIK), and 1.11 TL/m3(0.32 $) (EPDK, 2017). All these inputs in 2017 indicate that, regardless of the size of the house, the number of rooms or the type of building, the annual electricity bills can be estimated at around 1700 TL (485 $) (and between 640 TL (182 $) to 1750 TL (500 $) per year, respectively.

In the report published by TUIK (2017), the variety and usage rate of heating systems in residences were detailed as follows; while 57.1% of the users continue to use stoves, the rate of use of the independent heating systems is 25.6%, the central heating system is 11.4%, air conditioners, electric heaters and other systems is 5.9% (Figure 2.11). Moreover, the report lists the first three provinces where the stove is used the most as a heating system are Osmaniye (91.8%), Şırnak (89%) and Muş (88.9%), respectively. On the other hand the provinces with the most common use of independent heating system is Ankara (65.1%), Istanbul (60.1%) and Eskişehir (39.7%).

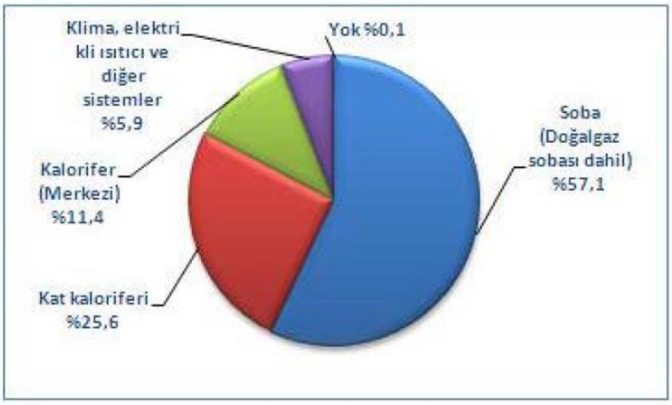


Figure 2.11 Heating system utilization rate in the house (Source: TUİK, 2011)

In parallel with the growth of the population and economy and the rise in living standards, the more intensive use of electronic devices has increased the use of electrical energy over the years (Figure 2.12), (Türkay, Özbağcı ve Akça, 2012, Şahin & Köksal, 2013)

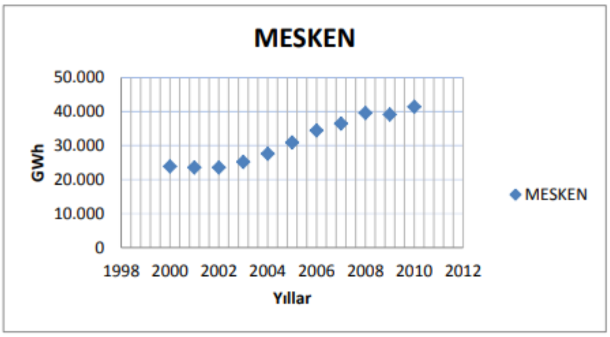


Figure 2.12 Distribution of electrical energy in the residential area by years (Source: Türkay, Özbağcı ve Akça, 2012)

In this framework, energy efficiency in residences has gained importance and the relationship between housing and energy use has been discussed from occupant's energy use perspectives. The yearly change graph of electrical energy use in residences in Turkey proves the importance of the consumption pattern of air conditioning systems, lighting and electrical household appliances as well as heating energy.

2.6 The critiques on the relationship between climatic region and residential building energy conservation studies in Turkey

Physical characteristics and geographical conditions such as climate, natural resources and materials are important criteria for organizational decisions to be taken in the construction process of a country. In terms of building science, the issue of climate has a major impact, especially within the scope of building energy consumption studies. The ability to carry out studies on building energy performance to a certain standard and evaluate the results is based on a clear definition of climatic characteristics. This is an important issue for design strategies and material choices. Therefore, in the first part, the aim is to draw a general framework of the studies on climatic classification of Turkey. The second part is limited to researches focusing on the climatic characteristics when assessing energy considerations in residential buildings, in order to see to how important the climatic factors are on this relationship in Turkey. The strategy for the second part review was first conducted with a search of doctoral dissertations in architecture listed in YÖK (Council of Higher Education) electronic thesis center. Additionally, to keep up to date with latest research relevant to climatic factors on residence energy profile in Turkey, academic articles were also searched through the databases. The key words were ‘residence/residential’, ‘house/housing’, ‘energy’, and ‘climate/climatic’.

2.6.1 Studies on climatic regions in Turkey

Turkey is located in the middle-temperate zone due to its climatic/geographical position (Gönençgil, 2010). However, it is stated that the basic factors that determine the climatic characteristics such as altitude, continentally, atmospheric events and exposure show regional differences due to Turkey’s geographical characteristics, which is the main reason for creating its climate diversity (Şensoy, Demircan, Ulupınar & Balta, 2007, Gönençgil, 2010). In order to describe this diversity systematically, climate classification studies have been carried out for Turkey with different methods (Çiçek, 1996; MGM, 2017; Ünal, Kindap ve Karaca 2003; Yılmaz ve Çiçek, 2016, Bölük, 2016, Gönençgil, Biricik, Atalay, Aydinözü, Çoban & Ertek 2016, Öztürk, Çetinkaya & Aydın, 2017). Each climate classification in its own discipline diversifies according to the methods used and is named after the scientist who developed it such as Köppen, Trewartha, Aydeniz, Erinç, Thornthwaite, De Martonne, etc. The Research Department of the Climatology Branch Directorate within the body of the General Directorate of Meteorology, in Turkey, has made the classification studies for each method mentioned above belonging to 81 provinces, and the explanations below have been obtained from this source (https://www.mgm.gov.tr/iklim/iklim-siniflandirmalari.aspx). While each method is similarly based on the precipitation regime, it differs due to the fact that each has its own rules and boundaries related to the basic parameters of the climatic events such as temperature, precipitation, relative humidity, evaporation, pressure, sunshine duration/intensity, and wind speed/direction; and also relationships such as those between precipitation and temperature ratio, or precipitation and evaporation ratio, or precipitation regime and vegetation. The general definition and properties of the methods is summarized as follows.

In its climate classification, Erinç (date) has taken into account the annual average maximum temperature, which leads to water loss caused by precipitation and evaporation as the main factor. According to its precipitation effectiveness indices, Turkey has been divided into 5 climatic zones, namely arid, semi-arid, semi humid, humid and very humid (Appendix B. & C.). Aydeniz's (date) index on the other hand consists of the parameters of average temperature, precipitation, average relative humidity, and average sunshine duration, which defines humidity coefficient "Nks" and drought coefficient "Kks" values. Unlike the Erinç method, it adds a very arid climate and divides Turkey into 6 different groups as very arid, arid, semi-arid, semi humid, humid and very humid (Appendix B. & C.). When both classifications are compared, the Erinç precipitation index indicates that there is a semi humid climate event in Turkey, while the Aydeniz Drought index expresses it as semi-arid. Another method that categorizes according to the Annual Drought Index is the De Martonne method (Appendix B. & C.), and in the study conducted for Turkey, 6 classes such as arid, semi-arid, between semi-arid and humid, semi-humid, humid, very humid emerge like the Aydeniz classification. Again, it expresses the prevailing climatic event as semi-arid.

As a plant physiologist, Köppen discovered that plants express indicators for many climatic elements. In the study conducted according to the Köppen Climate Classification associated with this discovery, 10 climate classifications were made for Turkey (Appendix B. & C.). The difference from other classifications is that it is classified according to the temperature as well as the precipitation regime. On the other hand, the Köppen-Trewartha classification draws attention to the distinction between humid and arid climates.

The results show that the climate of Turkey is highly variable. While the northeast Black Sea coastal areas have a relatively wetter climate, a part of the East and Southeast of Turkey and most of central Anatolia have experienced semi dry periods (Deniz, Toros & Incecik, 2011).

Gönençgil et al (2016) define the climate types in Turkey according to the geographical region boundaries. The study determines the regions according to the bioclimatic features, which include soil, vegetation and topography conditions, as well as climatic events such as precipitation, temperature, relative humidity. It presents 10 different climate descriptions in Turkey, including Black Sea climate with 3 different climatic characteristics such as humid-temperate Black Sea coastal zone climate, humid cold Black Sea mountain climate and Black Sea back semi humid-semi arid climate; 2 different Mediterranean climates such as the main Mediterranean climate and the semi humid-humid Mediterranean mountain climate; 3 different continental climates such as Central Anatolia - Thrace semi-arid climate, Eastern Anatolia semi-arid cold climate and Southeastern Anatolia semi-arid hot climate; 2 different transition climates such as Marmara and Mediterranean background climate (Appendix D.).

Besides the studies on climate classification based on the systematic grouping of the meteorological events as mentioned above, the influence of those events on human comfort has also become a matter of classification studies. Olgyay (1963) and Givoni, (1969) define comfort zones with the bioclimatic chart by bringing together climatic findings, and offer alternative air conditioning solutions according to regional climatic data to the designer in building design. The Bioclimatic chart of Olgyay is the pioneer and defines the index of thermal comfort in relation to dry bulb temperature and relative humidity, however, it is applicable only to outdoor climatic conditions (Givoni, 1992). On the other hand, the integration of building indoor thermal conditions into comfort boundary studies on the bio-climatic chart was developed by Givoni (1992) for unconditioned buildings via a conventional psychrometric chart.

The regional climate and geographical conditions are accepted as the main drivers in order to design buildings conditioned passively in the studies, and bioclimatic approach forms the basis of Özdeniz’s (1991) climate classification study in Turkey. The author proposed the map of Turkey classifying the region into seven climate categories such as temperate, cool, temperate-dry, temperate-humid, hot-dry, hot-humid, and composite climates (Appendix E.& F.), based on bioclimatic studies in the literature. In the context of bioclimatic approaches, this study also supports the climatic boundaries of the proposed map by evaluating traditional housing characteristics in each defined climatic region. On the other hand, Ovalı (2019) claimed that the studies on the built environment/climate and traditional architecture/climate relationship in Turkey classify the climate regions as 5 regions as hot-humid, hot-dry, temperate-humid, temperate-dry and cold. The author presents this climate classification obtained from the literature via the map and the list of the cities (Appendix E. & F.). Another the regional study belongs to Kazmaoğlu and Tanyeli (1979) who defines the regions according to "material", "forming", roof covering, and "space layout" characteristics of Turkish folk architecture (Appendix E. & F.). The authors state that structural characteristic of folk house architecture is diversified due to the climatic and socio-economic conditions of each defined region.

Although climate zoning was not initially developed for building energy studies, since allowing the use of uniform recommendations for building thermal performance throughout the whole region within the same climatic zone, it has become an important matter of the energy-efficiency studies and national building codes (Walsh, Cóstola, & Labaki, 2017). While diversifying the regions is necessary to define the climatic conditions, defining the correct number of regions by limiting if necessary, is also important to characterize the building energy efficiency approaches of the countries in practice.

Being simple and having a reduced number of input variables, the most common climate zoning studies is the degree days method (DDM) to evaluate energy demand and energy consumption (CIBSE, 2006). It is defined as the climatic zoning method with the calculation based on the differences between the outdoor temperature and a base temperature over a specified time period. If the daily average temperature is lower than the base temperature, the difference between those temperatures gives heating degree days (HDD). In Turkey, with the last update the Turkish standard about "Heat Insulation Regulations in Buildings" (TS 825, 2013) classifies into five HDD climate zones (Appendix E. & F.) taking into account only the heating energy requirement. This standard is compulsory to install the necessary thermal insulation for the efficient use of energy in house buildings. It also determines the rules for calculating the net heating energy demand in buildings and the highest allowable heating energy loss in buildings. The Turkish Meteorological Service provides the HDD and cooling degree days (CDD) data for each city both monthly and yearly. Tükel, M., Tunçbilek, E., Komerska, A., Keskin, G.A. & Arıcı, M. (2021) introduced reclassified climatic zones of Turkey based on the climatic data obtained by the degree day method but integrating thermos-economic analysis including optimization of thermal insulation of wall components and fuel type. They reclassified into 5 zones same as TS 825 standard, however, 16 out of 80 cities shifted to another zone (Appendix E. & F).

2.6.2 Energy concerns of the residential type building in terms of climatic characteristics of Turkey

A number of studies have focused on the impact of climatic diversity on the energy-conscious design of residential type building in Turkey. The subject flow has been shaped with limited studies evaluating the relation of climate characteristics on the energy demand of residential buildings. In this context it was summed up as follows; the studies are varied from the general framework of energy-efficient house design approaches to national energy performance models, from decision-making for new to improvements for existing building regarding thermo-physical properties of the building envelope, from implementation of national standards to thermal performance evaluation of residential building.

The matter of diverse climate in Turkey has led the studies to the importance of local architectural richness of Turkey to understand the interactions between climate and energy efficient house design (Özdeniz, 1991; Akın, 2001; Kabuloğlu Karaosman, 2004; Kısa Ovalı, 2009 & Karagülle, 2009; Terim 2011). Studies on either the local housing structure belonging to the selected single climate zone or the local housing examples in each different climate zone throughout the country with a holistic perspective support that the more the housing has forms, settlements, and materials compatible with the climate and geography of that region, the more energy-efficient it is. In addition to the studies proposing the general framework guiding the housing design stages with its environmental characteristics, national evaluation models have been developed as easy-to-understand guides for users to take energy-efficient design decisions in housing production (Kahraman, 2013, Özcan 2013, Kalfa 2014). The most important inference that can be made from those studies is that the climatic differences zoned throughout the country are significant in the housing-energy relationship. For example, Ovalı (2009) emphasizes the importance of climate conscious design of the housing in Turkey and claims that it saves 50% in energy use alone. Most of those studies accepted the climate classification divided into 5 regions as hot-humid, hot-dry, temperate-humid, temperate-dry and cold. However, in the study of Kalfa (2014), the sample provinces were selected representing 7 geographical regions as the climate regions and the results showed that the heating and cooling loads of the provinces located in the coldest and the hottest climates differ by 94% and 96%, respectively.

The other studies focusing on the heating and cooling load requirements of the residential buildings use more practical and simplified classification method for climatic regions such as DDM. These studies discussed the optimization of the optical and thermos-physical properties of the residential building, such as glass type, shading elements, wall construction, transparency ratio, orientation, form factor and volume, individually or in combination (Ayçam, 2006; Taşçı, 2018). The importance of the insulation levels in diverse climatic regions of Turkey has become the matter of those studies generally. The optimization of the investment cost payback periods of selected wall layers (Bolattürk & Dağdır, 2011, Ekici, Gülten & Aksoy, 2012, Ashrafian, T., Yılmaz, A.Z., Corgnati, S. P., Moazzen N., 2016; Kürekçi, 2016; Altun, Akgül & Akcamete, 2020), their environmental impact, and the user comfort as a performance indicator (Yılmaz, 2018) have been subject area of the studies. The results reveal that the insulation performance of the building envelope show significant difference among the regions where heating load is important, to regions with high cooling load. Furthermore, emphasizing the importance of structural measures to minimize solar heat gain, especially in regions with high cooling load, it is possible to say that handling heating and cooling loads together in building envelope design is a more effective solution for energy saving in the house. The important critique of the studies is about the insufficient classification of the climatic regions of Turkey based on the DDM in TS825. It consists of constant temperature data for each month accepted according to DDR and months with both heat loss and gain through the the building envelope is the representative climate indicator in the TS825 calculation method; this causes possible heat gains to be overlooked in the measures to be taken and therefore the energy performance of the house is predicted lower than reality (Koçlar Oral & Akşit, 2001; Altun, 2019). In parallel with these studies, Aksoy & Ekici (2013) draw attention on the solar radiation gain which assumes a constant value for each degree-day region; calculations with this approach show the building to require more heating energy than in reality. Diverse climatic condition from hot to cold and from humid to arid, especially due to the increasing glazed surfaces, led to the studies on the cooling load requirements of residential buildings (Yıldız, 2014) and some studies propose the creation of cooling degree-day zones (Bulut, Büyükalaca & Yılmaz, 2007; Pusat & Ekmekçi, 2016.) as well as optimum insulation requirements (Uçar &Dumrul, 2019). The conclusion of all these evaluations is that a steady state calculation to be made with monthly constant irradiance and temperature data is insufficient to obtain a realistic result on the national energy consumption profile of the house.

Apart from the studies in a single residential building design, the new approach has changed the evaluation scale from a single house to a housing island because residential communities create their own topography in the settlement plan and create its own microclimate (Hisarlıgil, 2009). Accordingly, it is possible to say with this study that planning and appraising bring together the surrounding houses in the most appropriate way, while making the housing design decisions to increase the energy use efficiency, is more effective than providing energy savings in the housing unit individually.

In addition to the researches on the essential measures to be taken in the production of energy efficient housing, researches are also carried out on the structural potentials that will reduce the total energy consumption of the existing housing stock. Timur (2019) draws attention to the thermal behavior of traditional architecture, especially due to the importance of the domestic architecture of Anatolia, which is worth preserving, in the housing stock and the importance of continuing its use in a sustainable manner that will meet the comfort needs of current users. The study on the subject offers thermal improvement suggestions with possible structural interventions that will not cause loss of heritage value, and underlines that a significant reduction in current housing energy consumption can be achieved (Timur, 2019)

CHAPTER 3

MATERIAL AND METHOD

In this chapter are presented the material and method used in conducting this investigation. It first describes research materials covering the survey questions and selected dormitories with information on their physical aspects and occupants. Procedures of sampling strategies, of data compilation process and of statistical evaluation are then described in the section on method.

3.1 Material of Research

The material used in this study consist of physical attributes and occupancy data of sampled dormitory buildings, which were compiled from architectural drawings, websites of universities and university authorities. Another material was data on user behavior collected through a general questionnaire, a self-report questionnaire and indoor environmental data recorded in selected dormitory rooms.

The pertinent information and data gathered during the study are described below under four sub-sections; data related to the sampled dormitory buildings; data obtained from the dormitory occupants through a questionnaire and a self report survey; and data recorded in the dormitory rooms to determine the environmental conditions and occupancy patterns.

3.1.1 Survey data on sample dormitory buildings

The samples of 7 dormitories were selected from 6 cities located in 5 different climatic regions. Sampling strategy is explained under the relevant subtitle. The buildings were randomly assigned reference designations as CR1_D1, CR2_D2, CR2_D3, CR3_D4, CR4_D5, CR5_D6 and CR2_D7 for the sake of maintaining simplicity for the rest of study as given in Table 3.1, which lists information about their year of construction, climate zone they are located in, gender type and capacity at the date of the field study, the heating system, and survey type carried out.

Table 3.1 List of sample of buildings where the surveys carried out

Name	City	Climatic region	Construction Year	Gender	Student capacity	Heating system
CR1_D1	Izmir	1	After 2009	F	504	Central heating
CR2_D2	Balıkesir	2	After 2009	M	185	Central heating
CR2_D3	Istanbul	2	2010	Mix	550	Central heating
CR3_D4	Ankara	3	2014	Mix	694	Central heating
CR4_D5	Sivas	4	After 2011	Mix	250	Central heating
CR5_D6	Kars	5	2009	Mix	250	Central heating
CR2_D7	İstanbul	2	2011	Mix	252	Central heating

Physical attributes of dormitory buildings such as floor plans Table 3.2 were gleaned from floor evacuation plans. The missing data were completed by the on-site plan sketches made during the fieldwork, observation, and dialogue with the authorities. It was observed that the planimetric organization of rooms was almost the same. Namely; it comprises rooms on either side of the corridors orienting opposite directions such as North-South or East-West with longitudinal plan scheme with a window on the short side, and furnished with bed, study table, and wardrobe. This hinted that rooms would have different heating loads due to their opposite orientations, and accordingly it would make different thermal preferences of users appear. Numerical data on occupancy capacity were obtained from both manager of dormitories and web site of the universities.

Table 3.2 Graphical Information of Sample Dormitory Buildings

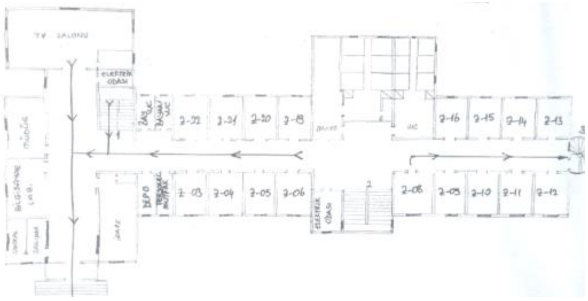
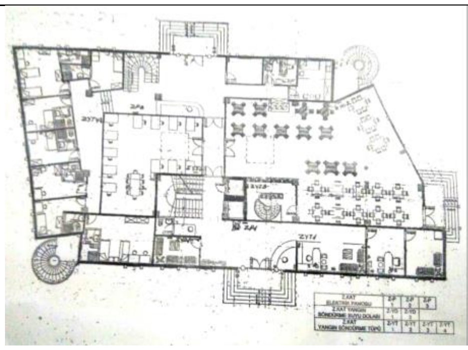
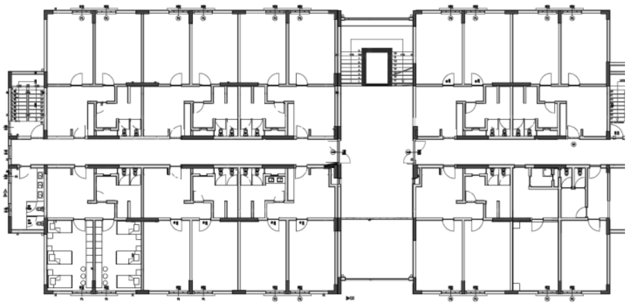
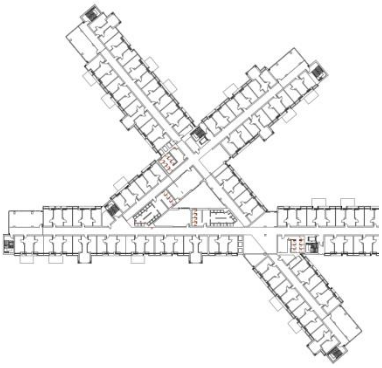
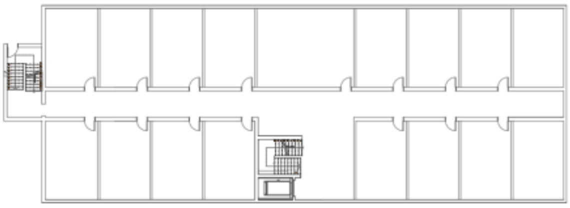
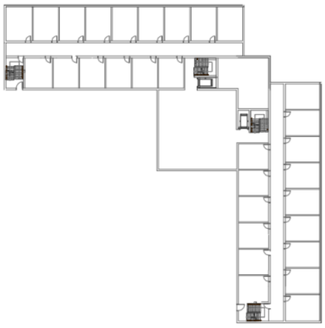
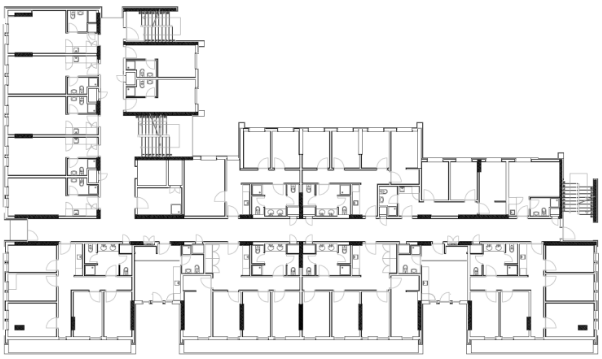
 CR1_D1İzmir 504 female	
 CR2_D2 Balıkesir 185 male	
 CR2_D3 İstanbul 550 mix	

Table 3.2 (Cont'd)

 CR3_D4 Ankara 694 mix	
 CR4_D5 Sivas 250 mix	
 CR5_D6 Kars 250 mix	
 CR2_D7 İstanbul 252 mix	

3.1.2 Survey data on questionnaire and self-report surveys

Two types of questionnaire surveys were carried out which are described below in relevant sub sections separately. Before to apply the both surveys, ethical approval was obtained from the Applied Ethics Research Center at Middle East Technical University (Appendix G)

a) Questionnaire survey

The contents of the questionnaire were prepared in accordance with the objectives of the study and were formulated based on the results and inferences of the studies in the literature survey. Most of the questions are the closed-ended type offering respondents a number of defined response choices while some of them are combined with the open-ended response by the additional category of 'other', providing an opportunity to the respondents to answer in their own way. To ensure that the instructions, questions, and scale items are clear and respondents can answer appropriately, a pilot test was conducted on a very small representative sample of the same type of people who were used in the main study. Furthermore, people were interviewed concerning their awareness and perception of their indoor environment and their behavior in relation to it.

The questionnaire survey (Appendix H comprised three main sections with a total of 48 questions: data on demographic information; data on occupant behavior in the dormitory room as well as in their family house where they lived together before moving to the university dormitory. These three main sections consist of question groups (Appendix I) that collect data on the geographical, demographic, and socio-economic diversity of the users, as well as the data on adaptive behavior, time of presence at home, awareness on domestic energy use, utility bills, thermophysical conditions of their living spaces, and satisfaction levels.

i. The demographic data comprises age and gender, place of birth and latest house location, education level, and dormitory location of the respondent.

With the Special Student Accommodation Services Regulation inTurkey dated 2017, the mixed dormitory system was abolished and the request for the buildings to be operated as separate female or male dormitories started. For this reason, the study carried out in each climate zone was chosen as either a women's dormitory or a men's dormitory. Therefore, the comparative analysis of the gender issue according to the climatic zones was made based on the climatic zones where the family houses of the respondents were located. Although a building type that accommodates users of similar age and educational status was chosen, the questions in this group were prepared to obtain information about the life in the residential building type the participants experienced in the provinces they lived in.

ii. — socio-economic data comprises of family size, the income of the family, heating and cooling system, size and type of house where respondent and their family lived and its ownership.

While examining the effect of climate zones on user thermal comfort preferences in the user thermal comfort relationship, questions were prepared to evaluate how much they were affected by the socio-economic variables. The lowest family income was considered as the possibility of unemployed family members. And therefore the lowest monthly income was considered to be below the net minimum wage. The minimum wage published by the Republic of Turkey Ministry of Finance and Treasury in 2016 was about 1.300 TL (371$ rate of exchange on 31.12.2016 was 1USD=3.5TL) and for the minimum salary it was accepted for 2016-2017 period. In determining the other monthly income range, it was accepted that there was only one employee in the family and that he worked in a state institution. Since the salaries vary depending on the task in the institution, 2016 teacher salary was determined as the monthly income range in determining the average amount. The average salary of an official (teacher, nurse, technical staff etc) was determined as 3500 TL (1000$) for 2016-2017. Other income ranges are grouped as monthly income ranges considering the probability that the number of employees in the family may be more than one, working in the private sector or a businessman.

Preference and use of heating and cooling in residences show regional differences due to the families' socio-economic differences as well as climatic requirements, housing type, accessibility to fuel type and infrastructure investments. Appendix J shows the natural gas-supplied provinces for 2017. Appendix K, on the other hand, shows the Distribution of Households according to the Heating System in the House in 2011 according to the provinces. According to this list, the heating systems utilized in Turkey were diversified as stoves, central heating for one dwelling (kalorifer), central heating for one or more buildings (merkezi ısıtma), electric heaters and air conditioners. If the provinces that characterize the district heating system in the list according to their climatic regions and the heating systems used were summarized we can state the following; In the first climate region, the stove characterizes the heating system with the highest rate in the provinces. For example, İzmir represents the lowest rate with 56%, while Hatay represents the highest rate with 84%. Second common heating system was electric heaters/air conditioners with the rate of 41% in Antalya.

In the 2nd climate region, the heating system varies according to the provinces. The lowest rate of stove usage was in Istanbul with 27%, and the highest rate was in Osmaniye with 92%. In Istanbul, central heating for one dwelling was used at a rate of 60% in residences. The provinces representing the other systems with the highest rate were; Central heating for one or more buildings was used the most in Edirne (26%), and air conditioning/electric heater was used the most in Muğla with 23%). The heater/air conditioner usage ratio decreases towards cold climatic regions to a negligible extent.

In the 3rd region, the heating system varies according to the provinces. The province with the lowest stove usage was Ankara with 20%, while the highest usage was in Iğdır with 86%. Eskişehir, on the other hand, was the province with the highest use of central heating for one dwelling with 40%. The province where central heating for one or more buildings was used at the highest rate was Elazig with 28%.

The use of stoves was increased in the 4th region, as in the 1st climate zone; The lowest utilization rate was 55% in Kayseri, and the highest was in Muş with 89%. The highest central heating for one dwelling usage was in Sivas with 24%, while the highest central heating for one or more buildings usage was in Kayseri with 26% .

In the 5th region, the lowest and highest stove usage was in Erzurum with 64% and Ardahan with 88%, respectively. The highest utilization of central heating for one dwelling and central heating for one or more buildings was in Erzurum and their rates were 17% and 19%, respectively.

iii. — data of thermophysical condition of living space comprised the orientation of living space, thermal insulation of building envelope, condition of window and balcony, number of heated spaces).

With the data obtained in this context, this section questions have been organized in order to both measure the user's energy consumption awareness and contribute to the establishment of a relationship between the thermophysical properties of the houses and the climatic differences on a regional basis.

iv. — data of respondent’s satisfaction evaluation on the indoor environment quality for both dormitory and the house on a 5-point Likert type scale is used, ranging from ‘very dissatisfied’ to ‘very satisfied’, and data on thermal problems respondent experienced in the living spaces.

One of the main purposes of the user-satisfaction questions in the survey was to evaluate the built environment in which the users live in terms of thermal comfort while asking questions about noise, light, and air quality in order to increase their awareness. It was to make them think whether the need for thermal comfort or the search for different comfort caused dissatisfaction. The contributions of the data obtained from these questions to the study were as follows: to compare whether the climatic difference made a difference in the thermal comfort satisfaction evaluations of the users who experienced living in different climatic regions; to question the user satisfaction about the thermal comfort quality in residences throughout Turkey; and to evaluate the thermal performance of the residential building envelope according to the climatic zones.

v. — data of occupant adaptive behavior comprises preference for ways of controlling the indoor environment and changing clothing.

This group of questions was organized in order to contribute to the evaluation of the effect of different climatic zones on the behavior of the user to adapt to the thermal conditions. Respondents were required to define how often they did each of the adaptive behaviors listed in the survey when the indoor air became hot or cold. The frequency was defined from always to never as often, sometimes, rarely. The adaptive behaviors were listed as open window, change clothes, adjust heaters, use blanket, AC, blind or fan, have a shower, go out, and change position. On the other hand, respondents were asked to indicate the combination of clothes they preferred to wear both in their rooms and at homes. Garments' choices were prepared as the graphical scheme to guide respondents to combine their typical clothing ensembles. The list was formed based on tables in ASHRAE 55 (2010) titled as "Clothing Insulation Values for Typical Ensembles" and "Garment Insulation" (Appendix L). Those lists supported the thermal insulation values (clo) of clothes, which was used as a numerical variable in thermal comfort calculations.

vi. — data on awareness of domestic energy use comprises use behavior of the energy systems in the house.

This group of questions was organized in order to contribute to examining user awareness in the relationship between heating-cooling system, household appliances usage habits and energy consumption in terms of climate and socio-economic factors. The questions were prepared for the respondents to indicate the frequency of behaviors between always and never for each statement.

vii. — data of occupant presence in house and dormitory room comprises the time period of occupied or unoccupied living spaces in a usual weekday and weekend.

This group of questions was organized in order to understand the general usage trend of the residential building on weekdays and weekends and to contribute to local heating regime evaluations.

viii. — data on energy consumption pattern comprises the average monthly electricity bills and the average annual heating costs

This group of questions has been organized in order to contribute to examining the relationship between residential energy consumption behavior and climate zones.

b) Self report survey

This survey (Appendix M) included seven questions to collect data every day about the respondents' thermal sensation, thermal preference, and thermal acceptability, as well as their adaptive behaviors and use patterns of the room. The thermal sensation vote was based on the ASHRAE seven-point sensation scale from too cold (-3) to too hot (+3). By means of thermal acceptability yes-no questions, respondents voted whether the current environment condition was as acceptable or not. If it was unacceptable, a further question was thermal preferences whether the discomfort was due to coolness or warmness. In order to get adaptive approaches, this survey also collected data about whether residents opened/closed the windows/doors or valves, or changed clothes. This was also examined as a behavioral approach representing user awareness on energy concerns. Moreover, respondents were asked to check their clothing by a clothing ensemble checklist to quantify its insulation levels (Appendix L). The other checklist was about respondents' activity just before filling out the questionnaire. Metabolic rates were assessed by a checklist of occupants' activities (Appendix N). Both checklists were prepared based on databases published in ASHRAE Standard 55. The survey also asked occupants to log which period of the day they were in their room by drawing a line on a 24-hour-diagram.

3.1.3 Empirical data on environmental conditions and occupancy pattern

In order to examine the relationship between the survey responses with the environmental air conditions, indoor air quality of sampled rooms and outdoor temperature and humidity values were also monitored via data recording equipment (Table 3.3). HOBO U12-012 data loggers record temperature and relative humidity within accuracy of ±0.35 K for air temperature and ±2.5% for relative humidity. HOBO MXCO2 data loggers record carbon dioxide, temperature, and relative humidity data in indoor environments within accuracy of ±0.21°C from 0° to 50°C for temperature, ±2% from 20% to 80% for humidity ±50 ppm ±5% of reading at 25°C less than 70% RH and 1,013 mbar for CO2 respectively. Testo 435-2 data logger with the probe Testo 0602 0743 records the radiant heat according to ISO 7243, ISO 7726, DIN EN 27726 and DIN 33403 with measuring range from 0 to + 120 °C.

In addition to recording air quality data, occupancy patterns and adaptive habits were also monitored. HOBO UX90-001State Logger was fixed on the window of each room for monitoring the duration of an open/closed event of the window within a time record of each change of state. HOBO UX90-006 was also used to log the state of lighting being on or off as well as the state of occupancy presence in the room.

While conducting field surveys a data logger was also placed outside of the sampled buildings to monitor temperature and humidity values of outdoor environment in order to get climatic condition of studied regions. Recording period was selected considering representative month for heating season. Consequently, two sources were utilized; TS825 provides a general idea for climatic regions and relatively their coldest month for winter, and the website of Turkish State Meteorological Service (https://mgm.gov.tr) archives monitored weather conditions of each city in Turkey, which enable to reach the information any time.

Table 3.3 List of equipment for recording data on environmental conditions and occupancy pattern

Equipment	Picture	Feature
HOBO U12-012		Temperature, Relative Humidity and Light data logger
HOBO UX90-006		Occupancy and Light data logger
HOBO UX90-001		State,Pulse, Event, Runtime data logger
HOBO MXCO2		Temperature, Relative humidity and CO2 data logger
TESTO 0602 0743		Radiant temperature probe
TESTO 435-2		Multi-function data logger

3.2 Method of research

The methodology used in this research is presented in four sub-sections: sampling strategy, climatology of the selected cities, conducting field surveys and monitoring environment and behavior data.

3.2.1 Sampling strategy

As mentioned in similar studies there are not only a number of non-technical parameters such as roles of socio-economic and behavioral aspects of occupants, but attributes of domestic buildings also have a lot of important factors such as floor and room numbers, different areas, glazing ratio and usage of spaces, different heating and cooling system and regime for each space, varying number of occupants, etc., which influence the energy demand of the built environment. Since gathering all these variables in one study are impossible, delimitations were essential, which reasonably determines the sampling criteria. As already noted in the ‘Procedure’ in chapter 1, the sample space was defined as dormitory buildings. While this type of buildings represent domestic living pattern, it automatically limits the complex diversity of house buildings and its users as listed in Table 3.4

Table 3.4 Comparison of dormitory unit to housing unit

Attributes	Dormıtory	House
Occupant profile	• Fixed number of user defined by rules • Occupant around similar ages • Occupant from different regions in one building • Occupant from similar regions but in different region • Limited activity types by rules • Limited activity schedule by lectures and rules • Monitoring utility bills by administration	• Different number of occupants • Different demographic characteristics of households • Different social-economic profile • Different activity type by different user in different time • Activity schedule depending work pattern and gender role • Being aware of utility bills
Physical profile	• Just one space usage at different times	• Different usage of spaces at different times • Different size of space
Physically evolving	• Similar building envelope for different climatic regions	• Similar building envelope for different climatic regions
Changing expectations	• Similar standard of living area • There is limited personal appliances • Controlling environmental comfort by adaptive approach	• Increasing in demand paralel to increasing standard of living • Ownership of appliances • Operating time of appliances, lighting, water heaters and HVAC

Besides existing limitations, getting permission to monitor environmental condition, obtaining the information on physical properties and operating systems of building, and getting more participants for conducting survey is more feasible in such a residential building. Additionally, this type of building did not only support reaching respondents together in one building who were from different socio-economic profiles and climatic regions, but it also provide the opportunity to do survey with occupant from similar socio-economic profiles but living in different climatic regions.

The following considerations were taken as the acceptance criteria and guided the sample size;

- The dormitory buildings in Turkey are operated by three types of organizations; by university authorities, private enterprise and the government. For easy access to information on buildings and students, dormitories that managed by universities were selected as study field.
- From the website of the Student Selection and Placement Centre (OSYM, https://www.osym.gov.tr/), the list of all universities in Turkey was obtained in 2016 and 73 private universities were excluded from the total number of 175 universities.
- Accommodation opportunity of the universities was examined on their websites. While 29 of the universities have their own dormitories available to support students accommodation needs, the rest contain information that directs their students to dormitories supported by the Credit and Dormitories Institution (*Kredi ve Yurtlar Kurumu*) or private enterprises.
- In order to understand the thermal comfort preferences of occupants in different climatic regions, public universities were grouped into five regions as defined in TS825 (Appendix E) regarding their locations and administrative operation type Figure 3.1 presents the number of universities in each climatic region from 1 to 5 respectively, which operate their own dormitory buildings on campus or have designated CDI dormitories.
- In order to support students' accommodation needs, universities provide dormitories with qualitative and quantitative differences from past to present in line with their facilities. Turkey has adopted Building Energy Performance Regulations (BEP) since 2009 and it stipulates that all new buildings constructed after 2011 must have an energy identity certificate with an energy performance class C or higher. Because this certification system ensures that the buildings have similar thermal performance, sample buildings were narrowed down as buildings constructed around 2009. Construction years of dormitory buildings were obtained from website of relevant universities and

from the manager/ director of dormitory buildings in a telephone interview. It was seen that 74 of the total dormitory buildings belonging to to 29 public universities were constructed before 2009, while 14 buildings were built after 2009 as shown in Figure 3.2

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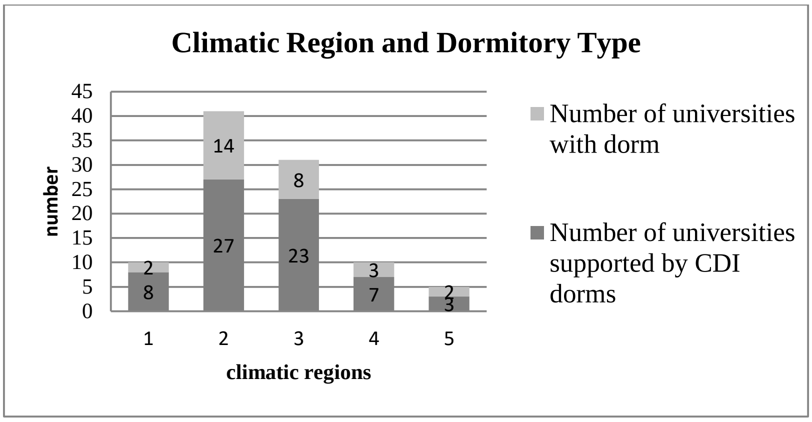


Figure 3.1 Number of universities grouped according to 5 climatic regions

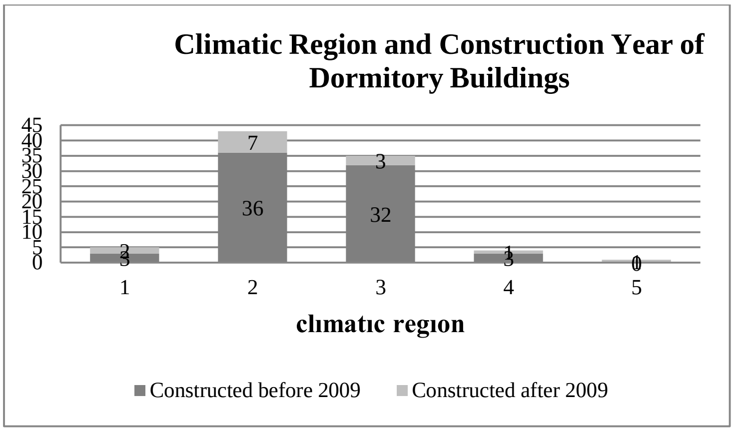


Figure 3.2 Number of dormitory buildings grouped according to construction period before or after BEP regulations

- Permission to conduct the field survey studies was sought from the selected universities and was granted to 7 out of the 13 dormitory buildings by the respective administration. The number of sample dormitories in each climatic region are shown in Figure 3.3. These dormitories were located in İzmir (CR1), Balıkesir (CR2), İstanbul (CR2), Ankara (CR3), Sivas (CR4) and Kars (CR5). Since 2 dormitories were located in Istanbul and 1 in Balıkesir, CR2 was represented by 3 dorms as compared to one each in the other 4 climatic regions.

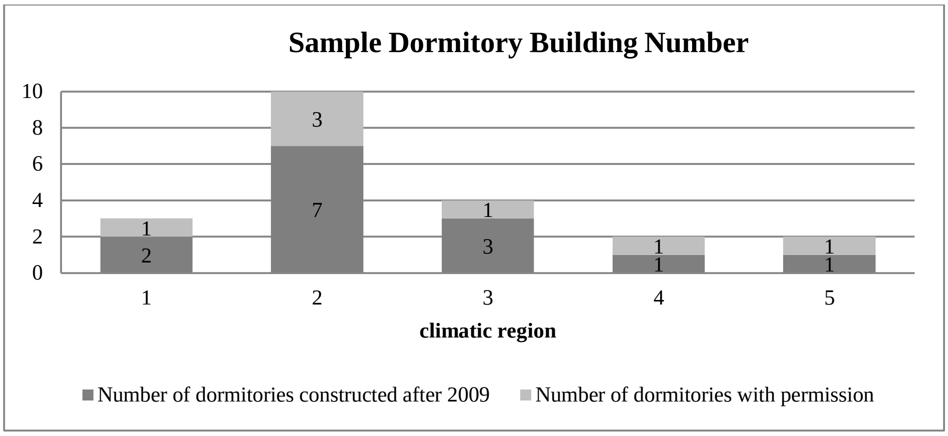


Figure 3.3 Number of sample dormitory buildings grouped according to each climatic region

3.2.2 Climatology of the selected cities

The climatic characteristics of the 6 cities, İzmir, Ankara, Balıkesir, İstanbul, Sivas and Kars, were defined according to different explanations with respect to the climate classification methods (Appendix B,C,D and E). For example, Ankara has Thrace semi-arid mesothermal climate, according to the geographical region boundaries (Gönençgil), while it is defined as semi dry temperate continental climate with hot summer and cool winter in other classifications. Balıkesir has Marmara regional climate, while it is expressed as semi dry temperate oceanic climate with hot summer and cool winter, in other classifications. İstanbul has Black Sea coastal temperate climate, i.e.Marmara climate regionally, which is defined as Mediterranean climate with subtropical dry and hot summers and cool winters. İzmir has Mediterranean climate regionally which is defined as Mediterranean climate with humid and very hot summer and cool winter. Kars has Eastern Anatolia semi-arid cold climate, which is expressed as temperate continental climate with warm summer and very cold winter. Sivas has Thrace semi-arid mesothermal climate which is defined as Mediterranean influenced Temperate Continental Climate with Warm and dry Summer Very Cold and humid Winter.

Other classifications take into account not only temperature, but also precipitation regime, vegetation, humidity, and drought but with different combinations and assumptions that set them apart. Namely, the climate classifications listed in Table 3.5 the climatic events experienced in these cities were considered to be similar according to their methods, and therefore they were defined in the same class. As a result, cities are shifting between climatic zones according to the chosen method. This situation hence reduces the number of climate zones of selected cities according to the selected classification methods.

According to another study (Kazmaoğlu &Tanyeli 1979) that analyzes the effect of climate diversity in Turkey on traditional Anatolian residential architecture under the headings of "material", "forming", "roof cover" and "space layout" and zoning on a map. The climatic characteristics of these six provinces İzmir, İstanbul, Balıkesir, Anakara, Sivas, and Kars were revealed on this map to diversify in terms of the local dwelling typologies.

Table 3.5 List of climate classifications for 6 cities.

CITY	**CIMATE CLASSIFICATION : Meteorological Approach**				
	AYDENİZ	ERİNÇ	KÖPPEN	KÖPPEN-TREWARTHA	DE-MARTONNE
ANKARA	Dry	Semi Dry	Csa	Dcak	Step – Semi Humid
BALIKESİR	Semi Humid	Semi Humid	Csa	Doak	Step – Semi Humid
İSTANBUL	Humid	Semi Humid	Csa	Csak	Step – Semi Humid
İZMİR	Semi Dry	Semi Humid	Csa	Cshk	Step – Semi Humid
KARS	Humid	Humid	Dfb	Dclc	Semi Humid
SİVAS	Semi Dry	Semi Humid	Dsb	Dcbo	Step – Semi Humid

KÖPPEN:
BSk: Cold semi-arid (steppe) climate
Csa: Hot-summer mediterranean climate
Dfb: Warm –summer humid continental climate
Dsb: Warm dry-summer continental climate
KÖPPEN-TREWARTHA:
Csak: Subtropical climate with dry summer with hot summer with cool winter
Cshk: hot summer, cool winter, Subtropical dry summer, Mediterranean climate;
Dcak: hot summer, cool winter, Temperate Continental;
Dcbo: warm summer, cold winter, Temperate Continental;
Dclc: warm summer, cold winter, Temperate Continental;
Doak: hot summer, cool winter, Temperate Oceanic;

CITY	**CIMATE CLASSIFICATION**		**Building Science**	**Approach**
	TS 825, 2013 (Only HDD)	Reclasification * (Both HDD and CDD)	Bioclimatic Classification **	Climatic classification***
ANKARA	3rd DDR	3rd DDR	2 (Temperate - Dry)	2 (Temperate - Dry)
BALIKESİR	2nd DDR	2nd DDR	3 (Temperate)	4 (Temperate – Humid)
İSTANBUL	2nd DDR	2nd DDR	3 (Temperate)	4 (Temperate – Humid)
İZMİR	1st DDR	1st DDR	7 (Composite)	5 (Hot -Humid)
KARS	5th DDR	5th DDR	1 (Cool)	1 (Cool)
SİVAS	4th DDR	4th DDR	1 (Cool)	1 (Cool)

* Source: Tükel, Tunçbilek, Komerska, Keskin, & Arıcı, 2021
**Source: Özdeniz, 1991
***Source: Ovalı, 2019

Within the scope of sampling strategy, TS 825 climate classification defines the climates of six cities where the study was conducted represent the 5 climate regions. In addition, considering Heating Degree Days (HDD) classification method of TS 825 standard, the monthly comparison graph of the average temperature and HDDs of the six cities have been presented in Figure 3.4 The data were obtained from Turkish State Meteorological Service on a monthly average values between 2008-2017 were taken.

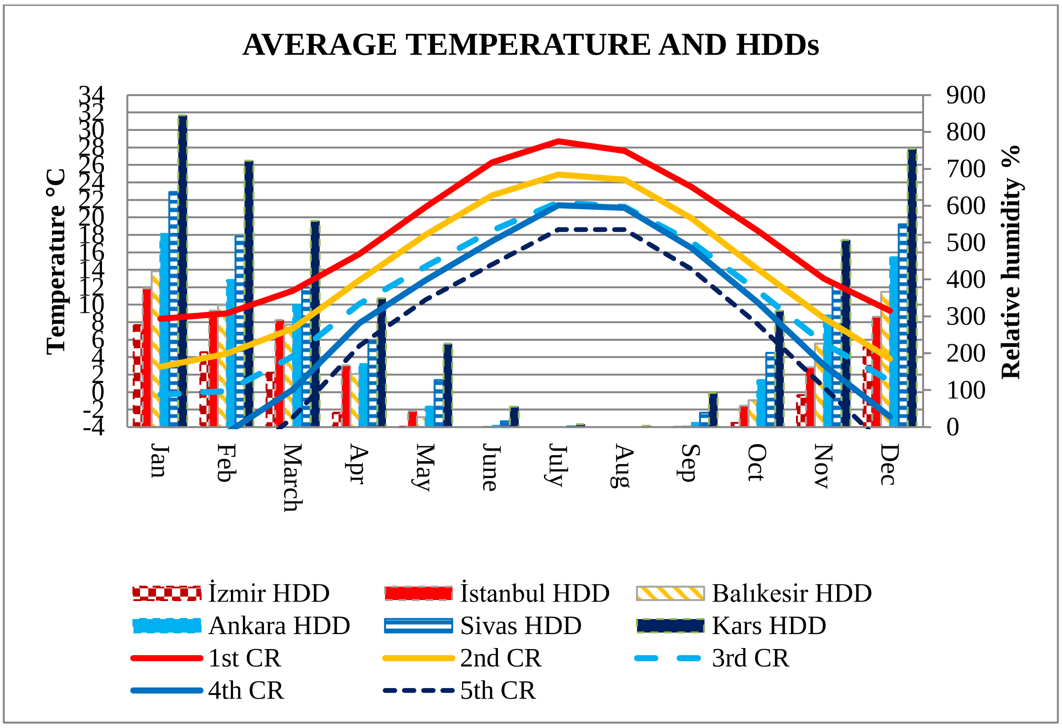


Figure 3.4 Monthly comparison graph of average temperature and HDDs of each climate regions of the cities İzmir, İstanbul, Balıkesir, Ankara, Sivas and Kars (Source: TS 825 and : https://mgm.gov.tr/veridegerlendirme/gun-derece.aspx)

Based on the average temperature of each climate regions as well as average HDDs of the cities according to TS 825 and the State Meteorological Office (Figure 3.4) the field survey was planned to be conducted at the beginning of January, which is the most critical month for heating period. However, because of the final exams of the academic semester and following holiday, students in the dormitories were not available to participate in any survey. Hence, field studies were conducted according to the participant’s schedule. As a consequence the survey time period varied from January to March.

3.2.3 Conducting field surveys

The field survey consisted of two kinds of paper based surveys, the comprehensive questionnaire and the self-report, as well as monitoring environmental condition and occupancy pattern by recording real-time data. Table 3.6 shows the number of participants of surveys, the dates and buildings when and where surveys were conducted.

Table 3.6 Number of participants and detail of dates and dormitory buildings where the surveys were conducted

CR	University	Dormitory	Capacity	Questionnaire	Date	Self-report	Monitored room	Dates
1	Dokuz Eylül Üniversitesi (İzmir)	CR1_D1	504	148(29%)	March 2016	16 (3%)	4 (16 people)	27 Dec-02 Jan 2016
2	Boğaziçi Üniversitesi (Istanbul)	CR2_D3	550	123 (22%)	February 2017	163(30%)	9 (17 people)	21-30 February 2017
		CR2_D7	252	71 (28%)	March 2016	5(2%)	5(5 people)	10-24 March 2016
2	Balıkesir Üniversitesi	CR2_D2	185	111(60%)	February 2017	-	-	-
3	Ortadoğu Teknik Üniversitesi (Ankara)	CR3_D4	694	105 (15%)	January 2017	-	-	-
4	Cumhuriyet Üniversitesi (Sivas)	CR4_D5	250	63(25%)	March 2017	40 (16%)	2(2 people)	09-16 March 2017
4	Kafkas Üniversitesi (Kars)	CR5_D6	250	78((31)%	January 2017	87(35%)	4 (7 people)	19-30 March 2017
TOTAL			2685 (100%)	697 (26% of total capacity)		308 (12% of respondees)	24 (47 dorm residents)	

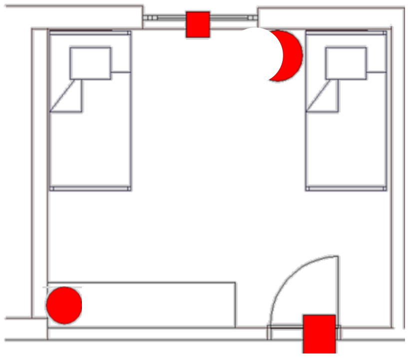
a) Questionnaire survey

The Questionnaire surveys based on 48 questions were carried out during 2016 and 2017 in winter season. It was on a voluntary basis, and individuals were supposed to answer the questions on their own during any period of the day. The questionnaire takes at least 15 minutes to answer. Total of 697 people participated in the survey which account for around 26% of the students who were residing in the selected dormitory buildings.

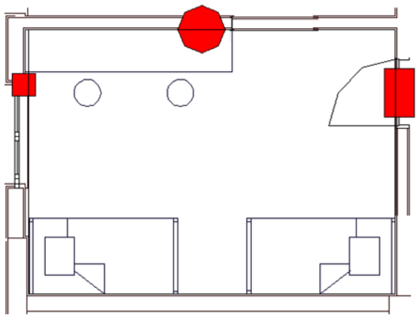
b) Self report questionnaire

A self-report questionnaire as a daily survey, assessing the indoor thermal environment and resident’s adaptive behavior, was conducted in the dormitories in İzmir, İstanbul, Sivas and Kars while both air indices such as the air temperature, humidity and CO2 level, and behavioral actions such as open/close window and presence time were recorded by data loggers in the rooms of respondents. In order to be able to evaluate these survey responses, it was necessary to collect data with data loggers at the same time. This survey could not be conducted in Balıkesir and Ankara, because the recording devices were not allowed by the dormitory authority. This survey was based on 7 questions carried out at the time intervals given in Table 3.6, and total of 308 residents participated in the survey which accounted for around 12% of the students who were living in the selected dormitory buildings. Detailed information is listed in Table 3.6.

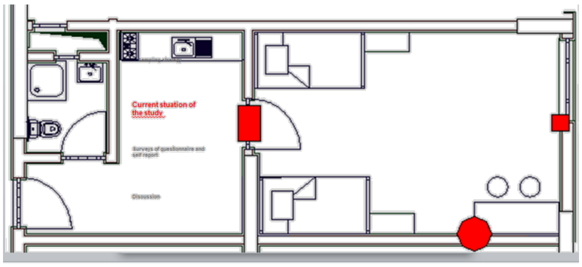
Beside the self report survey data collection from the dormitory residents, continuous measurements of the local indoor and outdoor environmental conditions around each subject, as well as of the subjects' behavioral actions were recorded. CO2, humidity and temperature data was recorded by the dataloggers at 5 minutes intervals throughout the whole monitoring period. Over all 47 participants from 24 rooms in five different dormitory buildings were monitored during the winter season for 7 day-periods. Sample schemes of room plans that show the data loggers’ locations were listed in Figure 3.5 They were positioned on the top of the shelves 1.8 m above the floor near the study desk where the student usually spent



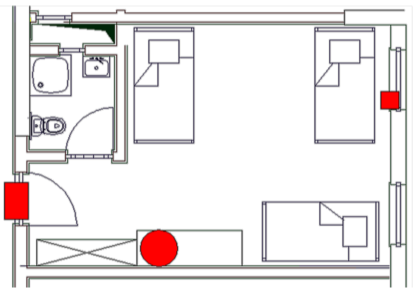
CR1_D1 İzmir



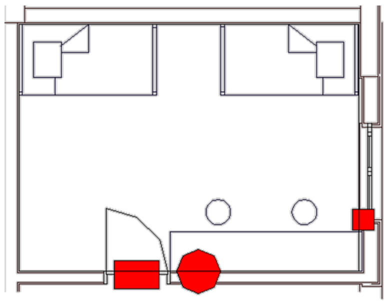
CR2_D7 İstanbul



CR2_D3 İstanbul



CR4_D5 Sivas



CR5_D6 Kars

Figure 3.5Sample schemes of room plans and the data loggers' locations

: Temperature, Humidity and CO_2 data logger; : Open/closed window state data logger
: State of occupancy data logger

time during the day. One of the the dataloggers was also placed outside on the window sill to record the outside air temperature and humidity. Before recording, the manual calibration of CO_2 datalogger in fresh air was processed outside each dormitory. Thus, the CO_2 reading was started at 400 ppm, which is the average value accepted for outdoor air. In addition, open/closed data logger was fixed on the window of each room for monitoring the duration of an open/closed event of the window within the time period of each change of state. Meanwhile, room occupancy change was monitored by the occupancy recording equipment, which was mounted over the door of the room where the students sleep and study. Time out value was set on 15 minute as the amount of time the datalogger waited before it recorded the room as unoccupied, when there was no motion in the room for 15 minutes.

Limitations and Delimitations of the Study

- The study was limited to the heating period. Questionnaire surveys and data recording could only be conducted for a short time period due to limited permission of the dormitory director and respondents 'requests.
- The study was carried out in the Universities' dormitory buildings that were built after 2009, i.e. post thermal regulations of TS825.
- Selected buildings and provinces representing the climatic regions were limited due to administrative permission procedures, economic and time constraints
- Evaluation based on age and education level was omitted because all respondents were university students and more or less in the same age group.
- Representative provinces and the number of users vary according to voluntary participation in the survey.
- The number of respondents for the relevant sample was very limited due to many reasons, not only due to administrative permission and financial issues, but also insufficient social awareness and doubts about the purpose of the study.

3.2.4 Data analyses

First, to summarize and organize characteristics of the responses from the surveys, tables, bar charts, and scatter plots of descriptive statistics with the distribution of frequency, averages, and mostly tendencies or percentages were used. Then inferential statistics were conducted by null-hypothesis significance testing. Since Microsoft Excel program was used for statistical tests, the study was carried out depending on its statistical analysis function limits. According to the data type, chi-square, one sample ANOVA and paired t-test were used. The main null hypothesis and categories with variables are listed in Table 3.7.

- H01: There is no difference between the socio-economic attributes of occupants from different climate regions in Turkey.
- H02: There were no differences among thermal comfort preferences of users from different climate regions in Turkey.
- H03: There were no differences among occupant's adaptive behavior to prevailing conditions of different climatic regions of Turkey.
- H04: There were no thermo-physical differences among the family houses located in different climate regions in Turkey
- H05: There was no difference between the energy use behavior of occupants from different climate regions in Turkey.
- H06: There was no relationship between socio-economic attributes of users and energy use pattern
- H07: There were no associations between awareness on domestic energy concerns and energy use
- H08: There were no influence of national insulation legislation and legal sanctions on the occupants' satisfaction/complaints with regard to thermal comfort.
- H09: There were no relationship between awareness on energy concerns and climate regions.

- H10: There were no relationship between awareness on energy concerns and socio-economic attributes in Turkey.

Table 3.7 Organization of null hypothesis testing

Categories	Null Hypothesis	Categories	Variables
Socio-economic parameters	H01	CRs	Income House type No of family members Ownership Dependent Person M2
Thermal comfort	H02	CRs	Thermal comfort sense Thermal comfort satisfaction Thermal comfort vote Thermal comfort preference Thermal comfort acceptance
Adaptive behavior	H03	CRs	Change clothing Open/close windows Adjust heater
Thermophysical conditions	H04	CRs	Sun orientation Wall Insulation Double Glazing Closed Balcony
Energy use	H05	CRs	Heating Bill Electricity Bill Heating/cooling System
Energy use	H06	Socio-economic	M2 House Type Income No of family member
Energy use	H07	Awareness on energy concerns	Energy Label Electricity Bill
Insulation regulations	H08	Thermal satisfaction /complaint	Wall Insulation Double Glazing Comfort Sense Cold Room Complaint Cold Wall Surface Humid Wall Surface
Awareness on energy concerns	H09	CRs	
Awareness on energy concerns	H10	Socio-economic	Income No of family member Shut/down heater Turn off lights/app Energy Label

CHAPTER 4

RESULTS AND DISCUSSION

In this chapter are presented descriptive data on surveys and environmental/behavioral data logging, conclusions from the analysis, and discussions of implications. In order to understand to what extent the data of the sample represents the population, inferential statistical methods were used.

4.1 Descriptive data on survey

This part was comprised of three subheadings; Data on Questionnaire Survey, Data on Self Report Survey, and recorded Data on Environmental and Behavioral variables. In order to understand the general tendencies of the sampled groups related to the variables in the research, and summarized the observations descriptive statistics were used.

4.1.1 Questionnaire Survey Data

The information on physical aspects and occupants behavior of both dormitory and residential buildings were obtained by asking relevant questions. In this part the answers were grouped according to climate regions and represented by the descriptive tables under the relevant subtitles; Demographic data, socio-economic attributes, thermal behaviors, and energy use behaviors.

A total of 697 questionnaires were filled by dormitory residents in the six cities that were denoted by the climate region abbreviations CR1_D (İzmir), CR2_D (Istanbul & Balıkesir), CR3_D (Ankara), CR4_D (Sivas) and CR5-D (Kars). CR_D, CR_H and CR_B. These codes were used to represent the climate regions of the cities where the dormitory buildings were, where respondents' family home were and where they were born, respectively. In Table 4.1 below, the “count” column of shows the number of respondents in each climate region. The columns of Tmax, Tmin, Hum (Humidity) and HDD (Heating Degree Day) give the data for the cities where the respondent have homes or dormitory rooms, that were taken for the year 2017 from the annual database of the Meteorological Service of Turkish State (https://mgm.gov.tr/). The number of cities in each CRs grouped according to the TS 825 climate region classification varied according to the number of samples, and therefore, the averages of the climate data of the cities were taken for each CR. In CR_D, sd value was 0 for four climate zones except second one, because in the 2nd region there were two cities while it was conducted in only one city representing each other CRs. In the CR_H and CR_B groups there was more than one city, but their numbers were not equal. For example, in the 4th and 5th climate regions the “count” was the lowest in the Table 4.1, because the cities in these groups in TS 825 and the participants from these regions had the lowest numbers compared to other CRs. Environmental indices columns shows that mean values of HDD increased from 1st CR to 5th CR, although there were no big differences between mean values of Tmax (maximum temperature) and Hum (relative humidity).

Table 4.1 Average values of environmental indices of climate regions

CR_D	count	Tmax_ μ	Tmax_ sd	Tmin_ μ	Tmin_sd	Hum_ μ	Hum_sd	HDD_ μ	HDD_sd
CR1_D	147	33	0.0000	6	0.0000	63	0.0000	985	0
CR2_D	290	29	2.0824	2	0.8717	75	3.7774	1845	55
CR3_D	100	30	0.0000	-3	0.0000	63	0.0000	2493	0
CR4_D	63	29	0.0000	-7	0.0000	67	0.0000	3174	0
CR5_D	73	26	0.0000	-16	0.0000	74	0.0000	4661	0
CR_H									
CR1_H	122	33	1.0704	6	1.0779	66	3.1687	852	169
CR2_H	334	31	3.6716	2	1.4677	70	6.8621	1661	221
CR3_H	143	30	1.5652	-3	1.6183	64	4.5572	2504	282
CR4_H	38	30	2.0688	-6	1.1880	65	4.3136	2997	143
CR5_H	33	27	1.5090	-16	1.1103	72	3.4701	4569	207
CR_B	count	Tmax_ μ	Tmax_ sd	Tmin_ μ	Tmin_sd	Hum_ μ	Hum_sd	HDD_ μ	HDD_sd
CR1_B	117	33	1.0689	6	0.4815	66	3.2370	857	176
CR2_B	332	30	3.6938	2	1.6496	70	6.9329	1683	248
CR3_B	125	30	1.6394	-3	1.2582	64	4.1480	2501	242
CR4_B	52	29	2.3191	-6	2.3628	65	3.8734	3038	143
CR5_B	44	27	1.3579	-16	1.1323	72	3.5459	4567	203

The number of people sharing the room and the furniture layout information of 6 dormitory buildings selected to represent the 5 climate regions was summarized in Tables 4.2 and Table 4.3. The floor layout of the dormitory buildings consisted of rooms on both sides of the corridor, thus leading to opposite orientations and different indoor environmental conditions (Figure 3.5). The number of occupants varies from a 1 person to 6 people, while the mean number is 4 people (Table 4.2). Furniture layout was asked to obtain information about whether the user does his/her daily activities in the room close to the window. Therefore, whether the bed and desk in the room were positioned close to or far from the window was asked. At the same time, it was asked whether the windows were convenient to open/close. Table 4.3 shows that in almost 50% of the rooms, the study tables were positioned closed to the windows, while the beds were placed far from the windows in 60% of the rooms. 90% of the windows were accessible to open/close behavior

Table 4.2 Average number of people sharing room in dormitory building

Dorm Room member	*CR1_D*	*CR2_D*	*CR3_D*	*CR4_D*	*CR5_D*	*Total*
Minimum	1	1	2	2	2	1
Maximum	4	6	4	3	4	6
Mode	4	6	4	3	4	4
Std. Deviation	0.79	2.01	0.54	0.38	0.60	1.43
N	148	304	105	63	77	697

Table 4.3 Furniture layout in dormitory building

Furniture in Dorm		*N*	*f*	*%*
Study table	next to window	685	335	48.9
	Far away		350	51.1
Bed	next to window	687	261	38.0
	away		426	62.0
Window in Dorm		*N*	*f*	*%*
	Operable (open/close)	687	624	90.8
	not operable		63	9.2

4.1.1.1 Demographic data

Of the 697 questionnaires filled by dormitory residents 689, 692 and 684 respondents answered questions about age, gender and education level, respectively in Table 4.4. Although the range of age was from 18 to 37, there were a few students above 26 (Graduate students) and below 19 years of age. The average age of all the participants was 22 years and 66% of the participants were female while 34 % were males. 95% of participants were undergraduate students.

Table 4.4 Overview of the number of persons participating in the questionnaire survey

		N	*f*	*%*	*Minimum*	*Maximum*	*Mean*	*Std. Deviation*
Age		689			18.00	37.00	21.47	2.11
Gender		692						
	Male		237	34.3				
	Female		455	65.7				
Educat.		684						
	UGraduate		667	95.4				
	Graduate		10	1.4				
	PhD		7	1				

In regard to climatic classifications, Table 4.5 shows that most of respondents were born in or lived in or educated in the cities located in climate region 2 (CR2) with the percentages of 50%, 42% and 50% respectively. The percentages of the rest were distributed in columns for CR1, CR3, CR4 and CR5.

Table 4.5 Data on climate regions according to the participants place of birth, family home and dormitory

		CR1	*CR2*	*CR3*	*CR4*	*CR5*	*N*
City/birth	*f*	118	333	125	52	45	673
	%	17.5	49.5	18.6	7.7	6.7	100
City/dormitory	*f*	148	304	105	63	78	698
	%	21.2	43.6	15.0	9.0	11.2	100
City/home	*f*	124	342	147	39	35	687
	%	18.0	49.8	21.4	5.7	5.1	100

4.1.1.2 Socio-economic attributes of the respondents

So as to get a general idea about the influence of the socio-economic factors on occupants' behavior with respect to the variable thermal surroundings the respondents were asked to provide information about number of family members with whom they live together and any dependent family members, with the information on occupancy pattern with respect to the time intervals during a week, type of house and size, state of ownership and income of their family (Table 4.6).

The average number of family members was 4 people, and 88% of them had no any dependent family members such as a baby, patients or elderly. 76% of 667 families owned their houses and 68% of 671 houses were a flat in an apartments-type building, almost 77% of which was larger than 90 m2; 67% of the families had a total monthly income range of 1.300 TL (371$) – 3.500 TL (1.000 $).

The percentage of household use during the day is affected not only by the presence of dependent individuals in the household but also by the parents' work status and the children's school schedule. Regarding the influence of those socio-economic indicators on the time of occupancy of the households, respondents were required to choose the time intervals of the day for unoccupied hours of their family homes and also for occupied hours of their dormitory rooms. The percentage of occupancy level of the rooms and dwellings during the day are listed in Table 4.7 and the results are illustrated in Figure 4.1 and Figure 4.2 Graphs show that both types of buildings were occupied for all hours in a day, but with different occupancy percentages. Occupancy trend was changing according to weekdays and weekends in dormitory rooms, while in the dwellings fluctuation is seen throughout the weeks. The results show that the most intensive occupancy period in dormitories was at night until 06:00 am on weekdays, but it shifted to morning time on weekends. As regards dwellings, graphs (Figure 4.2) showed that at least 65% of these types of buildings were always occupied by some family member.

Table 4.6 Data on family members; house type, size and ownership; and family's monthly income,

No.of family members		CR1_H	CR2_H	CR3_H	CR4_H	CR5_H	Total
Minimum		2	1	1	3	3	1.0
Maximum		8	13	8	10	12	13.0
Mean		3.88	4.367	4.239	4.666	5.813	4.344
Std. Deviation		1.0067	1.4178	1.1878	1.530	2.3201	1.4214
	N	*117*	*324*	*146*	*36*	*32*	*697*

Dependent f. member		CR1_H	CR2_H	CR3_H	CR4_H	CR5_H	Total
Old Person	*f*	5	20	10	4	3	42
	%	4.0	6.0	6.8	10.8	8.8	6.2
Baby	*f*	2	17	6	2	4	32
	%	1.6	5.1	4.1	5.4	11.8	4.7
Patient	*f*	3	4	2	0	2	12
	%	2.4	1.2	1.4	0.0	5.9	1.8
None	*f*	113	295	129	31	25	593
	%	91.1	87.8	87.8	83.8	73.5	87.5
	N	124	336	147	37	34	678
	%	100	100	100	100	100	100

House type		CR1_H	CR2_H	CR3_H	CR4_H	CR5_H	Total
Apartments	*f*	85	228	103	24	11	457
	%	71.4	69.3	71.0	66.7	32.4	68,1
Duplex flat	*f*	5	14	1	1	1	22
	%	4.2	4.3	0.7	2.8	2.9	3,3
OneStorey DetachedHouse	*f*	4	25	12	3	13	59
	%	3.4	7.6	8.3	8.3	38.2	8,8
MultiStorey Detached House	*f*	19	49	25	8	3	104
	%	16.0	14.9	17.2	22.2	8.8	15,5
Shanty house	*f*	2	3	1	0	1	7
	%	1.7	0.9	0.7	0.0	2.9	1
Country house	*f*	2	8	3	0	5	18
	%	1.7	2.4	2.1	0.0	14.7	2,7
Other	*f*	2	2	0	0	0	4
	%	1.7	0.6	0.0	0.0	0.0	0,6
	N	119	329	145	36	34	671
	%	100	100	100	100	100	100

Size of family home		CR1_H	CR2_H	CR3_H	CR4_H	CR5_H	Total
< 60 m2	*f*	2	7	5	0	2	16
	%	1.8	2.2	3.5	0	6.5	2.5
61-90 m2	*f*	25	72	23	6	6	132

Table 4.6 Cont.

	%	21.9	22.2	16.1	17.6	19.4	20.4
91-130 m2	*f*	58	163	74	11	12	318
	%	50.9	50.3	51.7	32.4	38.7	49.2
>131 m2	*f*	29	82	41	17	11	180
	%	25.4	25.3	28.7	50	35.5	27.9
	N	114	324	143	34	31	646
	%	100	100	100	100	100	100

Ownership		*CR1_H*	*CR2_H*	*CR3_H*	*CR4_H*	*CR5_H*	*Total*
Householder	*f*	86	248	113	29	26	502
	%	72.3	76.1	76.9	80.6	76.5	75,8
Tenant.	*f*	28	65	30	5	7	135
	%	23.5	19.9	20.4	13.9	20.6	20,4
Do not know	*f*	5	13	2	2	1	23
	%	4.2	4.0	1.4	5.6	2.9	3,5
	N	119	326	145	36	34	660
	%	100	100	100	100	100	100

Monthly income		*CR1_H*	*CR2_H*	*CR3_H*	*CR4_H*	*CR5_H*	*Total*
<1300 TL	*f*	25	47	19	6	7	107
	%	21.0	14.4	13.1	16.7	20.6	16
1301-3500 TL	*f*	46	147	61	16	14	286
	%	38.7	45.0	42.1	44.4	41.2	42,8
3501-6500 TL	*f*	26	81	45	10	4	166
	%	21.8	24.8	31.0	27.8	11.8	24,9
6501-10000 TL	*f*	9	15	5	0	0	30
	%	7.6	4.6	3.4	0.0	0.0	4,5
>10001	*f*	3	1	3	2	0	9
	%	2.5	0.3	2.1	5.6	0.0	1,3
Do not know	*f*	10	36	12	2	9	70
	%	8.4	11.0	8.3	5.6	26.5	10,5
	N	119	327	145	36	34	668
	%	100	100	100	100	100	100

Table 4.7 Percentage of occupancy level of the rooms and dwellings during the day

Occupied Dormitory rooms		*08:00-11:00*	*11:30-13:00*	*13:30-18:00*	*18:30-20:00*	*20:30-07:30*	*All day*	*N*
Weekdays	*f*	166	62	95	322	588		682
	%	24.3	9.1	13.9	47.2	86.3		
Saturday	*f*	241	232	134	48	111	317	666
	%	36.1	34.8	20.1	7.2	16.7	47.6	
Sunday	*f*	307	193	107	35	80	281	665
	%	46.2	29	16.1	5.3	12	42.3	
Unoccupied Family House		*07:00-12:00*	*12:30-18:00*	*18:30-07:00*	*Usually occupied*	*N*		
Weekdays	*f*	128	178	18	443	667		
	%	19.6	26.7	2.7	66.4			
Saturday	*f*	26	71	21	560	659		
	%	3.9	10.8	3.2	85			
Sunday	*f*	13	53	41	583	661		
	%	2	8	6.2	88.2			
		128	178	18	443	667		

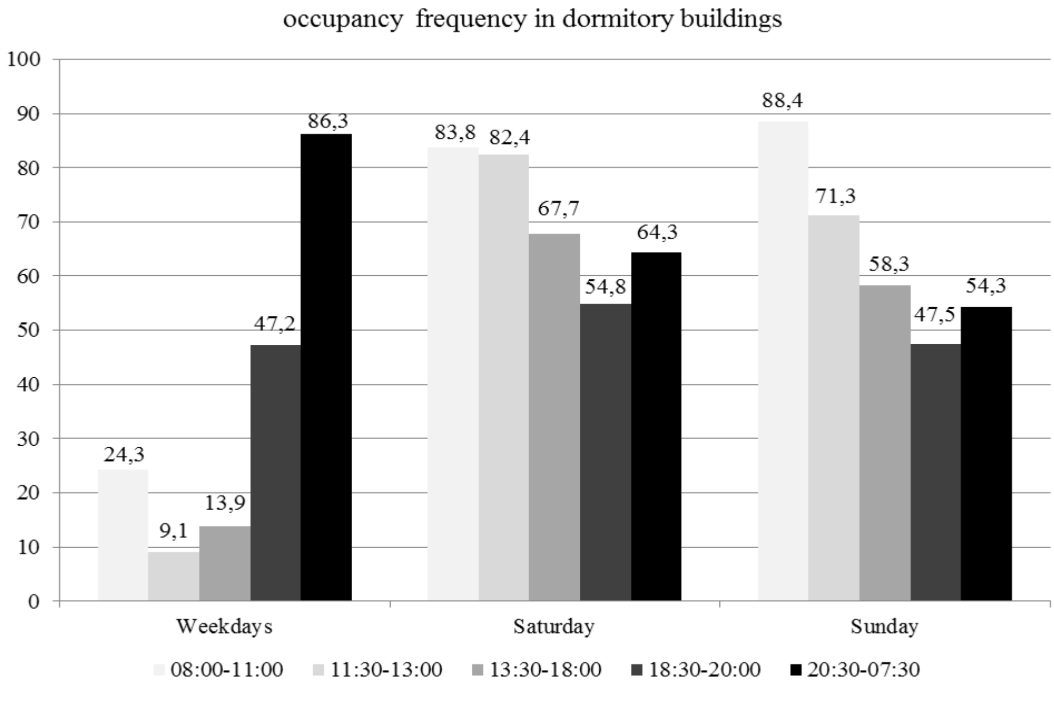


Figure 4.1 Occupancy frequency in dormitory buildings

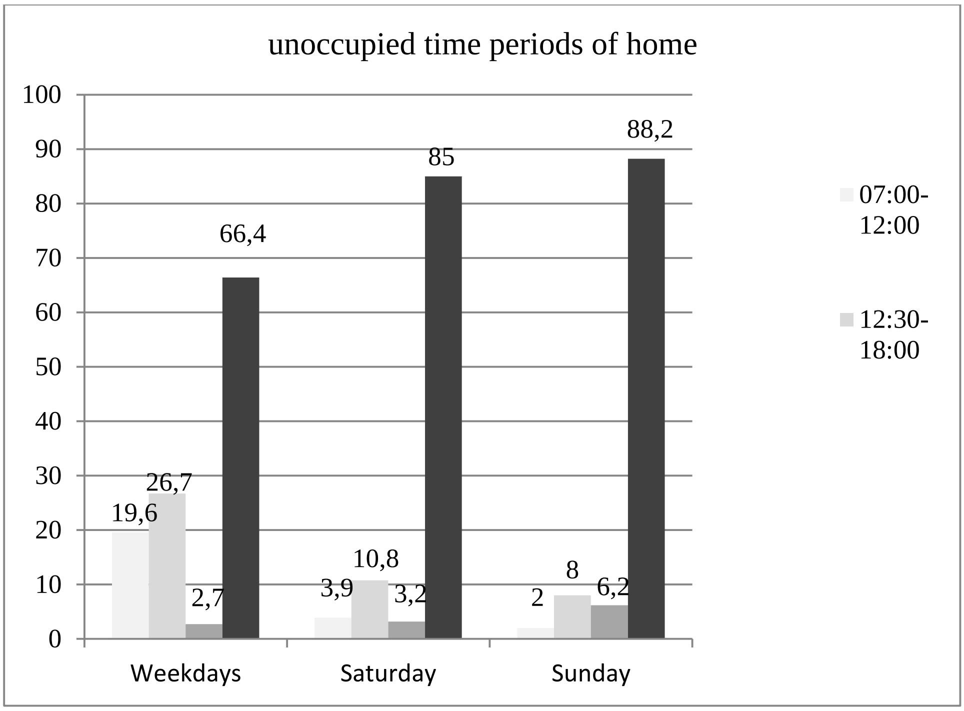


Figure 4.2 Unoccupied time periods of dwellings

4.1.1.3 Environmental satisfaction behaviors

Indoor environmental factors such as light, thermal comfort/ambient temperature and humidity, noise and indoor fresh air influence the changes in occupant behavior in terms of their satisfaction. Questions related to the satisfaction with the environment conditions in their family house (dwelling) and dormitory (room) were answered on a 5 point Likert scale from 1-very dissatisfied to 5-very satisfied. Table 4.8 gives the mean of satisfaction and shows that in general, participants considered their homes to have a better quality than the dormitories with respect to all indices of the indoor environmental conditions. Natural cooling and sound insulation had the lowest satisfaction level for the dwellings with 3 point. The lowest rating of all was used for the noise level in the dormitory rooms with 1 point, and though not as much as dorm room respondents rated low also for their homes in the 2nd, 4th and 5th climate regions where the number of family members was above 4. Daylighting level was the other issue that was rated low for dorm rooms in CR1, CR2 and CR5.

Table 4.8 Results of 5 point satisfaction scale on indoor environmental quality

		CR1	*CR2*	*CR3*	*CR4*	*CR5*	*Total*
Daylight/room	*m*	3	3	4	4	3	4
	f	147	298	105	63	75	688
Daylight/dwelling	*m*	4	4	4	4	4	4
	f	143	287	100	62	76	668
Sound Ins/room	*m*	1	2	2	2	2	2
	f	147	298	104	63	75	687
Sound Ins/ dwelling	*m*	3	3	3	4	3	3
	f	143	286	100	62	76	667
Temp/room	*m*	3	4	4	4	4	4
	f	146	299	105	63	76	689
Temp/ dwelling	*m*	4	4	4	4	4	4
	f	143	286	100	62	75	666
Freshair/room	*m*	3	4	4	4	4	4
	f	147	298	105	63	76	689
Freshair/ dwelling	*m*	5	5	5	5	5	5
	f	143	285	100	62	75	665
Phys.Cond/room	*m*	2	3	4	3	3	3
	f	147	298	104	63	75	687
N.Cooling/ dwelling	*m*	4	3	3	4	4	4
	f	143	286	100	62	75	666

Since the evaluation of the respondents' satisfaction with the room temperature of the dormitories in each CR was similar regardless of the climatic zone, the mean values in Table 4.9 showed that respondents from the colder or warmer climate region did not report a significant increase or decrease in satisfaction with the dormitory room temperatures. To understand these regional similarity results, the study examined respondents' data further on how many years they lived and studied in the climate regions (Table 4.10). These data showed that although the values of each CR_D regions were similar as in the CR_H regions, the duration of experience of respondents in the CR_H regions was longer, such as 18-19 years. Thus, the Mode values of CR_H in each CR_D were examined to understand which climate region the respondents mostly came from in each dormitory building (Table 4.10). These values showed that the respondents in the CR1_D, CR2_D, and CR3_D mostly came from CR2_H, while those in CR4_D and CR5_D were mostly from CR3_H and CR5_H, respectively.

Table 4.9 Comparative results of thermal satisfaction responses in dormitory rooms and living rooms across climate regions where participants house (CR_H) and dorm were located (CR_D).

Heat/DormRoom		*CR1_H*	*CR2_H*	*CR3_H*	*CR4_H*	*CR5_H*	*Total*
CR1_D	*m*	3	3	3	4	3	3.21
	s	1.4	1.3	1.3	1.5	0.8	1.31
	f	28	70	25	11	7	141
CR2_D	*m*	4	4	4	4	4	4.20
	s	1.2	1.0	1.1	1.2	2.1	1.08
	f	54	159	56	9	2	280
CR3_D	*m*	4	4	4	4	5	4.19
	s	0.8	1.0	1.0	1.0	0.7	0.94
	f	24	46	22	3	2	97
CR4_D	*m*	4	4	5	5	5	4.39
	s	1	1	1	1	Null	0.94
	f	6	24	25	5	1	61
CR5_D	*m*	4	4	4	3	4	3.96
	s	1.0	1.1	1.1	1.3	0.9	1.05
	f	7	22	14	7	21	71
TOTAL	*m*	4	4	4	4	4	3.98
	s	1.2	1.2	1.2	1.3	1.0	1.17
	f	119	321	142	35	33	650

Table 4.10 The years respondents lived and studied in the climate regions

Length of life in the city of dormitory	*CR1*	*CR2*	*CR3*	*CR4*	*CR5*	*Total*
Minimum	2	1	3	2	1	1
Maximum	24	27	24	6	27	27
Mode	2	2	4	2	5	2
Std. Deviation	4.0	5.7	3.3	1.3	5.4	4.8
N	146	295	104	63	76	684
Length of life in the city of family home	*CR1*	*CR2*	*CR3*	*CR4*	*CR5*	*Total*
Minimum	2	1	1	2	1	1
Maximum	26	32	23	24	21	26
Mode	18	18	19	18	19	18
Std. Deviation	5.5	5.1	5.0	4.9	4.8	5.1
N	120	337	138	39	34	668
Mod of CR_H for each CR_D	*CR1_D*	*CR2_D*	*CR3_D*	*CR4_D*	*CR5_D*	*Total*
Mod	CR2_H	CR2_H	CR2_H	CR3_H	CR5_H	CR2_H
N	148	300	102	63	74	687

Furthermore, data on the thermal sensations of respondents in their homes during the heating period were gathered. Table 4.11 shows that 47% of occupants feel neutral about the thermal conditions in their houses regardless of the climate region. However, the percentage values of each CR showed that the trend shifted from neutral to warm for the 4th and 5th climate regions. In order to guide thermal sensation awareness of the occupants in different perspectives regarding possible building thermal problems some more questions were asked as listed in Table 4.18 under the sub title "Energy use behavior". The fact that the number of respondents who said there was no problem about the thermal conditions at home was the highest (43%), confirmed the respondents felt in comfort thermally in their family house even when it was located in different climate regions.

Table 4.11 Percentage of thermal sensation in the house where respondents live

Thermal sense		*CR1_H*	*CR2_H*	*CR3_H*	*CR4_H*	*CR5_H*	*Total*
Cold	%	3%	1%	2%	3%	0%	2%
Cool	%	23%	16%	14%	14%	21%	17%
Neutral	%	48%	48%	49%	39%	26%	47%
Warm	%	24%	31%	29%	36%	47%	30%
Hot	%	2%	5%	6%	8%	6%	5%
TOTAL	%	100%	100%	100%	100%	100%	100%

Occupant adaptive behavior

Occupant adaptive behavior frequencies were summarized in Figure 4.3. Percentage values represented that aside from opening windows, respondents mostly preferred to change clothes both in dormitory room and in their house when indoor air was too hot in winter. Since dormitory buildings have central heating system without individual thermostat control, the only way to decrease indoor temperature is to turn off the valve of radiator in the rooms. Therefore, the frequency of adjusting the heater in dorm rooms turned out to be one of the least preferred behaviors, instead, building occupants chose to open the window as the second preferred action. On the other hand, because the frequency of adjusting the heater in winter was a preferred behavior at home, the tendency of open window behavior decreased compared to behaviors in dorm rooms.

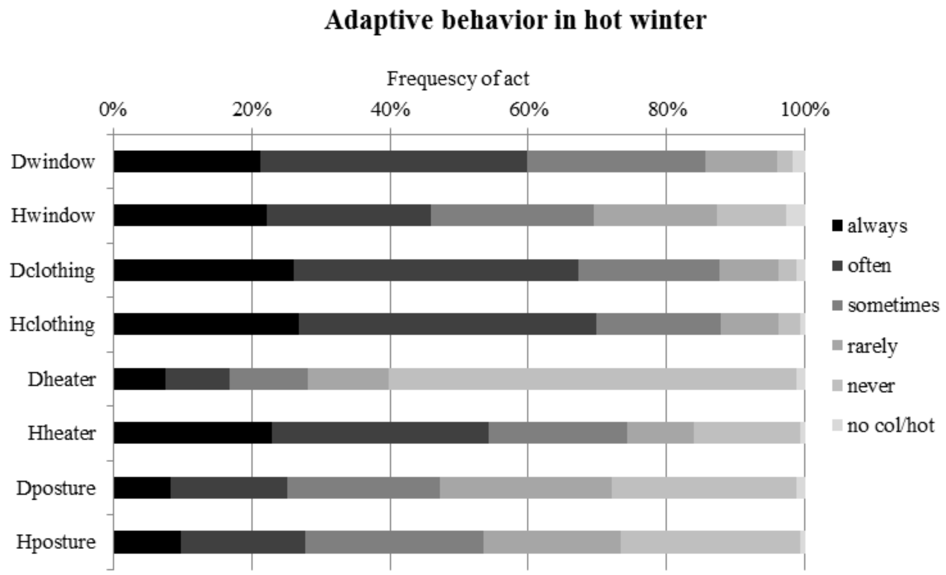


Figure 4.3 Percentage of adaptive behavior

The other question asked respondents to answer how often they prefer the adaptive behavior shown in Figure 4.4 and Figure 4.5 in support of thermal comfort when their house was cold in winter and hot in summer. Respondents often prefer to wear thicker clothes, increase the temperature of heating system and use blankets, respectively, in cold winter days. In hot summer, ventilating the room naturally (window use) was one of the most preferred behaviors after changing clothes. Moreover, around 20-25% of respondents selected the always frequency for air condition, fan and using blinds alternatives to become cooler.

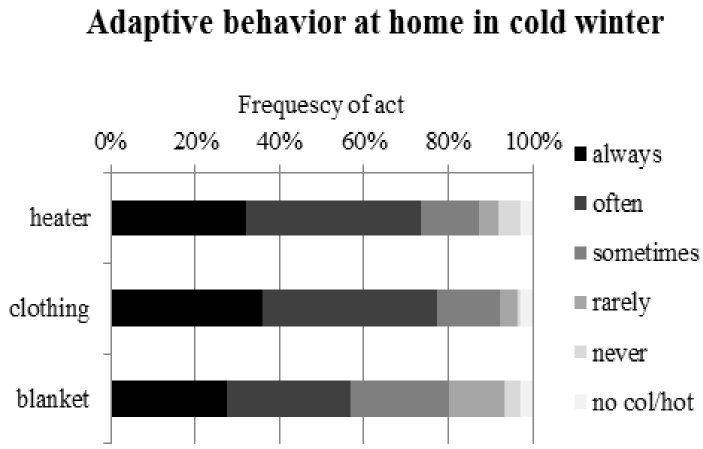


Figure 4.4 Frequency chart of adaptive behavior at home in winter season

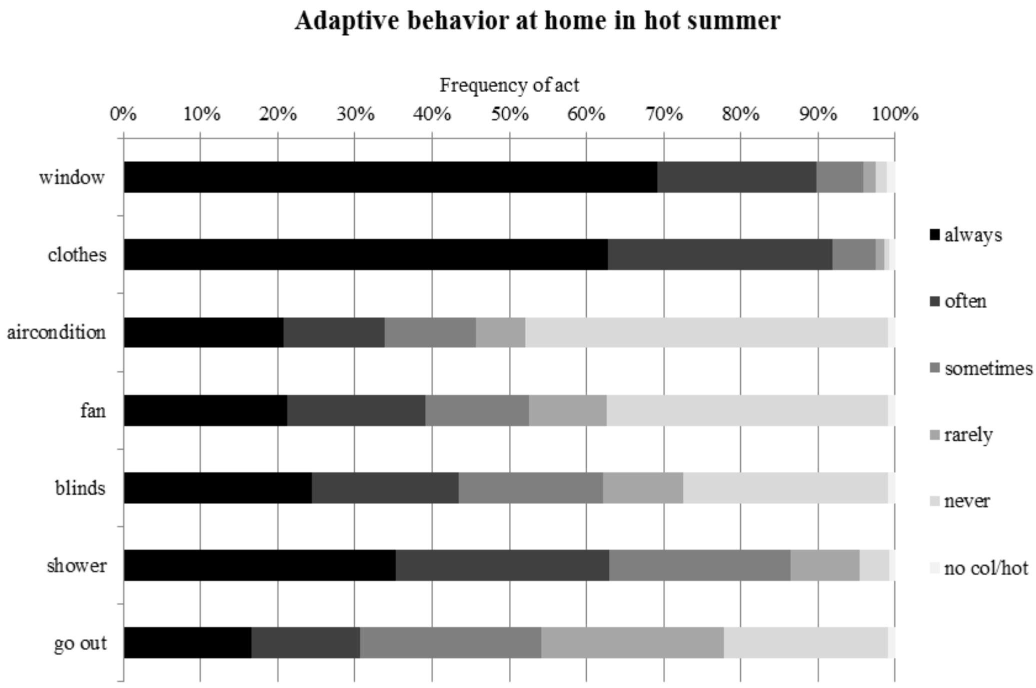


Figure 4.5 Frequency chart of adaptive behavior at home in summer season

The results mentioned above were grouped into climate regions and the frequency mode for each was listed in Table 4.12. When it was warm inside during the winter, the majority of respondents in all climate zones informed that they often prefer to open windows or wear thinner clothes in both dorm rooms and family homes. Also, depending on unable to adjust the heating system, the frequency mode of heating down behavior was "never" in dormitory rooms, but "often" in family homes except in region 5. When it was cold inside during winter, the respondents stated the frequency of all defined adaptive behaviors of raising heat, using blankets and dressing with thicker clothes as "often". Other than winter, when it was hot inside in summer the frequency of all listed adaptive behaviors other than the use of air conditioning (AC) and fan was answered similar for all regions. The frequency of AC and Fan usage was only chosen "always" by those whose family houses were in 1st climatic region, while in other zones it was indicated as "never".

Table 4.12 Occupant adaptive behavior frequencies across questionnaire survey showing the Mode values as the measure of central tendency

	mode as measure of central tendency				
Hot_Winter_Dorm and Home	*CR1*	*CR2*	*CR3*	*CR4*	*CR5*
Open Window_Dorm	Often	Often	Often	Often	Often
Open Window_Home	Often	Sometimes	Always	Often	Always
Thinner Clothing_Dorm	Often	Often	Often	Always	Often
Thinner Clothing_Home	Often	Often	Often	Often	Often
Heat down/_Dorm	Never	Never	Never	Never	Never
Heat down/_Home	Always	Often	Often	Often	Never
Position_Dorm	Never	Rarely	Never	Often	Often
Position_Home	Sometimes	Never	Sometimes	Often	Never
	mode as measure of central tendency				
Cold_Winter_ Home	*CR1*	*CR2*	*CR3*	*CR4*	*CR5*
Heat up	Often	Often	Often	Often	Often
Thicker Clothing	Always	Often	Often	Often	Often
Blanket	Always	Often	Always	Noanswer	Often
	mode as measure of central tendency				
Hot_Summer_ Home	*CR1*	*CR2*	*CR3*	*CR4*	*CR5*
Open Window	Always	Always	Always	Always	Always
Thinner Clothing	Always	Always	Always	Always	Often
AC	Always	Never	Never	Never	Never
Fan	Always	Never	Never	Noanswer	Never
Blinds	Never	Noanswer	Always	Noanswer	Noanswer
Shower	Always	Always	Always	Always	Sometimes
Go out	Noanswer	Noanswer	Noanswer	Noanswer	Noanswer

Apart from the evaluation of clothing adjustment behavior preference, the participants were also asked to indicate which clothing combination they preferred in their rooms and family homes in winter (Table. 4.13). Regardless of climate region and building, almost all respondents indicated that they wore the combination of light clothing. It should be noted that clothing levels became lighter even in dormitory rooms in cold climatic regions.

Table 4.13 The list of insulation values (Clo) of the clothes the respondents wear where they lived and studied

Clothing Insulation House (Clo)	*CR1_H*	*CR2_H*	*CR3_H*	*CR4_H*	*CR5_H*	*Total*
Minimum	0.38	0.38	0.38	0.38	0.45	0.38
Maximum	0.93	1.16	0.93	0.93	0.93	1.16
Mod	0.57	0.57	0.57	0.57	0.57	0.57
Std. Deviation	0.1260	0.1370	0.1293	0.1251	0.1449	0.1336
N	118	322	141	36	33	650
Clothing Insulation Dormitory (Clo)	*CR1_D*	*CR2_D*	*CR3_D*	*CR4_D*	*CR5_D*	*Total*
Minimum	0.45	0.37	0.38	0.38	0.38	0.37
Maximum	0.93	0.93	1.42	0.93	0.88	1.42
Mod	0.57	0.57	0.57	0.45	0.45	0.45
Std. Deviation	0.1232	0.1314	0.1647	0.1111	0.1165	0.1452
N	141	263	100	60	72	636

Motivate occupancy to open/close window

The frequency of window open/close action was seen to be the second prominent outcome of occupants behavior to control thermal conditions in dormitory. In this regard, another question was intended to identify what motivated respondents to operate the windows (Table 4.14). According to the data collected, 80% of respondents indicated that the reason for behavior of opening the window was to get fresh air, while only 23% stated that it was to cool the room

Table 4.14 Frequency value of what motivates occupants to open/close window of dormitory rooms

Open/closed window	*Cool off*	*Fresh air*	*Room mate*	*Open same time*	*Always open*	*N*
%	22.5	79.8	5.4	1.6	3.3	690

4.1.1.4 Energy use behaviors

Space heating, cooling and water heating are some of the largest expenses and a correspondingly important indicator of energy consumption that are controlled by the energy use habits of occupants. In addition to the climate diversity, the heating system varies with the dependency on regional infrastructure possibilities. As seen in Table 4.15, although the general average showed that individual gas boiler (called kombi by the users) was the most used heating system with approximately 40% users, regionally representative heating systems differed. In the 2nd and 3rd climate zones, the heating system was gas boiler with 44.4% and 60.3%,

Table 4.15 Data on heating and cooling systems in family homes

Heating sys		*CR1_H*	*CR2_H*	*CR3_H*	*CR4_H*	*CR5_H*	*Total*
Stove	*f*	33	86	17	11	18	165
	%	27.7	26.1	11.6	30.6	52.9	24.8
Central heating	*f*	32	81	36	19	10	178
	%	26.9	24.6	24.7	52.8	29.4	26.8
Electric heater	*f*	16	6	2	0	1	25
	%	13.4	1.8	1.4	0.0	2.9	3.8
Air conditioner	*f*	12	10	3	0	0	25
	%	10.1	3.0	2.1	0.0	0.0	3.8
Gas boiler(combi)	*f*	26	146	88	6	5	271
	%	21.8	44.4	60.3	16.7	14.7	40.8
	N	119	329	146	36	34	664
	%	100	100	100	100	100	100
Cooling sys.		*CR1_H*	*CR2_H*	*CR3_H*	*CR4_H*	*CR5_H*	*Total*
Fan (ceiling/pedestal)	*f*	19	74	27	10	2	132
	%	15.8	22.5	18.8	28.6	6.1	20.0
Air conditioner	*f*	74	96	18	3	3	194
	%	61.7	29.2	12.5	8.6	9.1	29.3
Nothing	*f*	27	159	99	22	28	335
	%	22.5	48.3	68.7	62.9	84.9	50.7
	N	120	329	144	35	33	661
	%	100	100	100	100	100	100

respectively. In the 4th and 5th climatic zones, the representative heating system was central heating with 53% and the stove with 53%, respectively. In the 1st climate zone, all heating systems were selected at similar rates, and there was no one system that can be called representative. In 2nd climate zone and 3rd climate zone representative heating system was the gas boiler, while it was the central heating system in 4th climate zone. Contrary to the use of heating systems, the overall trend except for the 1st region showed that more than 50% of respondents did not have any cooling system in their homes even though it is the hottest CR. The respondents from the 1st region stated that they use air conditioning system with a rate of 62%.

The thermal characteristics of family houses were also considered as another factor affecting energy use. Data on façade orientations of living spaces and thermal envelope of the houses were obtained via the answers of respondents for each climatic region. Table 4.16 shows that 12.3 % of the participants surveyed reported that their rooms lacked sunlight while the rest got sunlight in different periods of the day. These participants also reported on the amount of sunlight penetration in the living rooms of their family homes. The result shows that 4% of living spaces were either oriented towards north, or nearby structures obstacle access of sunlight penetration.

In order to obtain thermal properties of the building envelope, information about wall insulation, double glazing of windows and enclosed balcony was obtained through yes/no questions. The answers presented in Table 4.17 show that 42% of the 669 houses had insulated building envelopes, 70% of 660 houses had double glazed windows and 32% of 669 houses owners had enclosed the balconies. Meanwhile, 28% of students were not aware as to the presence of wall insulation in their homes.

Table 4.16 Data on the room façade orientation

Dorm Room Façade		*CR1_D*	*CR2_D*	*CR3_D*	*CR4_D*	*CR5_D*	*N*
Morning	*f*	53	92	21	27	26	219
	%	36.8	31.4	20.2	42.9	36.1	32.4
Afternoon	*f*	41	56	27	17	7	148
	%	28.5	19.1	26.0	27.0	9.7	21.9
Whole day	*f*	25	103	44	18	33	223
	%	17.4	35.2	42.3	28.6	45.8	33
Never	*f*	25	42	12	1	6	86
	%	17.4	14.3	11.5	1.6	8.3	12.7
	N	144	293	104	63	72	676
	%	100	100	100	100	100	100

Living Room Façade		*CR1_H*	*CR2_H*	*CR3_H*	*CR4_H*	*CR5_H*	*N*
Morning	*f*	21	55	21	2	6	105
	%	17.5	16.8	14.4	5.6	17.6	15.8
Afternoon	*f*	24	68	49	12	10	163
	%	20	20.7	33.6	33.3	29.4	24.5
Whole day	*f*	67	191	72	21	17	368
	%	55.8	58.2	49.3	58.3	50.0	55.4
Never	*f*	6	13	4	1	1	25
	%	5	4.0	2.7	2.8	2.9	3.8
Do not know	*f*	2	1	0	0	0	3
	%	1.7	0.3	0.0	0.0	0.0	0.5
	N	120	328	146	36	34	664
	%	100	100	100	100	100	100

Table 4.17 Data on envelope attributes of house buildings where the participants live

Wall Insulation		*CR1_H*	*CR2_H*	*CR3_H*	*CR4_H*	*CR5_H*	*N*
Yes	*f*	38	128	83	20	10	279
	%	31.9	39.0	57.6	55.6	29.4	42.2
No	*f*	36	101	35	10	16	198
	%	30.3	30.8	24.3	27.8	47.1	30.0
Do not know	*f*	45	99	26	6	8	184
	%	37.8	30.2	18.1	16.7	23.5	27.8
	N	119	328	144	36	34	661
	%	100	100	100	100	100	100
Double glazing		*CR1_H*	*CR2_H*	*CR3_H*	*CR4_H*	*CR5_H*	*N*
Yes	*f*	71	235	110	23	20	459
	%	60.7	72.8	76.9	65.7	58.8	70.4
No	*f*	31	56	28	9	10	134
	%	26.5	17.3	19.6	25.7	29.4	20.6
Do not know	*f*	15	32	5	3	4	59
	%	12.8	9.9	3.5	8.6	11.8	9.0
	N	117	323	143	35	34	652
	%	100	100	100	100	100	100
Enclosed balcony		*CR1_H*	*CR2_H*	*CR3_H*	*CR4_H*	*CR5_H*	*N*
Yes	*f*	27	94	62	17	10	210
	%	22.7	28.7	43.1	47.2	29.4	31.8
No	*f*	81	204	73	18	16	392
	%	68.1	62.2	50.7	50.0	47.1	59.3
No balcony	*f*	11	30	9	1	8	59
	%	9.2	9.1	6.3	2.8	23.5	8.9
	N	119	328	144	36	34	661
	%	100	100	100	100	100	100

Other than the thermo-physical properties of the family homes, the thermal problems related to physical and environmental conditions of dormitory rooms and family homes were asked. Regarding the plan type of dormitory, the rooms mostly share the interior walls and the exterior surfaces are quite small. Moreover, as shoes would prevent contact with the floor surface there were no options of complaints about the cold or damp surfaces of floor for dormitory rooms. That conditions for wall and floor surfaces were only desired for the family home. Furthermore, unlike the residences, the problem of infiltration was questioned for only the dorm building due to using the placement of the window-side desk and beds mostly. Almost 43% of respondents had no complaints about their family homes, while its ratio decreased to 33% for dormitory rooms (Table 4.18). Moreover, in almost all regions, the most common complaint with mean rates of 25% and 37% for both family home and dormitory rooms was the inability to ventilate living spaces due to cold weather. The secondary common problem for family homes was stated as cold interior air, cold wall surface, and cold floor surface in living spaces with mean rates of 19%, 22%, and 20% respectively. On the contrary, in dormitory rooms, the secondary problem was stated as the poor daylight level with a mean rate of 30%.

Table 4.18 Problems related to physical and environmental conditions of dormitory room and family home

Home		CR1_H	CR2_H	CR3_H	CR4_H	CR5_H	Total	N
Cold room	*%*	23.68%	16.50%	18.60%	21.21%	16.13%	18.54%	604
Humid room	*%*	7.89%	5.72%	0.78%	3.03%	6.45%	4.97%	604
Poor daylight level	*%*	5.26%	6.40%	13.18%	12.12%	19.35%	8.61%	604
Air pollution (ACH)	*%*	10.53%	14.48%	10.08%	9.09%	6.45%	12.09%	604
Cold weather(ACH)	*%*	20.18%	24.24%	27.91%	27.27%	41.94%	25.33%	604
Cold wall surf.	*%*	19.30%	23.91%	18.60%	24.24%	22.58%	21.85%	604
Humid wall surf	*%*	8.77%	12.12%	10.85%	9.09%	16.13%	11.26%	604
Cold floor surf	*%*	18.42%	20.88%	17.83%	18.18%	22.58%	19.70%	604
No problem	*%*	42.98%	42.76%	42.64%	45.45%	38.71%	42.72%	604
Dormitory		CR1_H	CR2_H	CR3_H	CR4_H	CR5_H	Total	N
Cold room	*%*	18.37%	4.50%	8.65%	6.56%	14.86%	9.48%	675
Humid room	*%*	5.44%	5.19%	3.85%	6.56%	12.16%	5.93%	675
Poor daylight level	*%*	41.50%	30.80%	31.73%	9.84%	21.62%	30.37%	675
Air pollution (ACH)	*%*	21.77%	12.11%	7.69%	11.48%	22.97%	14.67%	675
Cold weather (ACH)	*%*	53.06%	32.53%	40.38%	19.67%	37.33%	37.57%	676
Cold air infiltr	*%*	18.37%	7.61%	20.19%	13.11%	28.00%	14.64%	676
No problem	*%*	17.69%	35.99%	31.73%	52.46%	34.67%	32.69%	676

In order to see the heating energy usage habits, the respondents were asked about their tendencies to turn on the heating systems for all day or partially at different times of the day in each room of their home. Table 4.19 shows the percentage comparison of the heating regime tendencies of the households according to the climate regions. While the tendency for all-day heating towards cold climate regions (CR1 to CR5) was expected to increase, a decrease was observed in the CR4 and CR5 regions due to use density of the stove as the heating system. In other words, depending on the heating system, the intermittent heating regime in the 1st and 5th regions was preferred more than the other regions.

Table 4.19 Heating energy use habits of the respondents

Family Home Heating Periods		CR1_H	CR2_H	CR3_H	CR4_H	CR5_H	Total
All day Heating	%	55.6%	73.4%	80.0%	72.2%	68.8%	72.5%
Partially Heating	%	44.4%	26.7%	20.0%	27.8%	31.3%	27.5%

When the rates on the basis of rooms were analyzed (Table 4.20), the heating need for the whole day was high for the living room in all regions, while this rate decreased towards the warmer regions, as expected. In addition to the climatic effect, the rates showed that the heating system had an impact on increasing the use of an all-day heating regime for the other rooms in the 3rd and 4th zones.

Table 4.20 The rates of heating periods regime for the rooms of the family home

Rooms Heating Periods /All day		Living Room	Salon	Bed Room	Kitchen	Guest Room	Child Room	Study Room
CR1_H	All day%	53.6%	33.0 %	25.0%	27.7%	20.5%	25.9%	20.5%
	Partialy %	46.4%	67.0 %	75.0%	72.3%	79.5%	74.1%	79.5%
CR2_H	All day%	71.0%	46.5 %	46.5%	48.1%	31.6%	44.8%	30.0%
	Partialy %	29.0%	53.5 %	53.5%	51.9%	68.4%	55.2%	70.0%
CR3_H	All day%	74.3%	53.6 %	64.3%	67.1%	45.7%	61.4%	45.7%
	Partialy %	25.7%	46.4 %	35.7%	32.9%	54.3%	38.6%	54.3%
CR4_H	All day%	88.2%	64.7 %	64.7%	67.6%	52.9%	58.8%	44.1%
	Partialy %	11.8%	35.3 %	35.3%	32.4%	47.1%	41.2%	55.9%
CR5_H	All day%	80.0%	56.7 %	40.0%	60.0%	40.0%	50.0%	43.3%
	Partialy %	20.0%	43.3 %	60.0%	40.0%	60.0%	50.0%	56.7%

Besides climatic factors, varied heating systems, thermo physical features of houses and occupant behaviors cause the annual heating bill to differ in each region as shown in Table 4.21. In particular, more than 35% of the respondents living in the 5th region, where the stove usage was over 50%, stated that they did not know their billing information. In other regions, more than 25% stated that they paid bills between 1001-2000 TL (286$ -571$). The rate of those paying more than 2000 TL, on the other hand, increased from 6% to 19% towards colder climate regions. Although the annual heating bill showed regional differences, more than 70% of the participants, similarly in all climate regions, stated the range of 51-150 TL (15$ -43$) for the monthly electricity bill.

Table 4.21 Data on monthly and annual utility expenses

Annual Bill/Heating		*CR1_H*	*CR2_H*	*CR3_H*	*CR4_H*	*CR5_H*	*N*
<500 TL	f	19	48	20	3	4	94
	%	16.0	14.7	17.5	8.6	12.5	15.0
501-1000 TL	f	29	71	26	6	6	138
	%	24.4	21.7	22.8	17.1	18.8	22.0
1001-2000 TL	f	29	85	40	12	4	170
	%	24.4	26.0	35.1	34.3	12.5	27.1
>2001	f	7	32	20	5	6	70
	%	5.9	9.8	17.5	14.3	18.8	11.2
Do not Know	f	35	91	38	9	12	185
	%	29.4	27.8	33.3	25.7	37.5	29.5
	N	119	327	114	35	32	627
	%	100	100	100	100	100	100
Monthly Bill/Electricity		*CR1_H*	*CR2_H*	*CR3_H*	*CR4_H*	*CR5_H*	*N*
<50 TL	*f*	1	21	5	0	0	27
	%	0.8	6.4	3.4	0.0	0.0	4.1
51-100 TL	*f*	48	135	72	17	14	286
	%	40.7	41.2	49.7	47.2	43.8	43.4
101-150 TL	*f*	45	89	37	13	9	193
	%	38.1	27.1	25.5	36.1	28.1	29.3
>150	*f*	15	32	9	5	2	63
	%	12.7	9.8	6.2	13.9	6.3	9.6
Do not Know	*f*	9	51	22	1	7	90
	%	7.6	15.5	15.2	2.8	21.9	13.7
	N	118	328	145	36	32	659
	%	100	100	100	100	100	100

In order to understand respondents' awareness on the importance of energy consumption in daily life, They were asked to indicate the frequency of behaviors between always and never for each statement. Table 4.22 shows that the behaviors in which the respondents defined "always", similarly in each region, were as follows, turning off unused lamps, unplugging unused electrical appliances, and operating washing machines and dishwashers when they are fully loaded. The rate of turning off the lights at “always” frequency was stated as the most common behavior in comparison to the others (Figure 4.6). Behaviors that were highly stated as "never" were turning the heating down or off when the home was unoccupied or during sleep time in cold climate regions, and increasing the heating during sleep time in all climate regions except 5th one. Although it did not affect the thermal comfort of the respondents, the Mode was taken as the central tendency value for checking the energy label behavior, which was always and often with a total of 50% for all regions. The rest of the 30% responded as rarely and never. The highest rate of "always" answers were given by the participants from climate zone 1, as 30%. Figure 4.6 presents the comparative rate of energy use behavior of respondents in their daily life regardless of climate region division.

Table 4.22 Rate of behavior relating to energy use habits

			CR1_H	*CR2_H*	*CR3_H*	*CR4_H*	*CR5_H*
Off HS/unocc.	*CR1_H*	*Mod*	Always	Always	Never	Never	Never
Down HS/unocc.	*CR1_H*	*Mod*	Often	Often	Often	Often	Sometimes
Down HS/night	*CR1_H*	*Mod*	Often	Often	Never	Never	Never
Up HS/night	*CR1_H*	*Mod*	Never	Never	Never	Never	Sometimes
Light off	*CR1_H*	*Mod*	Always	Always	Always	Always	Always
Unplug	*CR1_H*	*Mod*	Always	Always	Always	Always	Always
Full WM	*CR1_H*	*Mod*	Always	Always	Always	Always	Always
Energy Label	*CR1_H*	*Mod*	Often	Always	Always	Always	Often

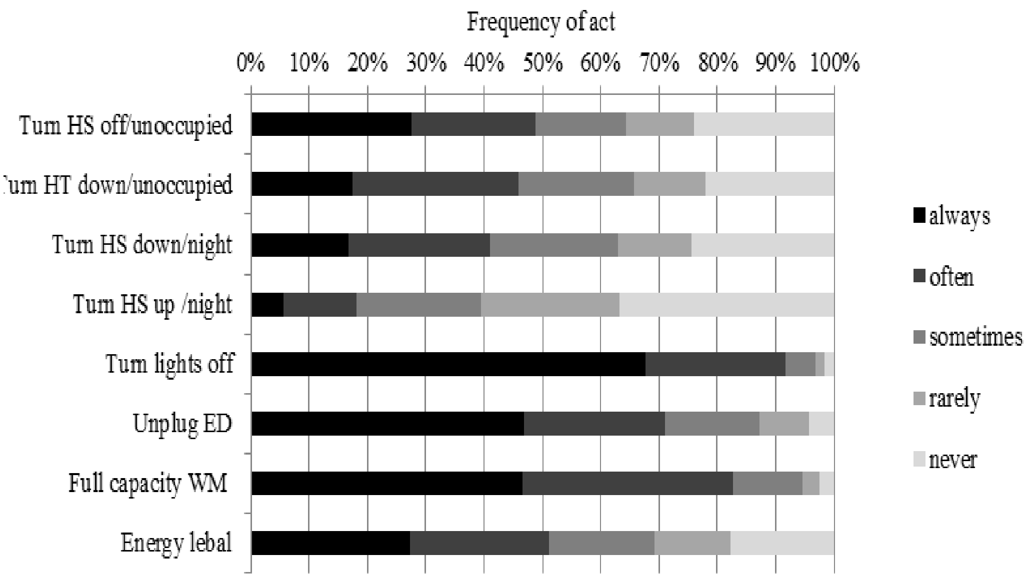


Figure 4.6 Comparative rate of activities which were accepted as respondents habits in their daily life.

4.1.2 Self report survey data

A total of 300 questionnaires were filled by dormitory residents in the four cities. This study was not carried out in the 3rd climate region, since the respondents of the 4 dormitories accepted the placement of the devices in the rooms in order to log the environmental and behavioral data and the self-report survey. However, since the residents of the dormitories located in the 1st, 2nd, 4th, and 5th climate regions represent all climate regions in terms of both the city they were born in and the city they live in, the data was obtained for the 3rd climate region as shown in the Table 4.23. In terms of numbers, the highest participation occurred from among those living in the 2nd region.

Table 4.23 The number of samples represented the climate regions

Represent CR House		*CR1_D*	*CR2_D*	*CR3_D*	*CR4_D*	*CR5_D*	*Total*
CR1_H	*f*	3	37	-	1	8	49
CR2_H	*f*	9	94	-	11	24	138
CR3_H	*f*	3	31	-	14	18	66
CR4_H	*f*	-	5	-	12	4	21
CR5_H	*f*	1	-	-	1	26	28
Total	*F*	16	167	-	39	80	302
Represent CR Birth		*CR1_D*	*CR2_D*	*CR3_D*	*CR4_D*	*CR5_D*	*Total*
CR1_B	*f*	3	28	-	-	6	37
CR2_B	*f*	6	95	-	11	15	127
CR3_B	*f*	4	34	-	9	20	67
CR4_B	*f*	-	6	-	17	3	26
CR5_B	*f*	3	-	-	1	34	38
Total	*F*	16	163	-	38	78	295

4.1.2.1 Thermal comfort

Thermal comfort was investigated as a function of four thermal environmental parameters, along with activity and clothing level: air temperature, humidity, average radiant temperature, air velocity. Since the instantaneous average radiation temperature measured in the rooms at certain time intervals was similar to the inside air temperature, the continuous recording was not taken. And it was accepted as the same as the recorded inside temperature. Due to the heating period of the study, natural ventilation was out of the question. And therefore, it was assumed that the work was done in steady state conditions. Thus, the air velocity was taken as a constant. For the inside air temperature and humidity, 5-minute records were taken during the daily questionnaires. The results of recordings are given under the title of “Recorded Data on Environmental and Behavioral”. For the measurement of metabolic rate, the respondents were asked to indicate which activity they did in the last 15 minutes before starting the survey, by choosing the activity from the given options; which ranged from relaxing to high activity. The mode statistic of activity level showed that the majority of occupants were in in a relaxed or standing position just before filling out the questionnaire (Table 4.24). At the same time, they were asked to indicate the combination of the clothes they wear by combining the clothes alternatives given in the table. Clothing insulation values (clo) ranged between 0.36 (shorts, T-shirt) to 0.92 (pijama/tights, T-shirt and long sleeve thick sweater) as shown in the Table 4.24. The mode value of insulation (clo) for all CR was 0.57 clo (pijama/tights and T-shirt). In CR1, CR3, CR4 and CR5, participants preferred to wear clothing of similar thickness close to the overall mode value, while in CR2 thicker clothing (pijama/ tights and long sleeve T-shirt) was preferred.

Table 4.24 Metabolic rate and clothing insulation values with the indoor environment indices

Metabolic rate W/m2	*CR1_H*	*CR2_H*	*CR3_H*	*CR4_H*	*CR5_H*	*N*
Minimum	45	45	45	45	45	305
Maximum	175	175	175	175	175	
Mode	70	70	70	70	45	
Clothing Insulation Clo	*CR1_H*	*CR2_H*	*CR3_H*	*CR4_H*	*CR5_H*	*N*
Minimum	0.36	0.36	0,36	0.36	0.54	308
Maximum	0.92	0.92	0,92	0.92	0.92	
Mode	0.57	0.61	0,57	0.57	0,57	
Indoor indices	*CR1_D*	*CR2_D*	*CR3_D*	*CR4_D*	*CR5_D*	*Total*
Indoor Teperature Mean	24 °C	26 °C	-	25 °C	27 °C	26 °C
Indoor Humidity Mean	46 %	37 %	-	37 %	30 %	38 %

In addition to data on thermal comfort factors, building occupants were asked to evaluate their thermal comfort. Respondents were asked, “how they felt thermally”, “whether the room was comfortable”, and “how they preferred the room to be thermally: cooler or warmer”. The thermal sensation votes ranged from -2 (cool) to +3 (Hot), when the mean air temperature and humidity were ranged 24 °C to 27 °C and 30% to 46% RH respectively. Almost 75% of respondents voted, while the average temperature was 26 °C and the average humidity was 38%, that their dormitory rooms were warm, and only 15% felt neutral (Table 4.25). On the other hand the respondents agreed that the warmth they felt was comfortable and preferred that no change should be made, whether it was warmer or colder (Table 4.26). When 15% of respondents felt thermally neutral, all variables such as average humidity values of dormitory rooms along with the mode values of clothing insulation respondents wear, and their activity level were similar excluding the indoor temperature (Table 4.27).

Table 4.25 Thermal sensation vote on a 7-point scale; percentage results for dormitory occupants in the five climate regions

Thermal Sense		*CR1_H*	*CR2_H*	*CR3_H*	*CR4_H*	*CR5_H*	*TOTAL*
-3		0%	0%	0%	0%	0%	*0%*
-2		2%	1%	3%	0%	4%	2%
-1		4%	10%	8%	5%	7%	8%
0		20%	17%	9%	19%	7%	15%
1		29%	28%	27%	33%	11%	26%
2		33%	36%	44%	38%	61%	40%
3		12%	9%	9%	5%	11%	9%
	Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
N	308						

Table 4.26 Thermal acceptance and preference vote percentage results for climate regions

Thermal Acceptance		*CR1_H*	*CR2_H*	*CR3_H*	*CR4_H*	*CR5_H*
Comfortable	%	90	87	82	100	93
Uncomfortable	%	10	13	18	0	7
	Total	100	100	100	100	100
Thermal Preference		*CR1_H*	*CR2_H*	*CR3_H*	*CR4_H*	*CR5_H*
To be warmer	%	10	9	11	0	11
In comfort	%	78	67	67	100	82
To be cooler	%	12	23	23	0	18
	Total	100	100	100	100	100

Table 4.27 The mean and mode values of thermal environmental parameters along with activity and clothing level when respondents felt neutral thermally

Thermal Sense Neutral	*CR1_D*	*CR2_D*	*CR3_D*	*CR4_D*	*CR5_D*
Indoor Temperature Mean	24 °C	26 °C	-	25 °C	27 °C
Indoor Humidity Mean	46 %	37 %	-	37 %	30 %
Clo Insulation Mod	0.57	0.61	-	0.57	0.57
Metabolic Rate MET Mod	1.2	1.2	-	1.2	1.8

4.1.2.2 PMV calculations and evaluations

In order to compare respondents' thermal votes, the PMV calculation was made via The Center for the Built Environment (CBE) Thermal Comfort Tool which is a free online tool developed by the University of California Berkeley (https://comfort.cbe.berkeley.edu). It is based on the ASHRAE 55–2017, ISO 7730:2005 and EN 16798–1:2019 Standards. ASHRAE 55–2017 was selected for calculation and visualizations. The input data were the mean and mode values of the data for each climate region listed in Table 4.24. According to the results, PMV was in the range of 0.5 < PMV < +0.5 and respondents were expected to feel neutral for the 4 climate regions as shown in Figure 4.7 although they rated the rooms as warm.

The design of the heating systems installed in order to meet the heat requirements of the buildings is planned according to the indoor temperatures specified in the TS 2164 standard in Turkey (Appendix O). TS 2164 (https://intweb.tse.org.tr) is a Turkish standard defined as Principles for the preparation of the projects of the central heating systems. According to the standard, interior temperature of a living room in a house should be around 22 C. PMV analyses by online tool was run again using 22 C for indoor temperature, 50% for humidity, and observed values for met and clo (Figure 4.8). On the other hand, in second graph, indoor

	CR1_D	CR2_D	CR4_D	CR5_D
Compliance	✓	✓	✓	✓
PMV with elevated air speed	-0.36	0.12	-0.15	0.40
PPD with elevated air speed	8 %	5 %	5 %	8 %
Sensation	Neutral	Neutral	Neutral	Neutral
SET	23.8 °C	25.6 °C	24.5 °C	26.9 °C
Dry-bulb temp at still air	23.1 °C	25.3 °C	24.0 °C	23.3 °C

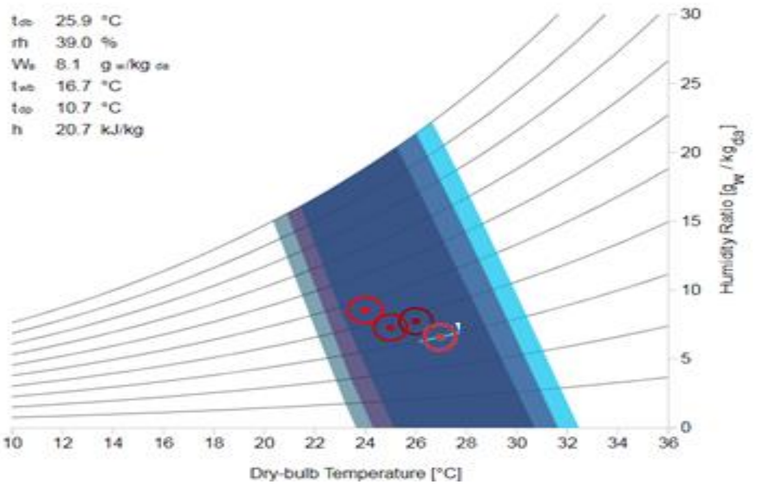


Figure 4.7 Comperative graph of thermal condition for 4 climate regions where self-report carried out.

temperature and humidity and met value was accepted similar but Clo value increased to 1 Clo which is the thermal insulation value for winter clothes. When ın the first graph thermal sense out of comfort band, in the second graph it is in comfort. Results confirm that if the heating period of the indoor temperature values is set at the accepted standards, the user can adjust the thermal comfort by wearing thicker clothes. That means in range 2C-5C the indoor temperature should be decreased. it is stated that an extra 7% of energy is consumed for each degree of temperature increase. (https://www.iea.org/topics/saving-energy) This increased rate mentioned in the sources was similar to the calculations made by changing only the internal temperature values on the example used in the TS 825 annual energy need calculation method. In the example of TS 825, the heating energy

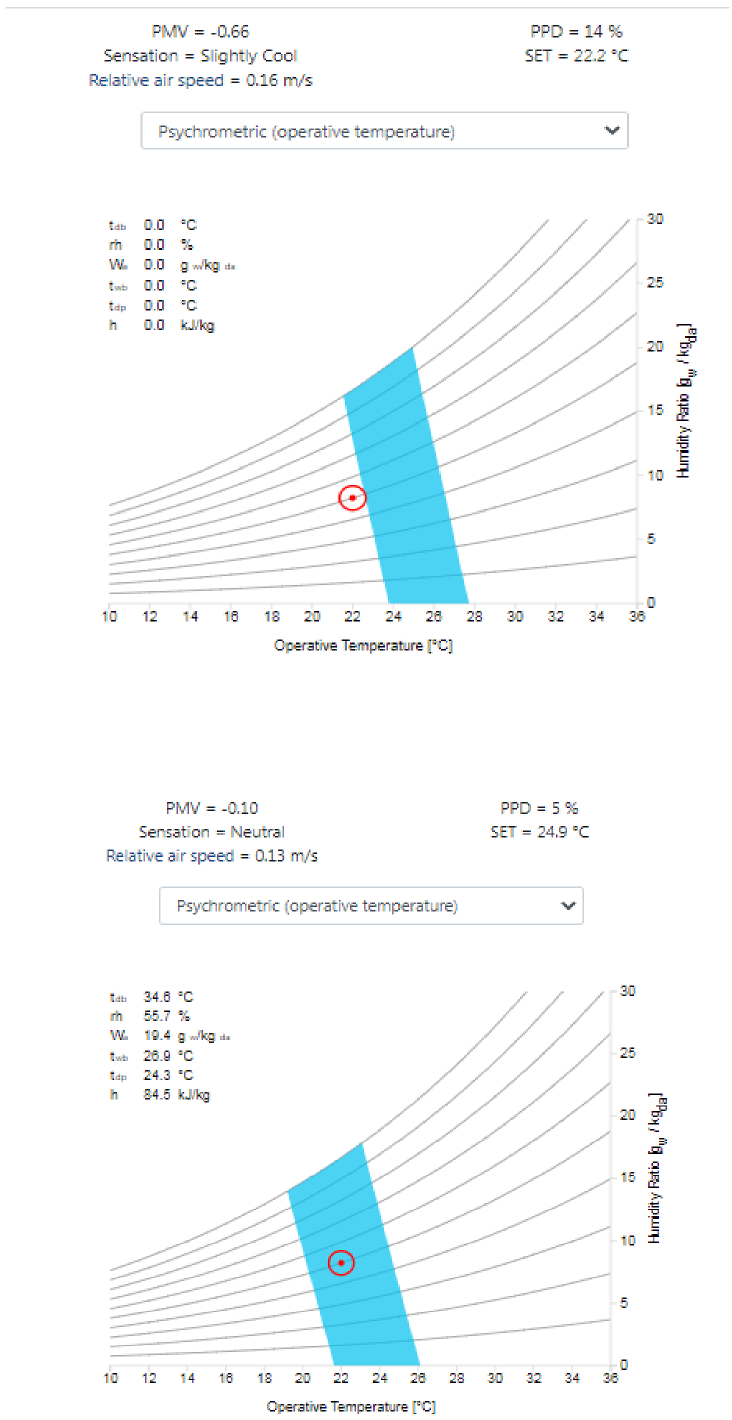


Figure 4.8 Graph of PMV a) 22 C for indoor temperature, 50% for humidity, and observed values for met and clo b) 22 C for indoor temperature, 50% for humidity, 1 Clo for the thermal insulation value for winter clothes

required for a 2-storey masonry building with a floor area of 90 m2 in the 3rd climate zone to be 19 C in January is 11,284,510 kJ, or 3160 kWh. However, when the indoor temperature accepted in this calculation was increased from 19 C to 22 C, and recalculated, a 17% increase in the heating energy need monthly occurred just because of the increase of 3 degrees.

All data of each comfort parameters of every survey was entered into the tool to calculate the trend of change of the PMV results. As shown in the Figure 4.9, the only correlation of PMV to temperature was satisfactory, with R^2=0.8108 which means that it was affected by the room temperature variations.

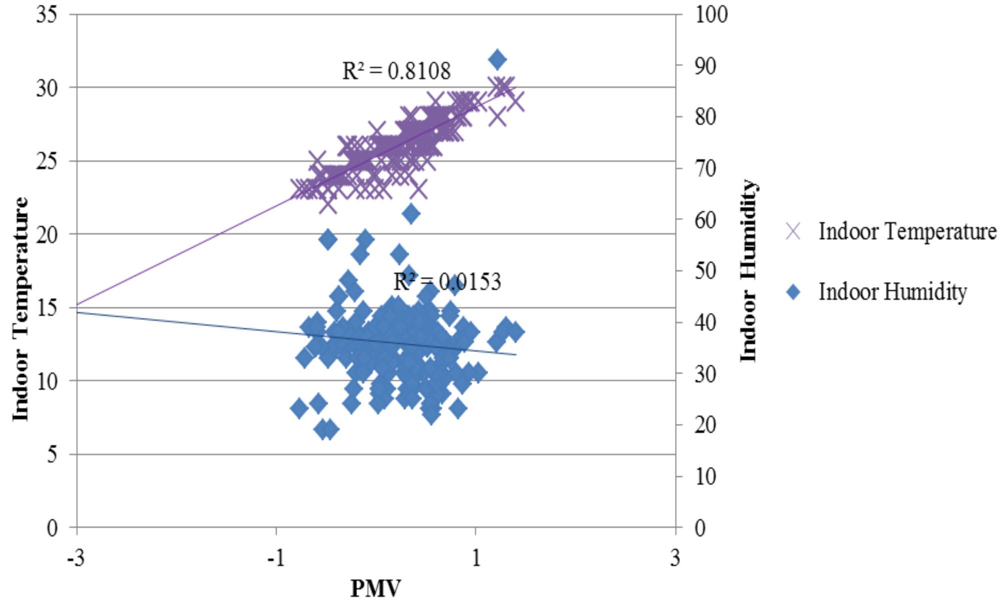


Figure 4.9 Metabolic rate, clothing insultion value and PMV against the indoor temperature

4.2 Empirical data on environmental condition and occupant behavior

Both the environmental parameters such as indoor and outdoor air temperature, relative humidity and CO2 concentration with the 5 minutes intervals and behavioral data such as open/close window and occupancy state with the one minute intervals were recorded during the self-report survey. The recorded environmental and behavioral data by the data loggers, that were introduced in material and method section, are presented in Appendix P via the comparative graphs. The recordings show that Kars had the coldest outdoor air temperature while Istanbul had the hottest temperature during the monitoring dates. Whereas, outdoor humidity of the cities had similar fluctuations. Table 4.28 gives the mean, standard deviation, minimum and maximum values of each environmental parameters recorded in the rooms. Indoor temperature ranged from 15 °C to 29 °C, relative humidity was within 14%-55%. CO2 concentration was fluctuated from 142 to 4309 ppm, due to the window open/close actions and occupancy state in a day.

Table 4.28 The Mean, standard deviation, minimum and maximum values of indoor and outdoor temperature and humidity values recorded in dormitory rooms

Indoor/Outdoor Temperature C		*CR1_D*	*CR2_D*	*CR3_D*	*CR4_D*	*CR5_D*
Tin	*Min*	19	24	-	19	15
	Max	25	29	-	27	28
	Mean	23	27	-	26	26
	Sd	0.60	1.04	-	0.77	0.92
Tout	*Min*	-5 C	4	-	-4	-7
	Max	13 C	18		12	17
	Mean	2 C	11	-	3	5
	Sd	3.67	3.30	-	3.44	5.42
Indoor/Outdoor Humidity		*CR1_D*	*CR2_D*	*CR3_D*	*CR4_D*	*CR5_D*
Hin	*Min*	34	29	-	26	14
	Max	55	44	-	54	45
	Mean	46	36	-	40	28
	Sd	3.22	3.20	-	4.01	5.63
Hout	*Min*	40	51	-	32	13
	Max	95	90		100	100
	Mean	70	72	-	75	46
	Sd	14.24	10.92	-	19.76	20.45
Indoor/Outdoor CO2		*CR1_D*	*CR2_D*	*CR3_D*	*CR4_D*	*CR5_D*
CO2 int	*Min*	1011	197	-	177	142
	Max	4309	1170	-	2033	1630
	Mean	617	513	-	792	553
	Sd	820.30	162.7	-	328.295	272

In order to record the open/close state of windows' and the occupants' presence the data loggers were configured to record at 1-minute intervals. The Figure 4.10 showed the occupancy rate at times of the day as a percentage. The value of 100% meant that the room was occupied. The timeout value for the occupancy sensor was set to 15 minutes that was the max amount of time the logger allowed to set that was the time to wait with no motion detected before it records that the room was 0% occupied, which means unoccupied. Especially at about 8 hours of sleep time, the occupancy rate was recorded as 0% due to the timeout configuration.

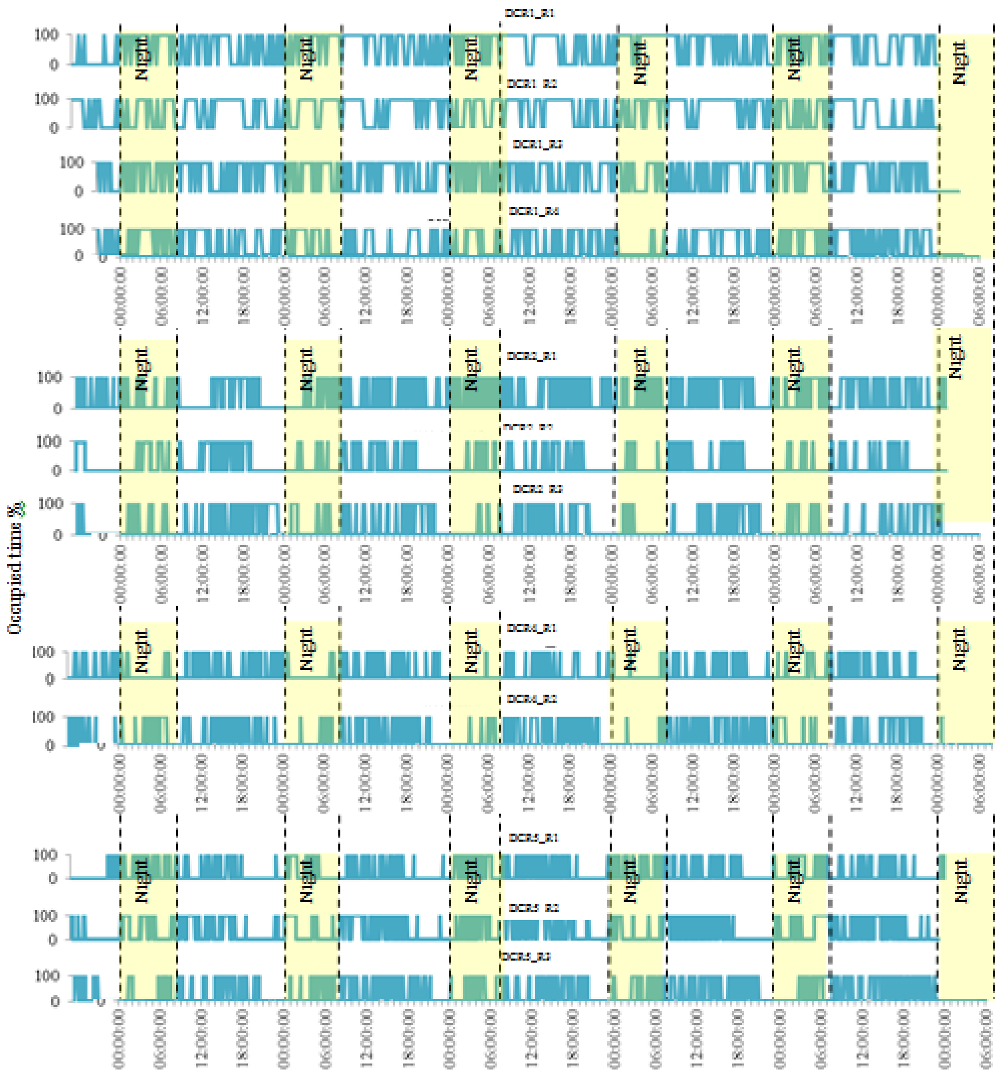


Figure 4.10 Occupied time of 5 days period

However, the increase in CO_2 records at night hours proved that the room was occupied as shown in Appendix P. The records showed that the rooms with more than two people were occupied all day but with the small unoccupied time fluctuations, while the rooms with two people were unoccupied during different time intervals in a day but with similar trends in a weekday. The fluctuations were between the hours 08:00 to 12:00 and 13:00 to 18:00 as shown in the Figure 4.10.

4.3 Data analyses

Statistical analyses were carried out to determine relationships between important variables and variances between data sets belonging to different variables, such as CR of the homes, birthplace or dormitory. Hypotheses presented in chapter 3 were also tested and the results are presented in the following pages.

4.3.1 Socio-economic attributes of occupants and climate regions

Although the descriptive tables in section 4.1.1.2 provided general information about family structures in the context of socio-economic data, in this section it was aimed to draw inferences about the associations between the variables listed in Table 4.29 and the five climate regions. The null hypothesis of H01 was defined as having no relationship among socio-economic attributes of occupants from different climate regions in Turkey. However according to house type and number of family member, there were regional relationship, while for the association between income, ownership, dependents persons and size of house (m^2) variables and climatic regions H01 was accepted.

Table 4.29 The results of the null hypothesis of H01 and the variables

H01: There were no any relationship amongis no difference between the socio-economic attributes of occupants from different climate regions in Turkey.					
Category	Variables	Category	Test	P value	Result
Socio-economic	Income	CRs_H	Chi-square	.15	H01 accepted
Socio-economic	Housetype	CRs_H	Chi-square	<.001	H01 rejected
Socio-economic	No of family members	CRs_H	Anova	<.001	H01 rejected
Socio-economic	Ownership	CRs_H	Chi-square	.95	H01 accepted
Socio-economic	Dependent person	CRs_H	Chi-square	.24	H01 accepted
Socio-economic	M2	CRs_H	Chi-square	.21	H01 accepted

Although the housing size and home ownership rates did not show significant regional differences, there occurred a relationship between the climatic regions of the housing typology. Unlike other regions, the rate of single-family house type in the 5th CR was higher than in other regions. In all other CRs, the rate of apartment-type housing was the highest. Another variable that differed significantly between climatic regions was the number of family members. From the 1st climate region to the 5th climate region, the average number of individuals increases from less than 4 to more than 6 (Figure 4.11).

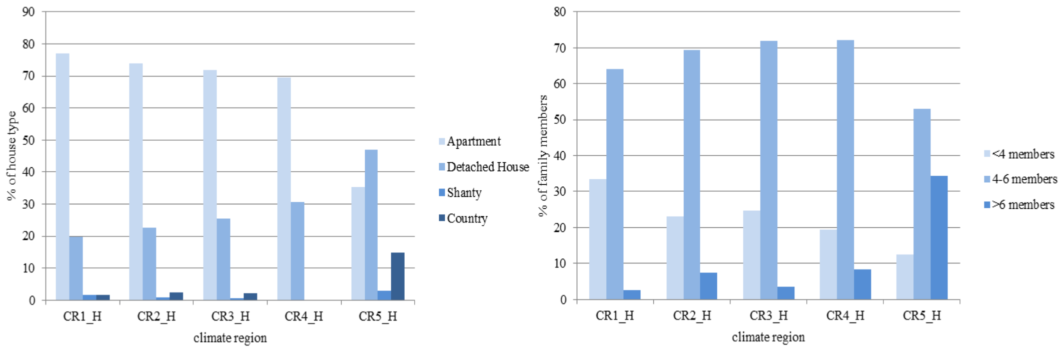


Figure 4.11 Relation of house type (a) and number of family members (b) variables with climate regions.

4.3.2 Thermal comfort of occupants and climate Regions

The thermal sense of the respondents for the thermal conditions of the dormitory building were evaluated in the previous section with the PMV study by grouping them according to the climatic regions they lived in. Under this title, whether there was a significant difference between thermal perception, thermal acceptance and thermal preferences and if there were then the reasons were examined. Since the relationship of thermal comfort with socio-economic and thermal adaptation variables of respondents grouped according to climate zones was examined, the answers given for the dormitory rooms as the thermal environment was included in this part. In this way, not people only from different socio-economic profiles or climatic regions, but who have also similar socio-economic profiles but live in different climatic regions, could be evaluated under similar thermal conditions.

In order to draw inferences about the associations between the variables of occupants' thermal comfort and five climate regions, the null hypothesis of H02 was defined as there were no differences among thermal comfort preferences of users from different climate regions in Turkey (Table 4.30). Respondents whose family homes were located in a hot climate and lived in a dormitory located in a cold climate, or vice versa, were found to have different thermal satisfaction on dormitory rooms, which led to a rejection of the H02 (Figure 4.12). However, the relationship between thermal sensation vote of respondents and climate regions were not found. There were only occurred the linear impact of the indoor temperature to the thermal sensation vote of the respondents (Figure 4.9).

In both graphs below, assuming that the climate conditions get colder from 1 to 5, the thermal satisfaction decreased as the climatic difference between the region where the respondents lived and the region where they were educated increased. This direction was the same in both directions from hot to cold or cold to hot.

Table 4.30 The results of the null hypothesis of H02 and the variables

H02: There were no differences among thermal comfort preferences of users from different climate regions in Turkey					
Category	Variables	Category	Test	P value	Result
Thermal Behaviors	Thermal satisfaction	Cold to Hot CRS	Chi-square	.01	H02 rejected
Thermal Behaviors	Thermal satisfaction	Hot to Cold CRs	Chi-square	.001	H02 rejected
Thermal Behaviors	Thermal sense vote	CRs_H	Chi-square	.65	H02 accepted
Thermal Behaviors	Thermal sense vote	Tint	ANOVA	.73	H02 accepted
Thermal Behaviors	Thermal sense vote	Hint	ANOVA	.56	H02 accepted
Thermal Behaviors	Thermal sense vote	Tout	ANOVA	.01	H02 rejected

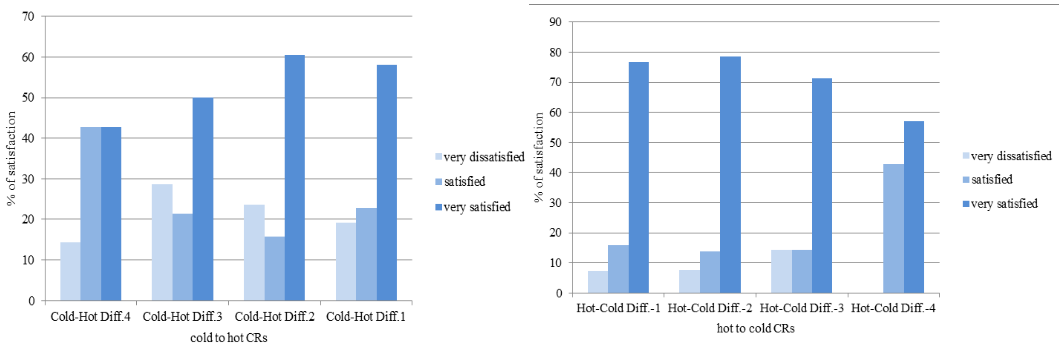


Figure 4.12 Relation between satisfaction state in transition from cold climate to warm climate (a) from warm climate to cold climate (b)

4.3.3 Adaptive behaviors and climate regions

The frequency of adaptive behavior (Figure 4.3 & Figure 4.4) revealed that the most often preferred behavior was to wear thicker or light clothing. The null hyphothesis of H03 was set on clothing choice behavior and defined as there were no differences among occupant's adaptive bahaviour to prevailing conditions of different climatic regions of Turkey (Table 4.31). Paired t-test was conducted to determine whether there is any difference in the clothing preferences of the participants due to the climate transition from hot to cold or cold to hot during the moving from the city where they lived to the city where they were educated. In

Table 4.31 The results of the null hypothesis of H03 and the variables

H03: There were no differences among occupant's adaptive bahaviour to prevailing conditions of different climatic regions of Turkey.					
Category	Variables	Category	Test	P value	Result
Adaptive Behaviors	Clothing choice	CRs_H	Anova	.11	H03 acccepted
Adaptive Behaviors	Clothing choice	CRs_D	Anova	<.001	H03 rejected
Adaptive Behaviors	Clothing choice	Hot to cold CRs (-4)	Paired t-test	.02	H03 rejected
Adaptive Behaviors	Clothing choice	Hot to cold CRs (-3)	Paired t-test	.01	H03 rejected
Adaptive Behaviors	Clothing choice	Hot to cold CRs (-2)	Paired t-test	<.001	H03 rejected
Adaptive Behaviors	Clothing choice	Cold to hot CRs (1)	Paired t-test	<.001	H03 rejected
Adaptive Behaviors	Clothing choice	Cold to hot CRs (2)	Paired t-test	.60	H03 accepted
Adaptive Behaviors	Clothing choice	Cold to hot CRs (3)	Paired t-test	.63	H03 accepted
Adaptive Behaviors	Clothing choice	Cold to hot CRs (4)	Paired t-test	.66	H03 accepted

other words, -4 indicates the transition from the warm climate zone to the cold climate zone, and 4 indicates the transition from the cold to the warm. The null hypothesis for -4, -3, -2, and 1 was rejected. Namely, the transition from a hot to a cold climate region influenced the respondents to adapt to the prevalent indoor condition by changing clothes.

The graph (Figure 13) shows the clothing change behavior comperatively. Mean values of Clo were measured according to transition regions (Table 4.32). There are 3 different clo value curves in the graph. The first one belongs to the clothes that the users prefer in the residences and the second one belongs in the dormitories. The third one shows the difference in clothing preference in the transition from the residential area to the dormitory area. The x-axis shows the regional variation range from -4 to 4. While thicker clothes were preferred in residential areas, thinner clothes were preferred in dormitory areas. High internal temperatures trigger the respondents to choose thinner clothing. But this adaptive behaviour was decreased from cold to warm climate region.

Table 4.32 Mean values of clothing insulation (clo) respondents preferred to wear

	-4	-3	-2	-1	0	1	2	3	4
mean Clodiff.	0.15	0.1	0.1	0.08	0.08	0.04	0.02	-0.03	0.02
mean Clodorm	0.5	0.5	0.5	0.56	0.57	0.62	0.63	0.66	0.76
Mean Clohouse	0.65	0.6	0.6	0.64	0.65	0.66	0.65	0.63	0.78

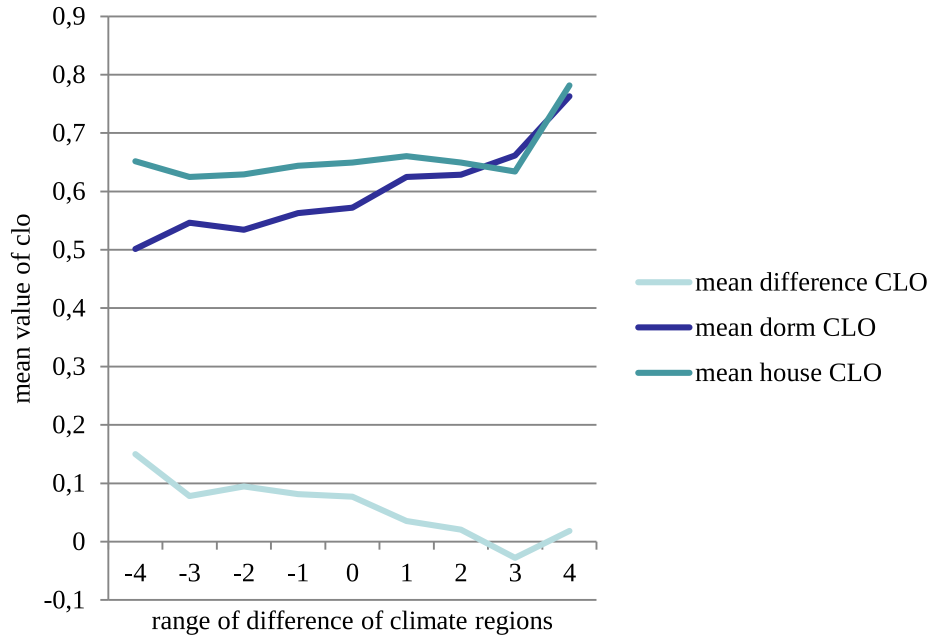


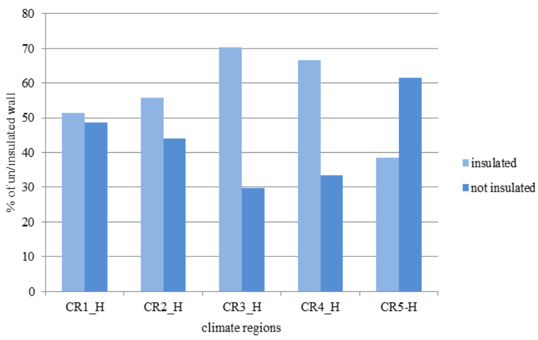
Figure 4.13 Mean value of Clo according to range of difference of climate regions

4.3.4 Thermo-physical characteristics of residential buildings and climate regions

In order to determine whether the variables considered as thermo-physical characteristics of residential buildings differed between 30% and 70% regionally was significant or not, the null hypothesis of H04 was defined as having no thermo-physical differences among the family houses located in different climate regions in Turkey (Table 4.33). Since the responses regarding the living space facade orientation and double glazing of windows were similar for each region as shown in Table 4.6, there was no significant regional difference in the penetration of sunlight into the living rooms and double glazing of the family homes and thus H04 was accepted. On the other hand, the percentage of wall insulation and enclosed balconies increased in cold climate regions. Contrary to the results, wall insulation of family homes in the 5th climate region had the lowest rate than in other regions. The 3rd and 4th CR family houses had the highest ratio for both thermo-physical applications (Figure 4.14).The results showed significant regional differences by rejecting H05.

Table 4.33 The results of the null hypothesis of H04 and the variables

H04: There were no thermo-physical differences among the family houses located in different climate regions in Turkey					
Category	Variables	Category	Test	P value	Result
Thermal Characteristics	Sun orientation of living room	CRs_H	Chi-square	.24	H04 accepted
Thermal Characteristics	Wall Insulation	CRs_H	Chi-square	.007	H04 rejected
Thermal Characteristics	Double Glazing	CRs_H	Chi-square	.08	H04 accepted
Thermal Characteristics	Closed Balcony	CRs_H	Chi-square	.003	H04 rejected



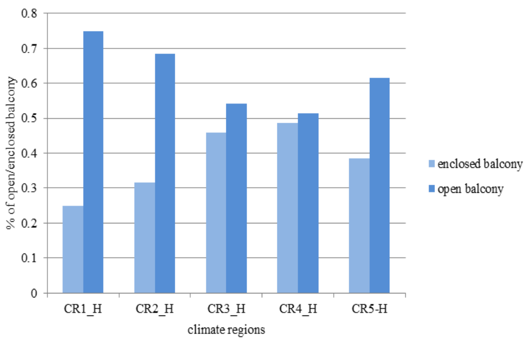


Figure 4.14 Relation of insulated wall (a) and enclosed balcony (b) variables with climate regions.

4.3.5 Energy use behaviors of occupants and climate regions

Considering the regional differences in the relationship between energy use and user behavior, which depends on many variables, null hypotheses were established on three main factors, which were utility bills, socio-economic factors and awareness of domestic energy concerns (Table 4.34, Table 4.35 and Table 4.36).

Although the annual heating and monthly electricity expense ranges showed regional differences (Table 4.21), the only relationship between bills and CRs was about electricity, where H05 was rejected (Table 4.34). The other variables were the heating and cooling systems examined whether there were any associations of them to CRs while regional infrastructure varied. Other variables were the heating and cooling systems, which were examined for any relationship with the CRs. Since the regional infrastructure possibilities were variable, heating systems in the house also varied regionally as shown in Table 4.15. The fact that the p-values were less than .001 showed that there were significant relationships between the CRs and heating and cooling system. Cooling system was mostly selected by the respondents from 1st climate region, as can be expected due to its higher cooling degree days (CDD).

Table 4.34 The results of the null hypothesis of H05 for the energy use behaviour and energy related variables

H05: There were was no relationship amongdifference between the energy use behavior of occupants from different climate regions in Turkey.					
Category	Variables	Category	Test	P value	Result
Energy Use Behaviors	Heating Bill	CRs_H	Chi-square	.59	H05 accepted
Energy Use Behaviors	Heating Bill/m2	CRs_H	Anova	.12	H05 accepted
Energy Use Behaviors	Electricity Bill	CRs_H	Chi-square	.04	H05 rejected
Energy Use Behaviors	Heating System	CRs_H	Chi-square	<.001	H05 rejected
Energy Use Behaviors	Cooling System	CRs_H	Chi-square	<.001	H05 rejected

Figure 4.15 shows that except the 1st climate zone, all climate regions had representative heating systems but different from each other. When in 2nd climate region and 3rd climate region the most used heating system was the gas boiler, it was

the central heating system in the 4th climate region. In the 5th climate region stove was the most used heating system. In the summer period, from the 1st climate region, which had a very high air conditioning usage rate, to the cold climate zone, it shifted to the use of natural ventilation. The use of fans was mostly preferred in the 2nd and 3rd climate regions.

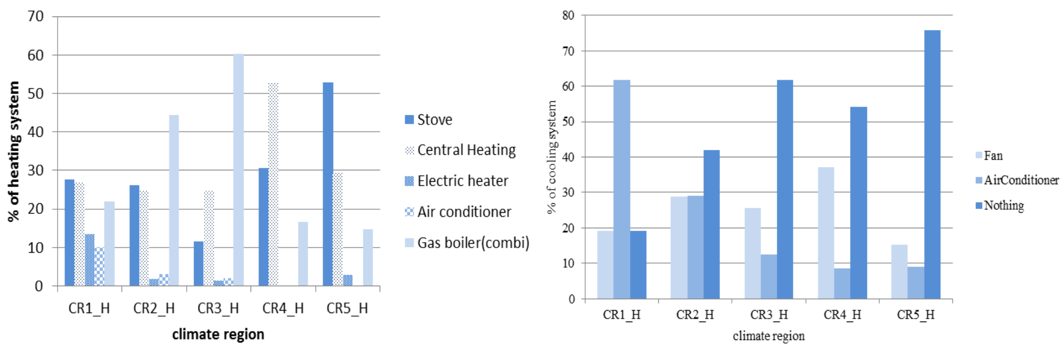


Figure 4.15 Relation of heating system (a) and cooling system (b) variables with climate regions.

In the second hypothesis, in which the relationship between energy use and occupants' behavior was examined, socio-economic characteristics of the respondents were used as variables. Thus, the null hypothesis of H06 was defined as having no relationship between the socio-economic characteristics of the respondents and their energy use pattern. Almost all variables listed in Table 4.35 had an association with utility bills except "house type".

Table 4.35 The results of the null hypothesis of H06 and the variables

•H06: There were was no relationship between socio-economic attributes of users and energy use pattern					
Category	Variable	Category	Test	P value	Result
Energy Use Behaviors	M2	Heating Bill	Chi-square	<.001	H06 rejected
Energy Use Behaviors	House Type	Heating Bill	Chi-square	.94	H06 accepted
Energy Use Behaviors	Income	Heating Bill	Chi-square	.01	H06 rejected
Energy Use Behaviors	Income	Electricity Bill	Chi-square	<.001	H06 rejected
Energy Use Behaviors	No of family member	Electricity Bill	Anova	<.001	H06rejected

Figure 4.16 shows the relationship that the annual heating bill increases as the area in m2 and monthly income increases. Similarly, there also occurred an increasing trend of monthly electricity bill with increasing monthly income and number of family members as shown in Figure 4.17.

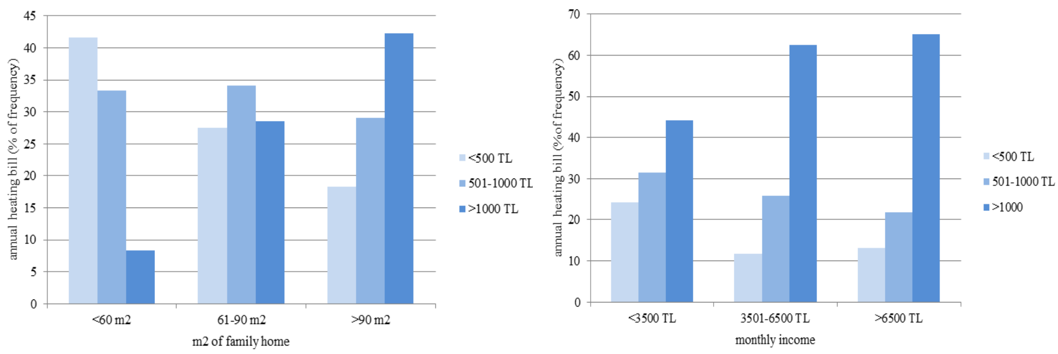


Figure 4.16 Relation of annual heating bill with area in m2 (a) and monthly income (b) variables.

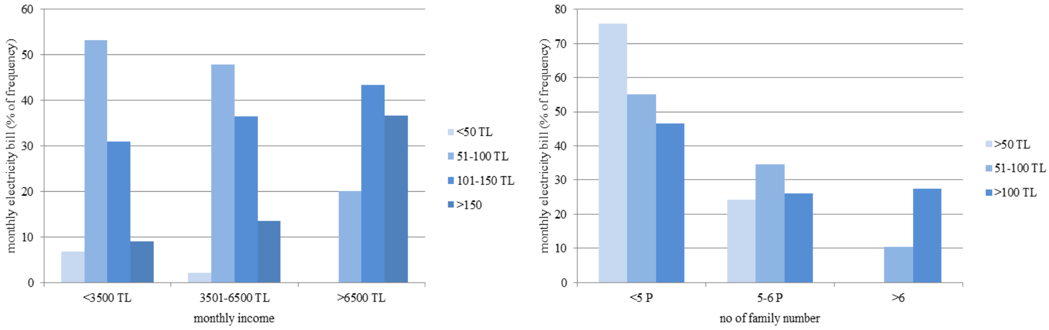


Figure 4.17 Relation of monthly electricity bill with income (a) and no of family number (b) variables.

In the third hypothesis, awareness on domestic energy concerns was used as variables. Thus, the null hypothesis of H07 was defined as having no associations between awareness on domestic energy concerns and energy use. Almost all variables listed in Table 4.36 had no association with utility bills except the variables of “awareness on energy label” and “turning off heating system”.

Table 4.36 The results of the null hypothesis of H07 and the variables

H07: There were no any assosiations associations between awareness on domestic energy concerns and energy use					
Category	Variable	Category	Test	P value	Result
Energy Use Behaviors	Aware_Energy Label	Electricity Bill	Chi-square	<.001	H07 rejected
Energy Use Behaviors	Aware_Turn off Light	Electricity Bill	Chi-square	.36	H07 accepted
Energy Use Behaviors	Aware_Turn off Appliances	Electricity Bill	Chi-square	.89	H07 accepted
Energy Use Behaviors	Aware_Turn off heatingSystem	Heating Bill	Chi-square	.004	H07 rejected
Energy Use Behaviors	Aware_HeatDown	Heating Bill	Chi-square	.57	H07 accepted
Energy Use Behaviors	Aware_Sleep/HeatingDown	Heating Bill	Chi-square	.05	H07 accepted

Figure 4.18 shows that the percentage of low bills shifted to higher bills, as energy saving behaviors decreased. This result gave a relationship between the act of turning off the heating system when the house was vacant and choosing appliances according to the energy label could reduce heatng and electricity bills, respectively.

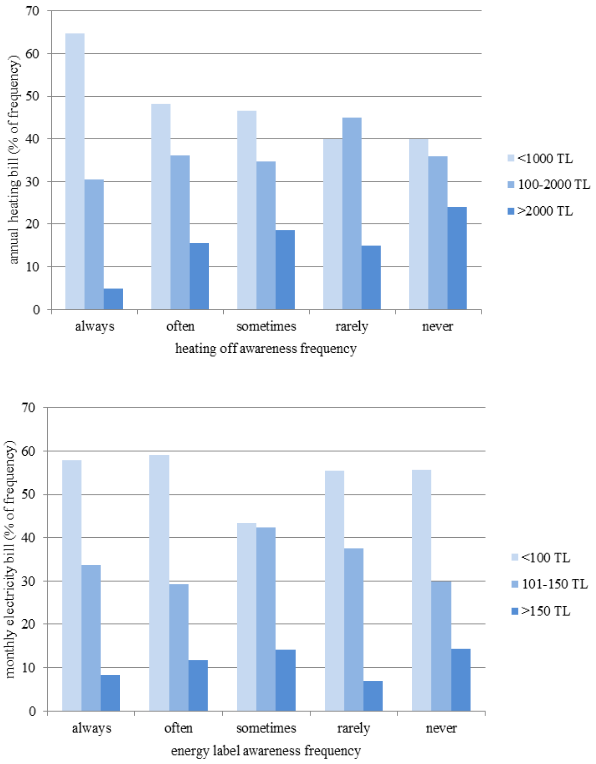


Figure 4.18 (a)Relation of annual heating bill with energy label awareness frequency (b) Relation of monthly electricity bill with heating off awareness frequency.

4.3.6 Insulation regulations and occupants' thermal behaviors

The insulation regulation in Turkey prescribes the thermal insulation applications in the building envelope according to the climatic regions. With this regulation, the null hypothesis H08 was defined in order to reveal in which ratio of the climate regions wall insulation and double glazing were applied and to compare how successful these regulations were in terms of residential thermal comfort. The null hypothesis was rejeted for all variables listed in Table 4.37.

Table 4.37 The results of the null hypothesis of H08 and the variables

H08: There were no any influence of national insulation legislation and legal sanctions on the occupants' thermal satisfaction/complaints with regard to thermal comfort.					
Category	Variable	Category	Test	P value	Result
Thermal Characteristics	T.Comfort Sense	Wall Insulation	Chi-square	<.001	H08 rejected
Thermal Characteristics	Cold Room Complaint	Wall Insulation	Chi-square	<.001	H08 rejected
Thermal Characteristics	Cold Wall Surface	Wall Insulation	Chi-square	<.001	H08 rejected
Thermal Characteristics	Humid Wall Surface	Wall Insulation	Chi-square	.04	H08 rejected
Thermal Characteristics	T.Comfort Sense	Double Glazing	Chi-square	<.001	H08 rejected
Thermal Characteristics	Cold Room Complaint	Double Glazing	Chi-square	<.001	H08 rejected
Thermal Characteristics	Satisfaction_Noise	Double Glazing	Chi-square	.001	H08 rejected

Participants who confirmed that their family homes had wall insulation were mostly thermally comfortable in their living spaces, while those living in uninsulated homes mostly said they felt colder, and most of them complained of the coldess of living room (Figure 4.19 (a) and (b)

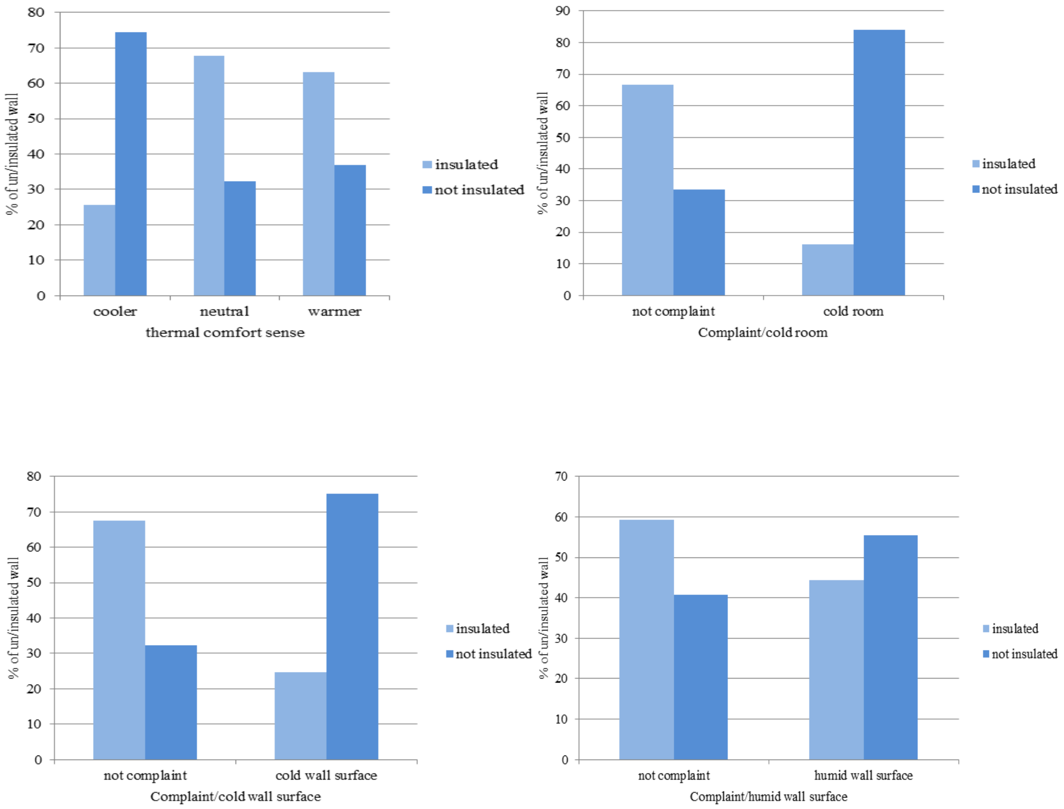
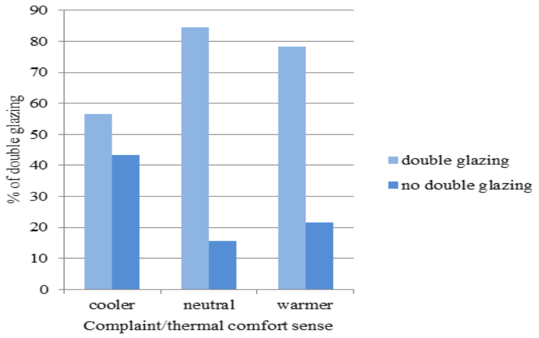
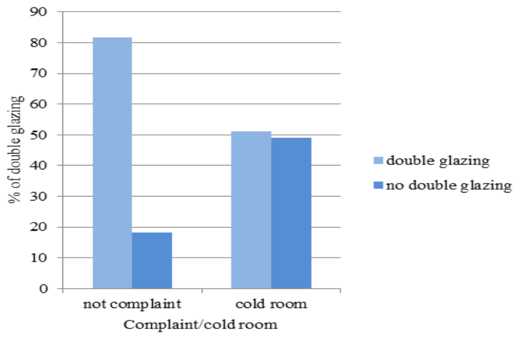


Figure 4.19 (a) Relation of un/insulated exteriror wall with (a) thermal comfort sense, (b) complaint/cold room (c) complaint/cold wall surface (d) complaint/humid wall surface

Apart from the wall insulation, double glazing was the another question to get feedback from respondents.The results showed that the respondents in the houses where having double glazed windows were in comfort in terms of thermal and noise (Figure 4.20).





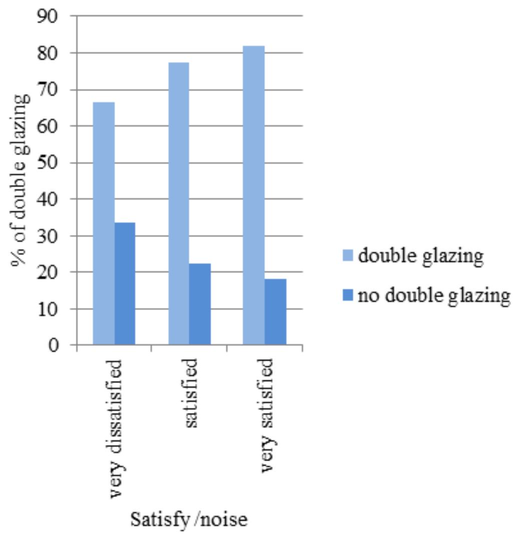


Figure 4.20 (a)Relation of double glazing window with (a) thermal comfort sense, (b) compplaint/cold room and (c) noise satisfaction

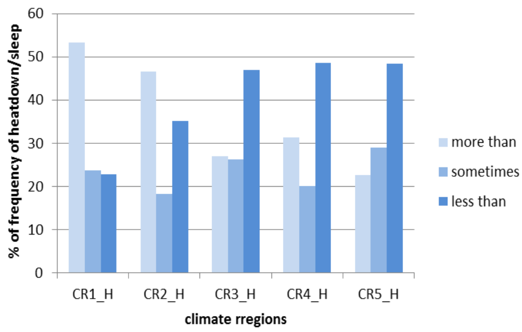
4.3.7 Occupants' awareness on domestic energy concerns

Since the frequency of energy conscious behaviors in which the respondents stated were similar for each CRs, the null hypothesis of H09 defined as having no relationships between CRs and awareness of respondents on energy concerns was accepted for almost all variables except for "shut downor reduce heating when sleeping" (Table 4.38).

Table 4.38 The results of the null hypothesis of H09 and the variables

H09: There were no relationship between awareness on energy concerns and climate regions.					
Category	Variables	Category	Test	P value	Result
Aware	Shut down heating	CRs_H	Chi-square	<.001	H09 rejected
Aware	Sleep/HeatingDown	CRs_H	Chi-square	<.001	H09 rejected
Aware	HeatDown	CRs_H	Chi-square	.06	H09 accepted
Aware	SleepHtup	CRs_H	Chi-square	.42	H09 accepted
Aware	Turn off light	CRs_H	Chi-square	.88	H09 accepted
Aware	Shut App	CRs_H	Chi-square	.84	H09 accepted
Aware	Full WashM	CRs_H	Chi-square	.83	H09 accepted
Aware	Energy Labeling	CRs_H	Chi-square	.54	H09 accepted

Figure 4.21 shows that while the frequency of reducing the temperature of the heating system during sleep time and turning off the heating when leaving the house was "more often than sometimes" in hot climate regions, this frequency of behavior shifted to "less than sometimes" towards cold climate regions.



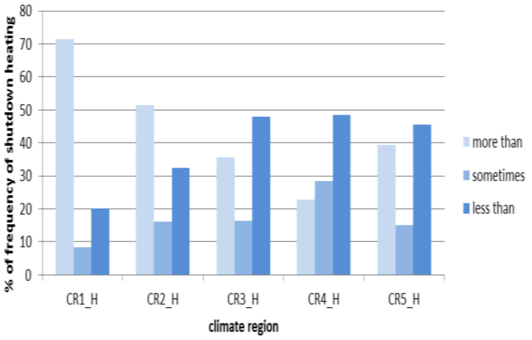


Figure 4.21 (a)Relation of heating down awareness frequency with climate regions (b) Relation of heating off awareness with with climate regions

Table 4.39 The results of the null hypothesis of H10 and the variables

H10: There were no relationship between awareness on energy concerns and socio-economic attributes in Turkey.					
Category	Variables	Category	Test	P value	Result
Aware	HeatDown	Income	Chi-square	.71	H10 accepted
Aware	Shutdown heating	Income	Chi-square	.05	H10 accepted
Aware	Turn off lights	Income	Chi-square	.58	H10 accepted
Aware	Unplug appliences	Income	Chi-square	.28	H10 accepted
Aware	Energy Label	Income	Chi-square	.44	H10 accepted
Aware	Shutdown heating	No of family member	Chi-square	.76	H10 accepted
Aware	Turn off lights	No of family member	Chi-square	.74	H10 accepted
Aware	Unplug appliences	No of family member	Chi-square	.11	H10 accepted
Aware	Energy Label	No of family member	Chi-square	.44	H10 accepted
Aware	HeatDown	House Type	Chi-square	.23	H10 accepted
Aware	Shutdown heating	House Type	Chi-square	.18	H10 accepted
Aware	UnplugApp	Ownership	Chi-square	.57	H10 accepted
Aware	Energy Label	Ownership	Chi-square	.31	H10 accepted
Aware	Shutdown heating	Heating system	Chi-square	<.001	H10 rejected
Aware	HeatDown	Heating system	Chi-square	<.001	H10 rejected
Aware	Energy Label	Sex	Chi-square	.005	H10 rejected
Aware	Full/WashingMachine	Sex	Chi-square	.01	H10 rejected

Table 4.39 (Cont'd)

Aware	Turn off lights	Sex	Chi-square	.002	H10 rejected
Aware	Unplug appliences	Sex	Chi-square	.002	H10 rejected
Aware	HeatDown	Sex	Chi-square	.13	H10 accepted

Also the relationship between awareness on energy concerns and socio-economic and demographic attributes of respondents was examined with in the scope of the H010 null hypothesis defined as having no relationship between them in Turkey (Table 4.39). Almost all variables except “heating system” for the socio-economis category had no association with the variables for awareness category. However, the null hypothesis of H10 was rejected in the examined relationship between “gender” and “awareness” except "heat-down" behavior.

Figure 4.22 shows that while the frequency of reducing the temperature of the heating system and turning off the heating when leaving the house was "more often than sometimes" in the house having easy adjustable heating systems espacially used in hot climate regions, this frequency of behavior shifted to "less than sometimes" towards the house having central heating systems located mostly in cold climate regions.

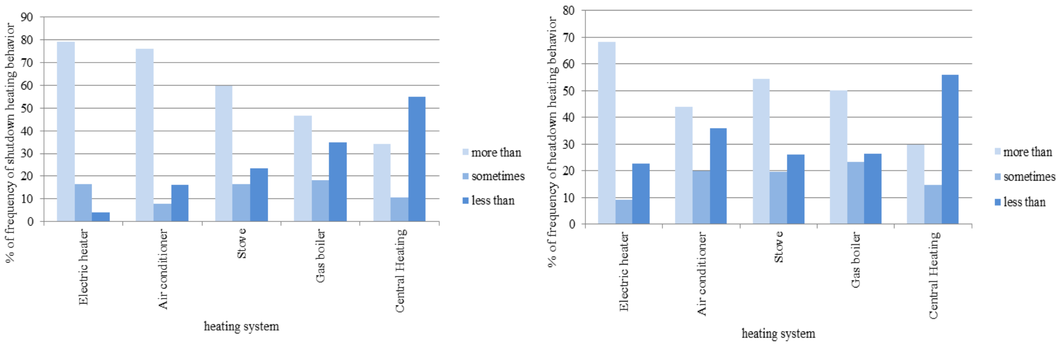


Figure 4.22 (a)Relation of shut down heating system awareness frequency with type of heatng system (b) Relation of heatdown awareness with with type of heatng system

Figure 4.23 shows that while the tendency to be aware of the energy label in the selection of household appliances was a more common behavior in the male group, using the dishwasher and washing machines when they were full was a more frequent behavior in the female group. Although the frequency of actions to turn off unnecessary lights seemed similar in both groups, the action of unplugging unused appliances showed that the female group was more aware, in parallel with the fact that she uses the house more often

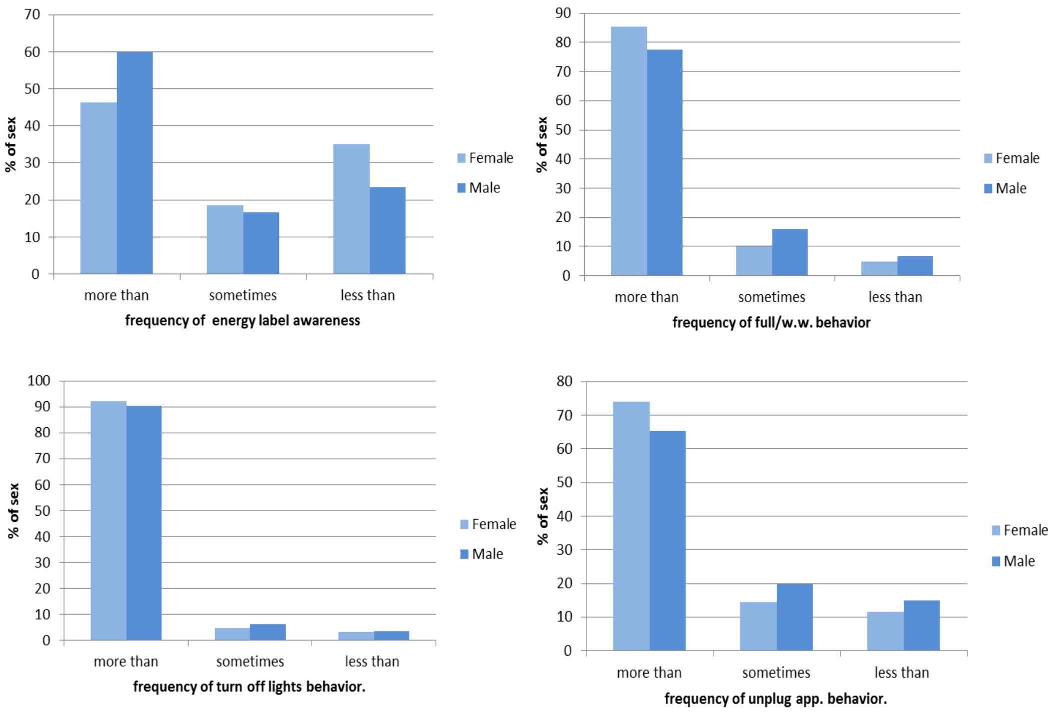


Figure 4.23 Relation of (a)energy label (b) using washing machine when full (c) turn off lights (d) unplug appliences awareness frequency with female or male (sex)

CHAPTER 5

CONCLUSION

Energy concerns in architectural research are emerging as important factors in integrating the built and natural environment. The main goal of energy efficiency is to do the same work with less energy without sacrificing comfort. Traditionally, in the construction industry energy demand is addressed through the building form and fabric, such as specifying insulation levels, glazing ratio, usable area, climate characteristics, location and orientation, etc. Hackett & Lutzenhiser (1991) define this mathematical model as the “unoccupied "test" houses”. Together with engineering disciplines, scheduling the building operation systems along with user presence and their interactions has been improved to enable the simulation of the building’s end-use energy. Yet, many of the factors that are used to simulate the building’s energy loads are based on generalized assumptions, especially the occupancy factor. Those standardized models bring bias into the energy policies by assuming that all occupants give similar responses in similar thermal environment. The fact that in Turkey the regional climate model is based on classifying the energy performance of housing that ignores the thermal response variability of households in diverse climatic regions, is one of the criticisms of this occupant-oriented study. This was the first problem that has been studied by seeking an answer to the question whether or not the thermal perception and preferences of households’ living in different climate regions diversify in line with the defined climatic zones, as per the current regulations.

As Rappoport (1969) points out that “house building is not a natural act and is not universal”; or in other words, housebuilding is a planned exercise that is unique to its environment. This context can help to explain the diverse attributes of housing, the observed differences in energy consumption habits, the varied adaptive behaviour patterns of households, and their various attitudes towards frugality, such as controlling energy consumption through efficient equipment use, thermostats, temperature settings, light switches, operating windows and vents, etc. On the other hand, energy consumption pattern in a country varies with the socio-economic parameters such as the price of energy, family income, house ownership, operating system, energy resources, and the type and size of the dwelling, the thermophysical condition of the dwelling, family structure and awareness of energy issues. This was the second problem that was studied to understand the thermal perceptions, preferences, attitudes and habits of households in different climatic regions of Turkey with respect to their varied socio-economic conditions and energy use patterns.

Within the context of these two main criticisms, six objectives listed under the relevant heading were set up. A holistic literature review was conducted to evaluate existing studies on user-oriented energy concerns in residential buildings, both internationally and in Turkey, and in both the focus was on the typology of residential buildings and their users with regard to their socioeconomic and demographic factors and the climate-related energy problem in Turkey.

Most of the studies confirm that there is a performance gap between the actual and expected energy consumption. Each study has contributed different information on the gaps in the literature within its limitations and methods; these gaps can be summarized as follows:

- There is a need to statistically identify the profiles of national building stock and domestic energy demand in thier countries.
- There is a necessity to investigate the relationship between regional patterns of occupants' activities and energy requirements
- Availability of real-time national database is important for occupant oriented-studies.
- There is a need for two-sided information flow between the local government's policies and domestic users to raise awareness of their daily energy use activities at home.

- Getting feedback on the effects of government policies on the energy loads of buildings is important.
- Internationally accepted standards are insufficient to reflect the real energy consumption data for the national building energy regime

Although there are many studies in the literature focusing on households energy-use behaviors but they should be evaluated in their own climatic context, environment and socio-economic condtions. Therefore, there was a need to understand the thermal perceptions and preferences of housholds in Turkey with respect to the varying socio economic condtions and different climatic regions. The summary of national studies on the subject is as follows

- Approximately 81% of the total residential buildings are apartment buildings with 2 or more floors. This building typology has changed to a single-storey detached building at the rate of 80% in the east. The most preferred material is brick with a ratio of about 80%. The net area sizes of the houses in Turkey are mostly between 71-110 m2 and have 3 to 4 rooms.
- Average family size varied from 6 members to 3 members, from east to west and north to south. Socio-economic development also increased from east to west and north to south. Ownership status increased in the opposite direction of socio-economic direction.
- Households are based on the nuclear family structure of 4 people on average
- High income, low electricity prices, the number of family members, the size of the house and house ownership have a negative effect on electricity consumption
- The tendency to use the house all day, that is the occupancy rate, increases as the income level decreases.
- Climate classification studies and maps were obtained, which were carried out with different methods based on the systematic grouping of the meteorological events, bioclimatic features and other indirect influences such as "material", "farming", “roof covering”, and "space layout" characteristics.

The results show that mapping the climate of Turkey is highly variable due to the different mapping approaches.

- Most of those studies accepted the climate classification of dividing into 5 regions as hot-humid, hot-dry, temperate-humid, temperate-dry and cold.
- Climatic differences prevalent throughout the country are significant in the housing-energy relationship
- The heating and cooling loads of the provinces located in the coldest and the hottest climates differ by 94% and 96%, respectively
- The insulation performance of the building envelope shows significant differences among the regions where heating load is important, to regions with higher cooling load.
- Because of the limitations of TS825 method, possible heat gains are being overlooked in the measures to be taken and therefore the energy performance of the house is predicted lower than reality.
- Planning and appraising the surrounding houses as a group with regard to their energy use efficiency is more effective than the housing units individually
- User-oriented studies on the optimization of building energy consumption and thermal comfort were mostly carried out in public buildings such as offices, hospitals, shopping centers, etc., since individual preference and intervention data are easily accessible
- In both spatial planning and the quantitative evaluation of plan layouts, natural light and heat gain can be obtained depending on the space usage density and daytime use in the houses.
- The study on the user profile, space usage and visual comfort preference, and the potential to save lighting energy showed that at least 1 or 2 people use the house during the day
- A simple decision support tool for the designer and the user was created by collecting data such as “frequency of use of the equipment” from the sample houses produced within TOKİ

- Besides demographic and socio-economic differences, structural differences in housing typology also affect behavioral differences in energy consumption trends
- Study on the ‘time-dependent’ change in household electricity usage habits suggested creating energy saving policies
- Post-occupancy evaluation (POE) studies guide the final design decisions for optimum comfort

The evaluations obtained from the literature survey and the objectives of this study have directed the methodology of the study.

There are very few studies in the literature conducted on evaluating the impact of household behavior on residential energy consumption in Turkey. Additionally, the general trend is to find an answer to the extent to which the interaction between occupants' behavior and building systems affects the building energy consumption. On the other hand, a scientific study on the effects of both Turkey's regional climatic characteristics and occupants’ socio-economic profile on the household-energy use relationship could not be found through the search in national and international academic databases. In order to have an idea of occupant-oriented energy consumption patterns in the residential buildings in Turkey, while considering the diversity of climate characteristics and socio-economic profile provides an opportunity for a comparative evaluation and related studies were reviewed to provide guidance for the research methodology. Thus, the reviewed literature helped formulate the questions of the survey research conducted. Data on residential thermal properties and residents’ socio-economic profiles and thermal behaviors were collected through these field surveys. Moreover, climatic,occupancy and adaptive behavior patterns data were obtained with on-site real time data logging. In order to understand the general tendencies of the sampled groups related to the variables in the research and to summarize the observations, descriptive statistics were used. Then inferential statistics tests such as chi-square, T-test and ANOVA were conducted to test the null-hypothesis for their significance. The following results were obtained:

1. The relationship of households energy use pattern with demographic indicators such as gender, family size, city of birth (climatic region) etc was analyzed.

   The average age of all the respondents was 22 years old who were mostly undergraduate students; 66% of them were female while 34 % were males. The analyses on the relationship between energy use behavior and demographic profile showed that, while the tendency to pay attention to the energy label in the selection of household appliances is more common in the male group, the use of the dishwasher and washing machines when they were full was more common behavior in the female group. Although the frequency of actions to turn off unnecessary lights seemed similar in both groups, the action of unplugging unused appliances showed that the female group was more aware.

2. The relationship between household's energy use pattern and socio-economic indicators such as income, ownership, operating systems, energy bills, type and size of dwelling, thermo-physical condition of dwelling, etc. were explored.

   According to house type and number of family member, there were regional relationships, while for the association between income, ownership, dependents persons and size of house variables and climatic regions there were no relationships among socio-economic attributes of occupants from different climate regions in Turkey. Similarly, in all CRs the average respondents' families had a total monthly income range of 1.300 TL (371$) to 3.500 TL (1.000 $) and lived in their family owned houses, which were larger than 90 m2. However, the number of family member increases from less than 4 to more than 6 from the 1st climate region (İzmir) to the 5th (Erzurum). Other than number of family members, the house type in the 5th climate region, which had a high rate of single-family houses rather than apartment-type houses, was also different from the other regions. The occupancy ratio during any day of the week showed that regardless of climate regions the family houses were always occupied by a family member every day. According to the answers received, since there was no dependent person in the families, parents' work status and the children's school schedule influenced that result.

The relationship between the socio-economic characteristics of the respondents and their energy use pattern was analyzed. The results showed that the annual heating bill increases as the area in square meters and monthly income increases. Similarly, there also occurred an increasing trend of monthly electricity bill with increasing monthly income and number of family members, as expected.

3. The thermal comfort preferences of occupants from different climatic regions of Turkey were revealed, for comparison.

   Environmental satisfaction questions showed that respondents considered their homes to have a better quality than the dormitories with respect to all indices mentioned in the questionnaire. Moreover, in answer to the question about thermal condition of the family house during the heating period, approximately 50% the respondents pointed out that they felt neutral and had no thermal comfort problems, regardless of the climate region. However, the percentage trend of thermal sensation answers for each CR shifted from neutral to warm for the 4th and 5th climate regions, though this results did not make a significant difference between climatic zones for residential buildings. The only complaint was about cold exterior weather as an obstacle to ventilating rooms in winter and a few of them also complained of cold and humid walls of their houses.

   However, respondents whose family homes were located in a hot climate and lived in a dormitory located in a cold climate, or vice versa, were found to have different thermal satisfaction in dormitory rooms. Their satisfaction decreased as the climatic difference between the region where the respondents lived and the region where they were educated increased. This trend was the same in both directions from hot to cold or cold to hot.

Moreover, the thermal sensation of the respondents for the thermal conditions of the dormitory building were evaluated with the PMV study. The result was in the range of $0.5 < PMV < +0.5$, meaning that the respondents in the four climate regions felt neutral; i.e. neither too hot nor too cold. However, self-report results showed most of the respondents felt warm; still they preferred to wear lighter clothes rather than make any interventions to reduce this warmth. Only15% of them voted that they felt neutral. This result was correlated with the indoor temperature variations recorded by the dataloggers.

4. A comparative study was conducted on the adaptation behavior patterns of those living in dormitories with different climatic conditions than their hometowns.

   Respondents' answers showed that the most often preferred behavior was to wear thicker clothes in winter and ventilate the room naturally in summer. However, regardless of climate region and building characteristics, almost all respondents indicated that they wore the combination of light clothing. It should be noted that clothing levels became lighter even in dormitory rooms in cold climatic regions because of the high heating temperatures. The frequency of window open/close action was mostly to get fresh air, if necessary, in winter because of the cold weather complaints. Thermostat control has been the least preferred behavior in dorm rooms and houses with non-intervention heating systems. Moreover, varied heating systems among the climate regions influenced heating energy-use habits to turn on the heating systems for the whole day or partially at different times of the day, in each room of their home. While the tendency for all-day heating towards cold climate regions (CR1 to CR5) was expected to increase, a decrease was observed in the CR4 and CR5 regions due to use density of the stove as the heating system. In other words, depending on the heating system, the intermittent heating regime in the 1st and 5th regions were preferred more than the other regions. When the rates on the basis of rooms were analyzed, the heating need for the whole day was high for the living room in all regions, while this rate decreased towards the warmer regions, as expected. In addition to the climatic effect, the heating system had an impact on increasing the use of an all-day heating regime for the other rooms in the 3rd and 4th zones.

5. The national awareness on domestic energy concerns were determined

   If consuming energy is a behavior, the most important way to reduce consumption is to increase awareness of the consequences of this behavior. Therefore, individual awareness in energy consumption is very important, besides climatic factors, varied heating systems, thermo-physical features of houses etc. The rate of turning off the lights at “always” frequency was stated as the most common behavior in comparison to the others. On the other hand, the "never" frequency increased for the behavior of turning the heating down or off when the home was unoccupied in the colder regions. Also, 30% of respondents responded as rarely and never checking the energy label behavior. However, surveys show that the act of turning off the heating system when the house was vacant and choosing appliances according to the energy label were only the behaviors to decrease the utility bills. The behavior of adjusting the heating system mostly depends on the lack of access to energy resources and the heating system, which was defined by the available infrastructure. For example, in the 5th region, where the stove usage was over 50%, respondents stated that they did not know their billing information. The relationship between available heating systems and heating behaviors were also analyzed. The results showed that houses having easily adjustable heating systems especially used in hot climate regions enable the users to adopt energy reducing behaviors, more than those living in houses with central heating systems located mostly in cold climate regions.

6. Information was gathered to get feedback on the influence of national regulations and legislation on the thermal perception of occupants

   In order to see the reflection of the necessity of improving the thermal performance of the building envelope brought by the national regulations, the issues of thermal insulation of the building envelope, the application of double glazing, and orientation to the south were evaluated regionally. The results showed that almost all respondents' reported that the living rooms in their homes got enough sunlight and most of them had double glazed windows; this may be the reason why these rooms were reported as being warmer. On the other hand, the percentage of wall insulation and enclosed balconies was higher in cold climate regions, except the 5th region where the income level of homeowners was lowest. Wall insulation of family homes in the 5th climate region had the lowest rate compared to the other regions, while the 3rd and 4th CR family houses had the highest ratio for both thermo-physical applications. The effect of thermally improved housing envelope turned out to provide much more thermal comfort than the non-insulated ones, as can be expected. One other result of this study was that double-glazed windows were considered to be important, not only for thermal comfort but also for sound insulation.

In summary; although there were a few differences in the thermal behavior of the occupants according to the climatic regions, a complete division was not observed. The reason for this was that standardization by grouping occupants as according to the current climatic zones was not applicable. As a matter of fact, it was deduced that the applying standard thermal regulations in all regions provided higher indoor temperatures that increased the thermal comfort threshold of the occupants further and thus turned the thermal adaptation advantage into a disadvantage in energy consumption. Although the improvement of thermal properties of the building envelopes should lead to a reduction in energy consumption for heating, the results showed the occupants tend to prefer higher indoor temperatures, wearing lighter clothes and reducing ventilationto conserve the heat in winter. This behavior inevitably leads to excessive energy consumption. Furthermore, the recorded thermal data also showed that the heating regime in the dormitory buildings was higher than the prescribed standards. This state of affairs is another reason for the higher energy consumption in not only dormitory buildings, but university campuses and other public buildings in the country. It is not surprising that the heating energy demand in Turkey is higher than that in Europe.

On the other hand, another inference was that the differences in user energy behavior were not just due to socio-economic diversity. This problem needs mitigation by adopting certain strategies at the national level, such as:

- Fair allocation of energy resources by providing the necessary infrastructure throughout the whole country;
- Increasing consciousness of energy expenditure by enabling energy metering, which is not possible in stove heating, hence the need for uniformity;
- Controlling unnecessary energy consumption through integration of energy management systems (EMS); and
- Application of strict regulations that would in turn increase users' awareness regarding the need to reduce energy expenditure in their buildings; e.g. every building should have its own heating regime and the users should be made responsible for behaving accordingly

Through such initiatives, occupants' adaptive behavior will be encouraged to achieve energy savings, such as putting on winter clothing when feeling cold rather than increasing the heating and continuing to wear light summer clothing. . According to the survey results, the average indoor temperature of rooms in dormitories revealed around 26 C, and most of the occupants preferred this temperature, which was an important item that needs to be resolved in order to avoid wasting energy in residential units. It has been observed that even an increase of only 3 degrees can result in an increase of 17% in one month's heating energy needed according to the

TS 825 heating energy calculation method. According to the data obtained in the PMV study, the indoor temperature was found to be between 3C and 5C higher than the temperature specified in the standard.

Apart from the inferences from this research, the contribution of this study to the literature was the real data collected in a wide range of scope, which was designed with a holistic approach to determine cause-and-effect relationship. This study was conducted not only by survey questionnaires, but also by real data obtained by data loggers recording of environmental indices and occupant behavior data, and logs filled by building occupants. Instead of the calculation inputs determined by international standards and accepted for energy simulation software, it provides real data contribution to national calculation methods with regional weekday and weekend occupancy data in dormitories and residences, and the thermal preferences data in Turkey. It helps to reduce the margin of error in the results obtained from such simulations of building renovations and improvements to improve energy performance. Therefore, similar studies should be extended to other building typologies to create a database on user behavior and energy consumption.

It should be noted that each approach to research depends on its own assumptions and determines its own limits; it is unfortunate that studies often ignore the important user behavior component of energy demand. These gaps determine the topics of future studies, just like the gaps and inferences in this work. Forexample, the results on the energy use awareness revealed that the occupants were more controlled in the energy they consumed within the scope of the role that they had in the families. This result showed that only invoice information is not sufficient and new researches are needed. In particular, informative methods that will raise the awareness of each individual regarding how much energy they consumed in their daily life should be researched, and solutions should be created by considering socioeconomic and demographic differences. On the other hand, most of the respondents stated that the living spaces of the family houses were exposed to the sun all day long and they did not have any problems in terms of thermal comfort and felt even hot. This means that the TS 825 standard, based on building envelope thermal insulation, should be studied more extensively in Turkey, especially in regions where the rate of sun exposure is high during the heating period. In other words, the effect of solar gains on both the building envelope and the user adaptive behavior should be investigated. Otherwise, even if the environment is heated more than necessary, it has been observed that the occupants do not complain about this temperature and can adapt to the ambient temperature by changing clothes. Therefore, the studies on integrating this solar gain and occupants' adaptive behavior into Ts 825 thermal energy calculations for the climate regions where the winter sun is effective, will prevent the design of a building envelope and heating system far above the minimum requirement.

REFERENCES

Abrahamse, W., Steg, L., Vlek,C. & Rothengatter, T. (2005). A review of intervention studies aimed at household energy conservation. *Journal of Environmental Psychology 25* pp. 273–291.

Al-Mumin, A., Khattab, O. & Sridhar, G. (2003). Occupants' behavior and activity patterns influencing the energy consumption in the Kuwaiti residences. *Energy and Buildings,* 35, 549-559. PII: S0378-7788(02)00167-6

Altun, M., Akgül, Ç.M., Akcamete, A. (2020). Effect of envelope insulation on building heating energy requirement, cost and carbon footprint from a life-cycle perspective. Journal of the Faculty of Engineering and Architecture of Gazi University 35:1 (2020) 147-163.

Altun, M., Akçamete, A., Akgül, C.M. (2019). Dış sıcaklık verisinin bina ısıtma enerji gereksinimine etkisinin ve TS 825 derece-gün bölge kümelendirmesinin geçerliliğinin incelenmesi. Investigation of the effect of outdoor temperature data on the building heating energy requirement and validity of the TS 825 degree-day region clustering. Pamukkale Univ Muh Bilim Derg, 26(6), 1062-1075, 2020

Akın, C., T. (2001). *Doğal çevre etmenlerine bağlı olarak yerleşme ve bina ölçeğinde iklimle dengeli konut tasarım denetleme modeli.* . [Doctoral dissertation, Yıldız Technical University]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Aksoy, U.T. (2002). *İklimsel konfor açısından bina yönlendirilmesi ve bina biçimlendirilmesinin ısıtma maliyetine etkisi.* [Doctoral dissertation, Fırat Üniversitesi]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Aksoy, U.T. & Ekici, B. (2013). TS 825 iklimsel verilerinin farklı derece gün bölgeleri için uygunluğunun değerlendirilmesi. METU JFA, 30/2, pp. 163-179

Albayrak, A. S. (2003).*Türkiye'de İllerin Sosyo-ekonomik Gelişmişlik Düzeylerinin Çok Değişkenli İstatistik Yöntemlerle İncelenmesi*. [Doctoral dissertation, İstanbul Üniversitesi Sosyal Bilimler Enstitüsü]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Alkışer, Y., Yürekli, H. (2004). Türkiye'de "Devlet Konutu"nun dünü, bugünü, yarını. *İTÜ Dergisi/a Mimarlık, Planlama, Tasarım, 3*(1), pp. 63-74

Andersen, R.V., Toftum, J., Ndersen, K. K. & Olesen, B. W. (2009). Survey of occupant behavior and control of indoor environment in Danish dwellings. *Energy and Buildings*, 41, 11-16. doi:10.1016/j.enbuild.2008.07.004

ANSI/ASHRAE Standard 55 (2010). Thermal Environment Conditions for Human Occupancy.

Arens E, Zeren L, Gonzales R, Berglund L, McNalls PE (1981). A new bioclimatic chart for environmental design. In Fernandes; Woods; Faist, eds. *Proceedings of International Symposium on Building Energy Management*. Oxford: Pergamon Press pp. 645-657.

Arı, E., Aydın, N., Karacan, S.& Saraclı, S. (2016), "Analysis of Households' Electricity Consumption with Ordered Logit Models: Example of Turkey", International Journal of Humanities and Social Science Invention, 5(6), pp. 73-84

Arslan, S. (2006). *Orta nitelikli konut salonlarinin iç mekân analizi.* [Master of thesis, Gazi Üniversitesi Fen Bilimler Enstitüsü]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

ASHRAE handbook, thermal comfort (2005). In: ASHRAE fundamentals handbook (SI). Atlanta: American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE)

Aslan, S. (2000). *The discussion of culture factor in user and designer interaction for todays house representation at İzmit example*. [Doctoral dissertation, Yıldız Technical University]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Arslanoğlu, N. (2015). *Isıl konfora ışınım etkisinin deneysel ve teorik incelenmes.* [Doctoral dissertation, Uludağ University]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Ashrafian, T., Yilmaz, A. Z., Corgnati, S. P., Moazzen, N.,(2016) Methodology to define cost-optimal level of architectural measures for energy efficient retrofits of existing detached residential buildings in Turkey, Energy Build., vol. 120, 58–77,

Atabay, S. (1982). Konut alanları planlaması Y.Ü. Yerleşme Bilimleri ve Şehircilik Araştırma Merkezi, Yayın no: 12 Y.Ü. Matbaa İstanbul. (in Doctoral dissertion of Akın, C.T. 2001)

Atalay, İ., 1997, Türkiye Coğrafyası, Ege Üniversitesi yayınları

Atmaca, İ. (2006). *Isıl konfor parametrelerinin insan üzerine etkisinin incelenmesi.* [Doctoral dissertation, Uludağ University]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Ayçam, İ. (2006). T*ürkiye derece gün bölgelerinde isitma gerektiren dönem için alçak katli konut binalarinda uygun cam tiplerinin saptanmasina yönelik bir yöntem.* . [Doctoral dissertation, Gazi University]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Bachelard, G. (1994). The poetics of space. Ed John R. Stilgoe in USA. https://archive.org/stream/G.BachelardThePoeticsOfSpace/G.%2C%20Bachelard%2C%20The%20Poetics%20of%20Space_djvu.txt

Başarır, L. (2018). *A model based on occupant movement analysis for spatial layout evaluation.* [Doctoral dissertation, Izmir Institute of Technology]. Council of

Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Batur, A. (1998). 1925-1950 döneminde Türkiye mimarlığı. In Y. Sey (Ed.). *75 yılda değişen kent ve mimarlık* (pp.209-234). İstanbul: Tarih Vakfı Yayınları.

Bektaş, C. (2013). *Türk evi.* YEM Yayın.

Beyaztaş, H. (2020). *Redefining building envelope based on different urban texture for the goal of achieving near-zero energy residential building neği.* [Doctoral dissertation, İstanbul Teknik Üniversitesi]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Bilgin, İ. (1998). Modernleşmenin ve toplumsal hareketliliğin yörüngesinde Cumhuriyet'in imarı. In Y. Sey (Ed.). *75 yılda değişen kent ve mimarlık* (pp. 255-272). İstanbul: Tarih Vakfı Yayınları.

Bolattürk,A. & Dağıdır, C. (2011). Güneş radyasyonu dikkate alinarak sicak iklim bölgelerindeki binalarda optimum yalitim kalinliğinin belirlenmesi. J. of Thermal Science and Technology. Isı Bilimi ve Tekniği Dergisi, 33, 1, 87-99, 2013

Bölük, E. (2016a). Aydeniz Iklim Siniflandirmasina Göre Türkiye Iklimi Meteoroloji Genel Müdürlüğü, Ankara. https://www.mgm.gov.tr/FILES/iklim/iklim_siniflandirmalari/aydeniz.pdf

Bölük, E. (2016b). Erinç Iklim Siniflandirmasina Göre Türkiye Iklimi. Meteoroloji Genel Müdürlüğü, Ankara. https://www.mgm.gov.tr/FILES/iklim/iklim_siniflandirmalari/erinc.pdf

Bölük, E. (2016c). Köppen Iklim Siniflandirmasina Göre Türkiye Iklimi Meteoroloji Genel Müdürlüğü, Ankara. https://www.mgm.gov.tr/FILES/iklim/iklim_siniflandirmalari/koppen.pdf

Bölük, E., Kömüşçü, A. Ü. (2018). Köppen-Trewartha Iklim Siniflandirmasina Göre Türkiye Iklimi. Meteoroloji Genel Müdürlüğü, Ankara. https://www.mgm.gov.tr/FILES/iklim/iklim_siniflandirmalari/K%C3%B6ppen-Trewatha.pdf

Bölük, E. (2016d). De Martonne kuraklik indeksine göre türkiye iklimi. Meteoroloji Genel Müdürlüğü, Ankara. https://www.mgm.gov.tr/FILES/iklim/iklim_siniflandirmalari/Demartonne.pdf

Bölük, E. (2016e). Thornthwaite Iklim Siniflandirmasina Göre Türkiye Iklimi Meteoroloji Genel Müdürlüğü, Ankara. https://www.mgm.gov.tr/FILES/iklim/iklim_siniflandirmalari/Thornthwaite.pdf

Brager, G.S., Dear, R.J.(1998). Thermal adaptation in the built environment: a literature review. *Energy and Building 27* pp. 83-96

Buildings Performance Institute Europe. (2011). *Europe's buildings under the microscope: Executive summary: A country-by-country review of the energy performance of buildings* ISBN:9789491143014. Retrivied from http://www.europeanclimate.org/documents/LR_CbC_study.pdf

Bulut, H., Büyükalaca, O., Yılmaz, T. (2007). Türkiye için ısıtma ve soğutma derece-gün değerleri. 16. Ulusal Isı Bilimi ve Tekniği Kongresi, Kayseri, Türkiye, 30 Mayıs-2 Haziran.

Cengizkan, A. (2010). 1950'li yıllarda Ankara'da konut: Modernleşme ve Demokratikleşmenin Konut Sunumuna Yansımaları. In E. Altan Ergut & B. İmamoğlu (Ed.). *Cumhuriyet'in Mekanları Zamanları İnsanları* (pp. 205-235). Ankara: Dipnot.

Çakır, M. T. (2008). *Enerji Kullaniminin Bölgesel Ve Sektörel Dağiliminin Çok Değişkenli Istatistiksel Analizi.* [Doctoral dissertation, Gazi Üniversitesi Fen Bilimler Enstitüsü]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Çalmaşur, G. & İnan, K. (2018). Hanehalkı Elektrik Talebini Etkileyen Faktörler: Türkiye Üzerine Bir Uygulama. *Erciyes Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi* December 2018(52):71-92.DOI: 10.18070/erciyesiibd.435627

Caner, İ. (2020). *Hastanelerde isitma ve soğutma yüklerinin isil konfor ve enerji verimliliği açisindan optimizasyonu.* [Doctoral dissertation, Balıkesir University]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Carpino, C., Mora, D., Arcuri, N., Simone, M. (2017) Behavioral variables and occupancy patterns in the design and modeling of Nearly Zero Energy Buildings. *Build. Simul. 10: 875–888*

Chen, S., Zhang, G., Xia, X., Chen, Y., Setunge, S. & Shi, L. (2021). The impacts of occupant behavior on building energy consumption: A review. Sustainable *Energy Technologies and Assessments 45*. www.elsevier.com/locate/seta

CIBSE. (2006). Degree-Days - Theory and Application. *CIBSE*. Pp:1-14 Retrieved from https://app.knovel.com/hotlink/toc/id:kpDDTATM0A/degree-days-theory- pplication/degree-days-theory-application

Çetin, S. (2010). Kimlik Arayışında Arkitekt Dergisinin Konut Söylemi ve Uygulamaları. In E. Altan Ergut & B. İmamoğlu (Ed.). *Cumhuriyet'in Mekanları Zamanları İnsanları* (pp. 235-252). Ankara: Dipnot.

Çevre ve Şehircilik Bakanlığı Planlı Alanlar İmar Yönetmeliği, https://www.mevzuat.gov.tr/

Çiçek, İ. (1996). Thorthwaite metoduna göre Türkiye'de iklim tipleri. Coğrafya Araştırmaları Dergisi, 12, 33-71.

ÇSB. https://iklim.csb.gov.tr/bmidcs-ve-turkiye-i-4376

Delzendeh, E., Wu, S., Lee, A. & Zhoub, Y. (2017). The impact of occupants' behaviours on building energy analysis: A research review. *Renewable and Sustainable Energy Reviews Volume 80, December 2017*, Pages 1061-1071. https://doi.org/10.1016/j.rser.2017.05.264

Deniz, A., Toros, H. and Incecik, S. (2011), Spatial variations of climate indices in Turkey. *Int. J. Climatol.*, 31: 394-403. https://doi.org/10.1002/joc.2081

Devlet Meteoroloji İşleri (DMİ). (1972). Türkiye iklim tasnifi (De martonne metoduna göre). Ankara

Devlet Meteoroloji İşleri (DMİ). (1988). Aydeniz metodu ile Türkiye'nin kuraklık değerlendirmesi. Ankara

Diamond, R. C. (2001). An overview of the U.S. building stock. In Spengler J.D. et al (Ed.), *Indoor Air Quality Handbook*. New York: McGraw Hill. http://energy.lbl.gov/ie/pdf/LBNL-43640.pdf

Dizkırıcı, A. S. (2009). *Konutlarda enerji verimliliğinin ölçümü için 5 yıldızlı derecelendirme sistemi ve ekonometrik uygulama*. [Doctoral dissertation, Sakarya Üniversitesi]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Dörter, C. H. (1993). *Konutlarda ısıtma enerjisi korunumu amaçlı mimari tasarıma yön verici ilkelerin ve çözümlerin belirlenmesinde bir yaklaşım araştırması*. [Doctoral dissertation, İstanbul Teknik Üniversitesi]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Dülgeroğlu, Y. (1993). Farklı toplu konutlarda blook ve konut birimlerinin mevcut ve tercih edilen mekansal özelliklerinin karşılaştırılması. *Konut Araştırmaları Sempozyumu* (pp. 269-287). T.C. Başbakanlık Toplu Konut İdaresi Başkanlığı ÖDTÜ Konut Araştırmaları Merkezi.

Ediger, V.Ş. & KentmenÇ. (2010). Enerjinin Toplumsal Boyutu ve Türk Halkının Enerji Tercihleri. https://dergipark.org.tr/tr/download/article-file/536

Ek, F.İ. (2012). *Mass-housing consensuses and theirEffects on design organizations in Terms of quality*. [Doctoral dissertation İzmir Institute of Technology]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Ekici, B. B., Gulten, A.A., Aksoy, U.T. (2012). A study on the optimum insulation thicknesses of various types of external walls with respect to different materials, fuels and climate zones in Turkey. Applied Energy Volume 92 April 2012, Pages 211-217. https://www.sciencedirect.com/

Ekinci, O. (1998). Kaçak yapılaşma ve arazi spekülasyonu. In Y. Sey (Ed.). *75 yılda değişen kent ve mimarlık* (pp.191-198). İstanbul: Tarih Vakfı Yayınları.

Enerji Piyasası Düzenleme Kurulunun EPDK, 2017

Enerji Verimliliği ve Çevre Dairesi Başkanlığı (YEGM, www.yegm.gov.tr)

Erman, T. (1998). Kentteki kırsal kökenli göçmenlerin yaşamında gecekonduu ve apartman. In Y. Sey (Ed.). *75 yılda değişen kent ve mimarlık* (pp. 317-324). İstanbul: Tarih Vakfı Yayınları.

Etzion, Y., Portnov, B. A., Erell, E., Meir, I. & Pearlmutter, D. (2001). An open GIS framework for recording and analyzing pos-occupancy changes in residential buildings-a climate-related case study. *Building and Environment,* 36, 1075-1090. PII: S0360-1323(00)00080-90

Faiers, A., Cook, M. & Neame, C. (2007). Towards a contemporary approach for understanding consumer behaviour in the context of domestic energy use. Energy Policy 35. Pg: 4381–4390. www.elsevier.com/locate/enpol

Fanger, P.O. (1970). Thermal comfort. Copenhagen: Danish Technical Press

Fuller, R. J. & Crawford, R. H. (2011). Impact of past and future residential housing development patterns on energy demand and related emission. *Journal of Housing and Building Environment*, 26, 165-183. doi 10.1007/s10901-011-9212-2

Gagge, A., Stolwijk, A., Nishi, Y. (1971). An effective temperature scale based on a simple model of human physiological regulatory response. ASHRAE Trans 77, 247–57.

Geçkin, Ş. (1995). *Konutta Mekan Standartlarının Geliştirilmesine Yönelik Evrimsel bir Araştırma.* [*Master's thesis, KaradenizTeknik Üniversitesi Fen Bilimler Enstitüsü*]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Gillott, M., Holland, R., Riffat, S. & Fitchett, J. A. (2013). Post-occupancy evaluation of space use in a dwelling using RFID tracking. *Architectural Engineering and Design Management*, 2(4), 273-288. doi: 10.1080/17452007.2006.9684622

Givoni, B. (1969), **Man, Climate and Architecture**, Elsevier, Amsterdam, New York.

Givoni, B. (1992). Comfort, climate analysis and building design guidelines Energy artd Buildings, 18 (1992) 11-23

Gönençgil, B. (2020). Klimatoloji (atmosfer ve sicaklik). İstanbul Üniversitesi Açik ve Uzaktan Eğitim Fakültesi, ders notu http://auzefkitap.istanbul.edu.tr/kitap/cografya_lisans_ao/klimataloji_atmosfer_ve_sicaklik.pdf

Gönençgil, B., Biricik, A.S., Atalay, İ., Aydinözü, D., Çoban, A. & Ertek, A. (2016). Türkiye Fiziki Coğrafyası. İstanbul Üniversitesi Açik ve Uzaktan Eğitim Fakültesi,dersnotu. http://auzefkitap.istanbul.edu.tr/kitap/cografya_lisans_ao/turkiye_fiziki_cografyasi.pdf

Görgülü, T. (2016). The apartment typology from past to present: the transition from rental apartment to "residence". *TÜBA-KED 14*, pp. 165-178

Hackett, B., Lutzenhiser, L. (1991). Social Structures and Economic Conduct: Interpreting Variations in Household Energy Consumption. Sociological Forum, Vol. 6, No. 3, 1991

Han, J., Zhang, G., Zhang, Q., Zhang, J., Liu, J., Tian, L., Zheng, C., Hao, J., Lin, J., Liu, Y. & Moschandreas, D. J. (2007). Field study on occupants' thermal comfort and residential thermal environment in a hot-humid climate o China. *Building and Environment,* 24, 4043-4050. doi:10.1016/j.buildenv.2006.06.28

Hisarlıgil. H. (2009). *Enerji etkin planlamada konut adasi tasarimi hipotetik konut adalarinin Ankara örneginde mikroklima analizi* [Doctoral dissertation, Gazi University]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Hong, T., Yan, D., D'Oca, S., Chen, C. (2017). Ten questions concerning occupant behavior in buildings: The big picture. Building and Environment, Volume 114, Pages 518-530, ISSN 0360-1323.https://doi.org/10.1016/j.buildenv.2016.12.006.

Horta, A. (2018). Energy consumption as part of social practices; The alternative approach of practice theory. The Oxford Handbook of Energy and Society. Dr. Debra J. DavidsonDr. Matthias GrossTem. Oxford University Press Pg: 31-44. https://books.google.com.tr/books?id=PCxhDwAAQBAJ&pg=PA13&dq=editions:ISBN0190633875&hl=tr&source=gbs_toc_r&cad=3#v=onepage&q&f=true

Horta, A., Wilhite, H., Schmidt, L.& Bartiaux, F.(2014). Socio-Technical and Cultural Approaches to Energy Consumption An Introduction. *Nature and Culture 9(2), Summer*. pp: 115–121. Berghahn Journals

Houa, J., Zhanga, Y., Suna, Y., Songa, Y., Chenga, R. & Luoa, S. (2017). Occupants' windows opening behaviour in residences during heating season in Tianjin, China. *10th International Symposium on Heating, Ventilation and Air Conditioning*, ISHVAC2017, 19- 22 October 2017, Jinan, China. Procedia Engineering 205 (2017) 2744–2748 www.sciencedirect.com

Houghton, F.C., Yaglou, C.P. (1923). Determining equal comfort lines. J Am Soc Heat Vent Engrs 29, 165–76.

Humphreys, M.A. & Nicol, J.F. (1998). Understanding the adaptive approach to thermal comfort. *ASHRAE Transactions*, Vol 104(1), pp991-1004.

Hwang, R. L., Cheng, M. J., Lin, T. P. & Ho, M. C. (2009). Thermal perceptions, general adaptation methods and occupant's idea about the trade-off between thermal comfort and energy saving in hot-humid regions. *Built and Environment*, 44, 1128-1134. doi:10.1016/j.buildenv.2008.08.001

İmamoğlu, V. (1993). İnsan, evi ve çevresi araştıma projesi: mimar bazı gözlemler. *Konut Araştırmaları Sempozyumu* (pp. 339-355). T.C. Başbakanlık Toplu Konut İdaresi Başkanlığı ÖDTÜ Konut Araştırmaları Merkezi.

İnan, K. (2018). *Türkiye'de hanehalkı elektrik talebini belirleyen faktörlerin ekonomik analizi*. [Doctoral dissertation, Erzurum Teknik Üniversitesi Sosyal Bilimler Enstitüsü]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

ISO (International Organization for Standardization) 7730 (2005). Ergonomics of the thermal environment Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria

Iwashita, G. & Akasaka, H. (1997). The effects of human behavior on natural ventilation rate and indoor air environment in summer – a field study in southern Japan. *Energy and Building*, 25, 195-205. PII S0378-7788(96)00994-2

Johansson, D., Bagge, H. & Lindstrii, L. (2011). Measurement of occupancy levels in multi-family dwellings-Application to demand controlled ventilation. *Energy and Building*, 43, 2449-2455. doi:10.1016/j.enbuild.2011.05.031

Kabuloğlu Karaosman, S. (2004). *Geleneksel yerleşmelere yönelik bir ekolojik değerlendirme model önerisi, İznik Gölü çevresi köy evleri*. Doktora Tezi. Mimar Sinan Güzel Sanatlar Üniversitesi.

Kaçel, S. (2019). *A new approach for post-occupancy evaluation related to occupant and environment in lighting system design.* [Doctoral dissertation, İTÜ]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Kahraman, İ. (2013). *A sustainable building assessment model proposal for new residential buildings in turkey.* [Doctoral dissertation, Dokuz Eylül Üniversitesi]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Kalfa, S. M. (2014). *Türkiye iklim bölgelerinde konut binalari için isitma ve soğutma yüklerinin belirlenmesinde kullanilabilecek bir yaklaşim.* [Doctoral dissertation, Karadeniz Teknik Üniversitesi]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Kaprol, T. (2010). 1930-1950 Dönemi Bursa'nın Korunması Gerekli Mimari Öğesi: Konut. In E. Altan Ergut & B. İmamoğlu (Ed.). *Cumhuriyet'in Mekanları Zamanları İnsanları* (pp. 187-203). Ankara: Dipnot.

Karagülle, C. (2009). *Yerel verilerin konut tasarim sürecinde değerlendirilmesi: Mardin örneği.* [Doctoral dissertation, İstanbul Teknik Üniversitesi]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Karahan, E. E. (2016). "The Relation between the Occupant Behaviour, Energy Efficiency and the Residential Building Characteristics: Case of Turkey."[Conference paper] *Conference: The Energy Cultures Conference; Sustainable Energy Futures: Understanding Behaviour and Supporting Transitions At: Wellington, New Zeland*. https://www.slideshare.net/EnergyCultures2/ebru-ergoz-karahan-the-relation-between-the-occupant-behaviour-energy-efficiency-and-the-residential-building-characteristics-case-of-turkey

Kısa Ovalı, P. (2009). *Türkiye iklim bölgeleri bağlaminda ekolojik tasarim ölçütleri sistematiğinin oluşturulmasi “Kayaköy yerleşmesinde örneklenmesi”.* [Doctoral dissertation, Trakya Üniversitesi]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Kısa Ovalı, P. (2019). Biyoklimatik Tasarım Matrisi (Türkiye). Trakya Üniversitesi Mühendislik Bilimleri Dergisi, 20(2), 51- 66

Koca, D. (2012). *Remapping contemporary housing production in turkey: a case study on housing patterns and marketing strategies.* [Doctoral dissertation, Orta Doğu Teknik Üniversitesi Fen Bilimler Enstitüsü]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Koçlar Oral, G. Akşit, Ş.F. (2001) TS 825 Isı Yalıtım Yönetmeliğinin Konutlarda Isı Korunumu Açısından Değerlendirilmesi, *TMMOB Makina Mühendisleri Odası Yalıtım Kongresi*, Eskişehir.

Küçükkural, Ö. M. (2013). *İstanbul Halkının Konut Eğilimleri Araştırması.*İstanbul Ticaret Odası, İstanbul.

Kürekçi, N.A.(2016). Determination of optimum insulation thickness for building walls byusing heating and cooling degree-day values of all Turkey’s provincialcenters Energy and Buildings 118 (2016) 197–213. www.elsevier.com/locate/enbuild

Kyrö, R., Heinonen, J., Saynajoki, A. & Junnila, S. (2011). Occupants have little influence on the overall energy consumption in district heated apartment buildings. *Energy and Buildings,* 43, 3484-3490. doi:10.1016/j.enbuild 2011.09.012

Levine, M., Ürge-Vorsatz, D., Blok, K., Geng, L., Harvey, D., Lang, S., Levermore, G., Mongameli Mehlwana, A., Mirasgedis, S., Novikova, A., Rilling, J. & Yoshino, H. (2007). Residential and commercial buildings. In B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (Eds), *In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.

Lutzenhiser, L. (1993). Social and behavioral espects of energy use. Annual Review of Energy and the Environment. Vol. 18:247-289 https://doi.org/10.1146/annurev.eg.18.110193.001335

Lutzenhiser, L., and M. Gossard. 2000. “Lifestyle, Status and Energy Consumption.” In proceedings of the 2000 ACEEE Summer Study on Energy Efficiency in Buildings. 8: 207-222. Washington, D.C.: American Council for an Energy Efficient Economy.

Lutzenhiser, L. (2012). People, Houses, Energy, and Behavior. “Behavior Towards Efficiency” Session. Best Fest Portland State University 12 September.

Meteoroloji Genel Müdürlüğü (MGM). (2017). İklim sınıflandırmaları. Erişim adresi: http://www.mgm.gov.tr/iklim/iklim-siniflandirmalari.aspx

Mithra Moezzi, M. &Lutzenhiser, L. (2010). What’s Missing in Theories of the Residential Energy User. ACEEE Summer Study on Energy Efficiency in Buildings., Portland State University

Nıcol, F.,Humphreys, M.& Roaf, S. (2012). Adaptive thermal comfort: principles and practice. Routledge,

Olcar, D. (2012). *Bursa Kaynarca – sıcak su bölgesinde jeotermal enerjinin konut tasarımında kullanılabilirliği üzerine bir araştırma* [Master of Thesis, Mimar Sinan Fine Arts University]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Olgyay, V. (1963). Design with Climate, Bioclimatic Approach to Architectural Regionalism. Princeton University Press, New Jersey.

Ouyang, J. & Hokao, K. (2009). Energy-saving potential by improving occupants’ behavior in urban residential sector in Hangzhou City, China. *Energy and Buildings,* 41, 711-720. doi: 10.1016/j.enbbuild.2009.02.003

Özcan, E. (2013). *Konutlarda sürdürülebilir mimarlik açisindan iklimsel konfor kriterlerinin değerlendirilmesi için bir model önerisi.* [Doctoral dissertation, Beykent Üniversitesi Fen Bilimler Enstitüsü]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Özdeniz, M.B. (1991). Bioclimatic analysis of traditional Turkish houses. *Environment International 17(4) pp:*325-336 DOI:10.1016/0160-4120(91)90019-M

Özüekren, Ş. (1996). Kooperatifler ve Konut Üretimi. In Y. Sey (Ed.). *Tarihten Günümüze Anadolu'da Konutve Yerleşme*, (pp. 355-365). Türkiye Ekonomik ve Toplumsal Tarih Vakfı Yayınları.

Öztürk, M. Z., Çetinkaya, G., Aydın, S. (2017). Climate Types of Turkey According to Köppen-Geiger Climate Classification. *Journal Of Geography* 35/ 17-27. http://dergipark.gov.tr/iucografya

Park, J. S. & Kim, H. J. (2012). A field study of occupant behavior and energy consumption in apartments with mechanical ventilation. *Energy and Buildings*, 50, 19-25. doi: 10.1016/j.enbuild.2012.03.015

Polat, G. (1993). Toplu konutlarda kullanıcı memnuniyetinin değerlendirilmesi yerleşmelerde sosyal etkileşimin irdelenmesi. *Konut Araştırmaları Sempozyumu* (pp. 269-287). T.C. Başbakanlık Toplu Konut İdaresi Başkanlığı ÖDTÜ Konut Araştırmaları Merkezi.

Pusat S, Ekmekci I. "A study on degree-day regions of Turkey". Energy Efficiency, 9(2), 525-532, 2016.

Rapoport, A. (1969). House form and culture. (Englewood Cliffs, N.J., Prentice-Hal

Republic of Turkey Ministry of Energy and Natural Resources http://www.enerji.gov.tr

Richardson I., Thomson, M. & Infield, D. (2008). A high-resolution domestic building occupancy model for energy demand simulations. *Energy and Building,* 40, 1560-1566. doi: 10.1016/j.enbuild.2008.02.006

Sarıoğlu, G., P. (2007). Türkiye'de Konut Araştırmaları İçin Veri Kaynakları ve Geliştirme Olanakları Üzerine. https://www.spo.org.tr/resimler/ekler/034fb6b66aacc1d_ek.pdf.

Santin, O.G., Itard, L. & Visscher, H. (2009). The effect of occupancy and building characteristics on energy use for space and water heating in Dutch residential stock. *Energy and Building,* 41, 1223-1232. doi:10.1016/j.enbuild.2009.07.002

Saylam Canım, D. (2015). B*inalarda enerji performansi hesaplama yöntemi (BEP-TR)' nin enerji performans değerlendirmesi ve kullanilabilirliğine yönelik bir uygulama* [Master of Thesis, Karadeniz Technical University]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Şen, H., Çemrek, F., Özaydın, Ö. (2006). Türkiye'deki Illerin Sosyo-Ekonomik Gelişmişlik Düzeylerinin Belirlenmesi. *SÜ İİBF Sosyal ve Ekonomik Araştırmalar Dergisi 6/11,* pp. 155-171.

Sey, Y. (1998). Cumhuriyet döneminde konut. In Y. Sey (Ed.). *75 yılda değişen kent ve mimarlık* (pp. 273-300). İstanbul: Tarih Vakfı Yayınları.

Shin, H. Y., Kim, G. & Kim, J. T. (2013). Effect of occupants' behavior of daylighting controls on residential visual environment. *Indoor and Built Environment,* 22 (1), 191-202. doi: 10.1177/1420326X12469735

Smith, H. H. (1993). Review of design with climate: a bioclimatic approach to architectural regionalism, Second Edition, by V. Olgyay. Landscape Journal, 12(1), 75–77. http://www.jstor.org/stable/43323219

State Institute Of Statistics Prime Ministry Republic Of Turkey (TUIK). http://www.turkstat.gov.tr

State Institute Of Statistics Prime Ministry Republic Of Turkey (TUİK), (2011) Nüfus ve Konut Araştırması, 2011. https://data.tuik.gov.tr/

State Institute Of Statistics Prime Ministry Republic Of Turkey, (TUİK). (2001). Building Census 2000. ISBN 975 - 19 - 2819 – 2.

State Institute Of Statistics Prime Ministry Republic Of Turkey, (TUİK). (2017). Turkey in Statistics 2017. https://data.tuik.gov.tr/

Steemers, K. & Yun, G.Y. (2009). Household energy consumption: a study of the role of occupants. *Building Research & Information*, 37(5-6), 625-637. Publisher: Routledge, London, UK. http://dx.doi.org/10.1080/09613210903186661

Sümengen, Ö. (2015). *Türkiye için konut binalarinin aydinlatma enerjisi gereksinimi açisindan değerlendirilmesine ilişkin bir yaklaşim.* [Doctoral dissertation, Istanbul Technical University]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Sven Schimschar, S., Boermans, T., Kretschmer, D., Offermann, M. & John, A. (2016). U-Value maps Turkey Applying the comparative methodology framework for cost-optimality in the context of the EPBD (Report No: BUIDE15722). https://www.izoder.org.tr/dosyalar/haberler/Turkiye-U-degerleri-haritasi-raporu-2016-Ingilizce.pdf

Swan, L. G., Uğursal, V. I. & Beausoleil-Morrison, I. (2011). Occupant related household energy consumption in Canada: Estimation using a bottom-up neural-network technique. *Energy and Buildings*, 43, 326-337. doi:10.1016/j.enbuild.2010.09.021

Şahin, M.Ç., Köksal, M.A. (2013). Standby electricity consumption and saving potentials of Turkish households. *Appl. Energy* 114, 531–538.

Şensoy, S., Demircan, M., Ulupınar Y., Balta, İ., 2007 , Türkiye İklimi, Meteoroloji Genel Müdürlüğü web sitesi http://www.mgm.gov.tr/FILES/iklim/turkiye_iklimi.pdf

Tapan, M. (1998). İstanbul'un kentsel planlanmasının tarihsel gelişimi ve planlama eylemleri. In Y. Sey (Ed.). *75 yılda değişen kent ve mimarlık* (pp.75-88). İstanbul: Tarih Vakfı Yayınları.

Taşçı, G. (2017). A new approach to increase energy efficiency of luxury high-rise residential buildings through an advanced facade component. [Doctoral dissertation, Istanbul Technical University]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Tekeli, İ. (2009). *Konut Sorununu Konut Sunum Biçimleriyle Düşünmek*. Tarih Vakfı Yurt Yayınları, İstanbul.

Terim, B. (2011). *Climatic considerations in traditional built environments: the effect of natural ventilation on thermal comfort in Alaçati, Izmir, Turkey.* [Doctoral dissertation, İzmir Institute of Technology]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

The Union of Chambers and Commodity Exchanges of Turkey (TOBB). (2011). *Türkiye inşaat malzemeleri sektör görünümü.* http://www.tobb.org.tr/Lists/MansetListesi/Attachments/233/Türkiye_İnşaat Malzemeleri Sektörü Görünüm Raporu.pdf

Timur, B.A. (2019). *Thermal retrofitting on traditional buildings with exterior hall (sofa): urban and rural houses of Muğla*. [Doctoral dissertation, İzmir Institute of Technology]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Topallı, N. (2012). *Enerji etkinliği ve Türkiye'de konut elektriği tüketiminin geri tepme (rebound effect) etkisi.* [Doctoral dissertation, Selçuk Üniversitesi Sosyal Bilimler Enstitüsü]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Toplu Konut ve Kamu Ortaklığı İdaresi Başkanlığı https://www.toki.gov.tr/kurulus-ve-tarihce

Toybıyık, S. S. (20017). *Creating Geographically Based Turkey Building Inventory* [Specialist dissertation, Ministry of Environment and Urbanization].

Turhan, C. (2018). Development of energy-efficient personalized thermal comfort driven control in HVVAC systems. [Doctoral dissertation, İzmir İnstitute of Technology University]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Tükel, M., Tunçbilek, E., Komerska, A., Keskin, G.A. & Arıcı, M. (2021). Reclassification of climatic zones for building thermal regulations based on thermos-economic analysis: A case study of Turkey, *Energy and Buildings, Volume 246,* 111121, ISSN 0378-7788, https://doi.org/10.1016/j.enbuild.2021.111121.

Türkay, M., Y. Özbağcı, Ş., Ş. Akça, B. (2012). *Türkie'nin enerji verimliliği haritası ve hedefleri.* Rapor, Koç Üniversitesi.

Turkish Standard Institute, TS 825 - Thermal insulation requirements for buildings, Aralık 2013.

Turkish Standard Institute, TS 2164 - Principles For the Prefaration of the Projects of the Central Heating Systems, https://intweb.tse.org.tr

Uçar A and Dumrul MU, "Bir konutun dış duvarları için ısıtma ve soğutma yüklerine göre optimum yalıtım kalınlığın tespiti ve enerji tasarrufu analizi". European Journal of Science and Technology, 16, 740-749, 2019.

Ulukavak Harputlugil, G. & Harputlugil T. (2016). Çevresel konfor ve enerji tasarrufu bağlaminda konut kullanicilari davraniş profilleri üzerine bir araştirma. Journal of the Faculty of Engineering and Architecture of Gazi UniversityYıldırım, K. (1999). *Konut mutfaklarının mekan ve donate organizasyonunda ergonomic yaşam.* [Doctoral dissertation, Gazi Üniversitesi Fen Bilimler Enstitüsü]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Ulukavak Harputlugil, G. (2012). "Assessing the Accuracy of National Calculation Methodology of Turkiye (BEP-tr) by Using BESTEST", ICONARCH-I, Proceedings of International Congress of Architecture-I, 15-17 November, Konya, Turkiye, pp. 66-75.

U.S. Energy Information Administration. (2011). *Annual Energy Review* 2011http://www.eia.gov/totalenergy/data/annual/pdf/sec2_4.pdf

Ünal, Y., Kindap, T., & Karaca, M. (2003). Redefining the climate zones of Turkey using cluster analysis. International Journal of Climatology, 23(9), 1045-1055.

Walsh, A., Cóstola, D. & Labaki, L.C. (2017). Review of methods for climatic zoning for building energy efficiency programs, *Building and Environment, Volume 112, pp: 337-350,* ISSN 0360-1323, https://doi.org/10.1016/j.buildenv.2016.11.046.

WBG (The World Bank Group) (2015). Republic of Turkey: Institutional Review of Energy Efficiency. Energy & Extractives Global Practice Europe & Central Asia *The World Bank Group. (Report no: ACS12738)* https://www.esmap.org/sites/default/files/esmap-files/ACS12738revd.pdf

Webster, J., Tomalty, R. & Korteling, B. (2009). Residentail energy use characterization on mapping: research and development of information for community energy and greenhouse gas planning in Canada. *45th ISOCARP Congress*. www.isocarp.net/Data/case_studies/1604.pdf

Wilhite, H. (2012). "The Energy Dilemma." Development and the Environment: Practices, Theories, Policies, ed. Kristian Bjørkdahl, and Kenneth Bo Nielsen, pp. 81–97. Oslo: Universitetsforlaget. Access in arcticle Socio-Technical and Cultural Approaches to Energy Consumption An Introduction by Ana Horta, Harold Wilhite, Luísa Schmidt, and Françoise Bartiaux. Nature and Culture 9(2), Summer 2014: 115–121 © Berghahn Journals

Wilhite, H., Nakagami, H., Masuda, T., Yamaga, Y. & Haneda, H. (1996). A cross-cultural analysis of household energy use behavior in Japan and Norway. *Energy Policy,* 24 (9), 795-803. PII: S0301-4215(96)00061-4.

Winslow, C.E.A., Herrington, L.P., Gagge, A.P. (1938). Physiological reactions and sensations of pleasantness under varying atmospheric conditions. Trans ASHVE 44, 179–96.

Yaka, İ.F., Önal, S., Koçer, A., Güngör,A. (2016). Binalarda Enerji Performansının Belirlenmesinde Farklı İllerin Karşılaştırılması. (Comparison of building energy performance of different provinces) Journal of Global Engineering Studies, Cilt 3: Sayı:2, 127-135

Yener, A. K. (1996). *Pencerelere uygulanan gölgeleme araçlarının tasarımında iklimsel ve görsel konfor koşullarının sağlanması amacıyla kullanılabilecek bir yaklaşım.* [Doctoral dissertation, İstanbul Teknik Üniversitesi]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Yıldız, Y. (2014). Impact of Energy Efficiency Standard and Climate Change on Summer Thermal Comfort Conditions: A Case Study in Apartment Building. Gazi University Journal of Science GU J Sci 27(3):1005-1013 (2014)

Yılmaz, A.Z. (2011). Bina enerji performansi ulusal hesaplama yöntemi (bep-tr) ile isitma ve soğutma enerjisi ihtiyacinin hesaplanmasi. X. Ulusal Tesisat Mühendisliği Kongresi –İZMİR , sf: 65-778

Yılmaz, B. Ç. (2018). *A performance based decision-making approach for insulation material selection: a social housing case*. [Doctoral dissertation, Istanbul Technical University]. Council of Higher Education Thesis Center (YÖK). https://tez.yok.gov.tr/UlusalTezMerkezi/giris.jsp

Yılmaz, E. ve Çiçek, İ. (2016). Türkiye Thornthwaite iklim sınıflandırması. Journal of Human Sciences, 13(3), 3973-3994.

Yılmaz, Z. & Özgünler, M. (1993). Toplu konutlarda iç iklim koşulları ve kullanıcıların iklimsel tepkimeleri. *Konut Araştırmaları Sempozyumu* (pp. 269-287). T.C. Başbakanlık Toplu Konut İdaresi Başkanlığı ÖDTÜ Konut Araştırmaları Merkezi.

Yılmaz, Z. (2006). Evaluation of energy efficient design strategies for different climatic zones: Comparison of thermal performance of buildings in temperate-humid and hot-dry climate. Energy and Buildings 39 (2007) 306–316. https://www.journals.elsevier.com/energy-and-buildings

Yohans Y. G., Mondol, J. D., Wright, A. & Norton, B. (2008). Real-life energy use in the UK: How occupancy and dwelling characteristics affect domestic electricity use. *Energy and Buildings,* 40, 1053-1059. doi:10.1016/j.enbuild.2007.09.001.

Yu, Z., Fungb, B.C.M., Haghighata, F.,Yoshinoc, H. & Morofskyd E. (2011). A systematic procedure to study the influence of occupant behavior on building energy consumption. *Energy and Buildings,* 43, 1409–1417. doi:10.1016/j.enbuilding.2011.02.002.

Yu, Z., Haghighat, F., Fung, B.C.M., Morofsky, E. & Yoshino, H. (2011). A methodology for identifying and improving occupant behavior in residential buildings. *Energy*, 36, 6596-6608. doi:10.1016/j.energy.2011.09.002

Zorlu, T. ve Sağsöz, A., 2010. Müstakil Konut Sitelerinde Kullanıcı Tercihlerine Bağlı Fiziki Müdahaleler: Trabzon Örneği, METU Journal of the Faculty of Architecture, 27, 2, 189-206, http://jfa.arch.metu.edu.tr/archive/0258-5316/2010/cilt27/sayi_2/189-206.pdf, 4 Şubat 2015.

APPENDICES

A. Information on Demograhics in Turkey

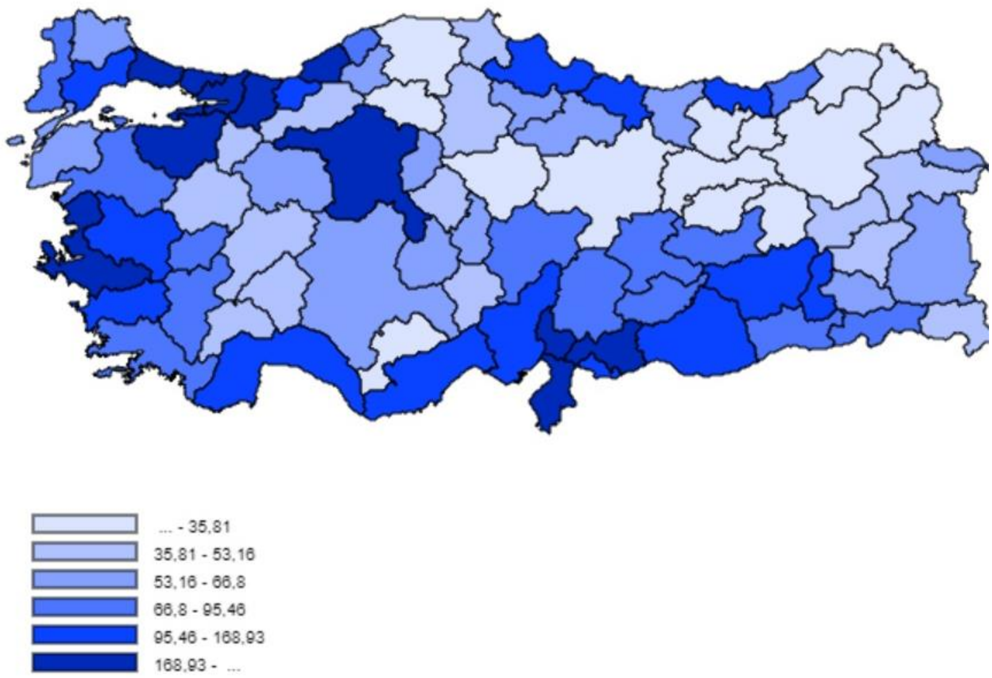


Figure A.1. Population density per square kilometer Source: TUIK, 2017

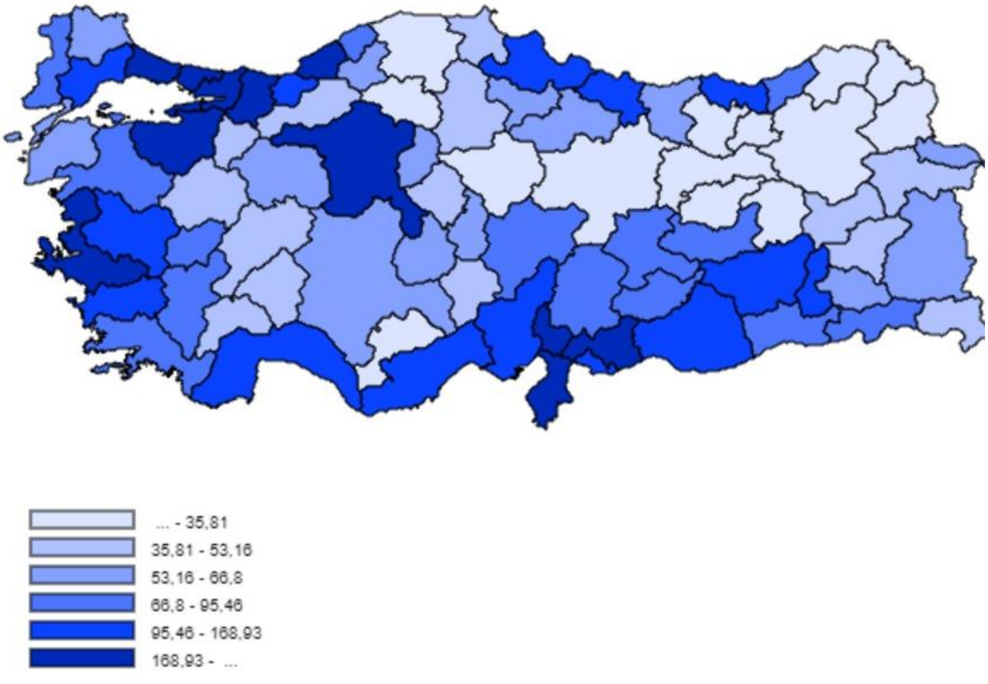


Figure A.2. population density per square kilometer Source: TUIK, 2017

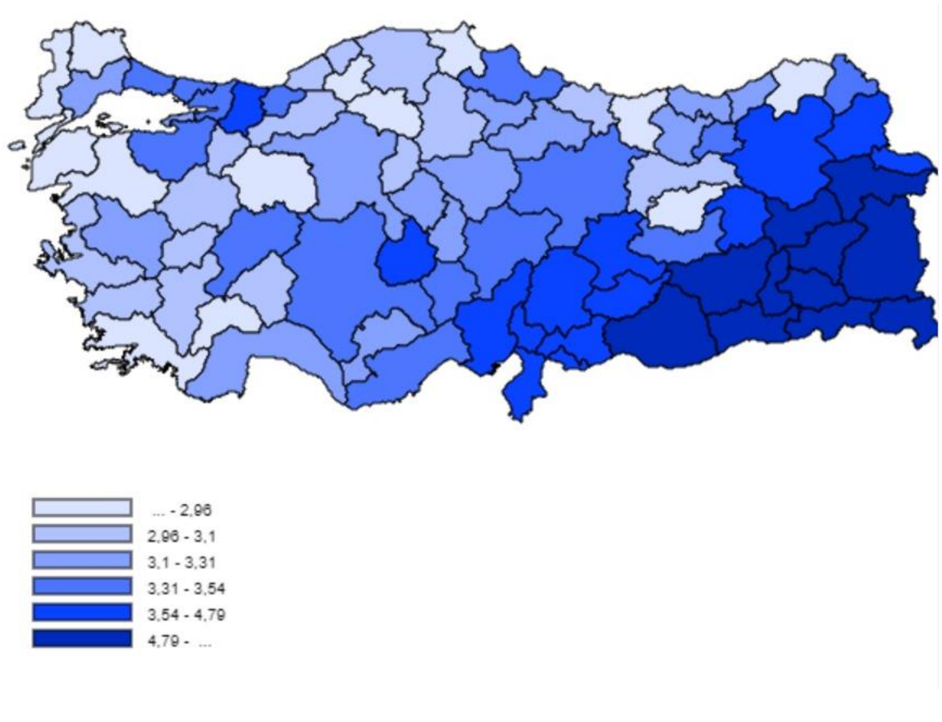


Figure A.3. population density per square kilometer Source: TUIK, 2017

B. Climatic Characteristics Of Cities In Turkey According To Climate Classification Methods

	CIMATE CLASSIFICATION METHODS				
CITY	AYDENİZ	ERİNÇ	KÖPPEN	KÖPPEN-TREWARTHA	DE-MARTONNE
ADANA	Semi Dry	Semi Humid	Csa	Cshk	Step – Semi Humid
ADIYAMAN	Dry	Semi Humid	Csa	Cshk	Step – Semi Humid
AFYONKARAHİSAR	Semi Dry	Semi Humid	Csa	Dcbk	Step – Semi Humid
AĞRI	Semi Humid	Humid	Dsb	Dcb”c	Step – Semi Humid
AKSARAY	Very Dry	Semi Dry	BSk	Dcak	Semi Dry
AMASYA	Semi Dry	Semi Humid	Csa	Doak	Step – Semi Humid
ANKARA	Dry	Semi Dry	Csa	Dcak	Step – Semi Humid
ANTAKYA (HATAY)	Humid	Humid	Csa	Csak	Step – Semi Humid
ANTALYA	Semi Humid	Humid	Csa	Cshk	Step – Semi Humid
ARDAHAN	Humid	Humid	Dfb	Dclc	Semi Humid
ARTVİN	Humid	Humid	Csb	Dobk	Semi Humid
AYDIN	Dry	Semi Humid	Csa	Cshk	Step – Semi Humid
BALIKESİR	Semi Humid	Semi Humid	Csa	Doak	Step – Semi Humid
BARTIN	Humid	Very Humid	Cfb	Dobk	Humid
BATMAN	Dry	Semi Dry	Csa	Cshk	Semi Dry
BAYBURT	Semi Humid	Semi Humid	Dsb	Dcbo	Step – Semi Humid
BİLECİK	Semi Dry	Semi Humid	Csa	Dobk	Step – Semi Humid
BİNGÖL	Semi Humid	Humid	Csa	Dcao	Semi Humid
BİTLİS	Humid	Very Humid	Csa	Dcbo	Humid
BOLU	Humid	Semi Humid	Cfb	Dcbk	Step – Semi Humid
BURDUR	Dry	Semi Dry	Csa	Doak	Step – Semi Humid
BURSA	Semi Humid	Semi Humid	Csa	Csak	Step – Semi Humid
ÇANAKKALE	Semi Humid	Semi Humid	Csa	Csak	Step – Semi Humid
ÇANKIRI	Semi Dry	Semi Dry	Cfa	Dcbo	Step – Semi Humid
ÇORUM	Semi Humid	Semi Humid	Cfb	Dcbo	Step – Semi Humid
DENİZLİ	Dry	Semi Humid	Csa	Csak	Step – Semi Humid
DİYARBAKIR	Dry	Semi Dry	Csa	Dchk	Semi Dry
DÜZCE	Humid	Humid	Cfa	Dobk	Semi Humid
EDİRNE	Semi Humid	Semi Humid	Csa	Doak	Step – Semi Humid
ELAZIĞ	Very Dry	Semi Dry	BSk	Dcao	Semi Dry
ERZİNCAN	Dry	Semi Dry	Csa	Dcao	Step – Semi Humid
ERZURUM	Semi Humid	Semi Humid	Dsb	Dcbc	Step – Semi Humid
ESKİŞEHİR	Dry	Semi Dry	BSk	Dcbo	Semi Dry

GAZİANTEP	Dry	Semi Humid	Csa	Dohk	Step – Semi Humid
GİRESUN	Semi Humid	Very Humid	Cfa	Cfak	Very Humid
GÜMÜŞHANE	Semi Dry	Semi Humid	Csb	Dcbo	Step – Semi Humid
HAKKARİ	Semi Dry	Humid	Dsa	Dcao	Step – Semi Humid
IĞDIR	Very Dry	Kurak	BSk	BSao	Semi Dry
ISPARTA	Semi Dry	Semi Humid	Csa	Dcak	Step – Semi Humid
İSTANBUL	Humid	Semi Humid	Csa	Csak	Step – Semi Humid
İZMİR	Semi Dry	Semi Humid	Csa	Cshk	Step – Semi Humid
KAHRAMANMA RAŞ	Semi Dry	Semi Humid	Csa	Cshk	Step – Semi Humid
KARABÜK	Semi Humid	Semi Humid	Cfa	Doak	Step – Semi Humid
KARAMAN	Very Dry	Semi Dry	BSk	Dcak	Semi Dry
KARS	Humid	Humid	Dfb	Dclc	Semi Humid
KASTAMONU	Semi Humid	Semi Humid	Cfb	Dcbo	Semi Humid
KAYSERİ	Dry	Semi Dry	Csa	Dcbo	Step – Semi Humid
KIRIKKALE	Dry	Semi Dry	BSk	Dcak	Semi Dry
KIRKLARELİ	Semi Humid	Semi Humid	Csa	Doak	Step – Semi Humid
KIRŞEHİR	Dry	Semi Dry	Csa	Dcao	Semi Dry
KİLİS	Very Dry	Semi Dry	Csa	Cshk	Semi Dry
KOCAELİ	Humid	Humid	Cfa	Cfak	Semi Humid
KONYA	Very Dry	Semi Dry	BSk	Dcao	Semi Dry
KÜTAHYA	Semi Humid	Semi Humid	Csb	Dcbk	Step – Semi Humid
MALATYA	Very Dry	Semi Dry	BSk	Dcak	Semi Dry
MANİSA	Semi Dry	Semi Humid	Csa	Cshk	Step – Semi Humid
MARDİN	Dry	Semi Humid	Csa	Cshk	Step – Semi Humid
MERSİN	Dry	Semi Humid	Csa	Cshl	Step – Semi Humid
MUĞLA	Humid	Humid	Csa	Csak	Semi Humid
MUŞ	Semi Humid	Humid	Dsa	Dcao	Semi Humid
NEVŞEHİR	Dry	Semi Humid	Csb	Dcbo	Step – Semi Humid
NİĞDE	Dry	Semi Dry	BSk	Dcbo	Semi Dry
ORDU	Humid	Very Humid	Cfa	Cfak	Humid
OSMANİYE	Semi Humid	Semi Humid	Csa	Cshk	Step – Semi Humid
RİZE	Very Humid	Very Humid	Cfa	Cfak	Wet
SAKARYA	Humid	Humid	Cfa	Cfak	Semi Humid
SAMSUN	Humid	Semi Humid	Cfa	Cfak	Semi Humid
SİİRT	Dry	Semi Humid	Csa	Cshk	Step – Semi Humid
SİNOP	Nemli	Humid	Cfa	Cfak	Semi Humid
SİVAS	Semi Dry	Semi Humid	Dsb	Dcbo	Step – Semi Humid
ŞANLIURFA	Very Dry	Semi Dry	Csa	Cshk	Semi Dry
ŞIRNAK	Dry	Semi Humid	Csa	Dohk	Step – Semi Humid
TEKİRDAĞ	Semi Humid	Semi Humid	Csa	Csak	Step – Semi Humid

TOKAT	Semi Dry	Semi Humid	Csa	Dcbk	Step – Semi Humid
TRABZON	Humid	Humid	Cfa	Cfak	Semi Humid
TUNCELİ	Semi Humid	Humid	Csa	Dcao	Step – Semi Humid
UŞAK	Semi Dry	Semi Humid	Csa	Doak	Step – Semi Humid
VAN	Dry	Semi Humid	Csa	Dcbo	Step – Semi Humid
YALOVA	Humid	Semi Humid	Csa	Csak	Step – Semi Humid
YOZGAT	Semi Humid	Humid	Csb	Dcbo	Step – Semi Humid
ZONGULDAK	Çok Nemli	Çok Nemli	Cfa	Cfbk	Very Humid

KÖPPEN: BSk: Yarı Kurak Step İklimi(soğuk); **Cfa:** Kışı ılık, yazı çok sıcak ve her mevsim yağışlı iklim; **Cfb:** Kışı ve yazı ılık, her mevsim yağışlı iklim; **Csa:** Kışı ılık, yazı çok sıcak ve kurak iklim (Akdeniz iklimi); **Csb:** Kışı ılık, yazı ılık ve kurak iklim; **Dfb:** Kışı Şiddetli, her mevsim yağışlı, Yazı Serin; **Dsa:** Kışı Şiddetli, Yazı Kurak ve sıcak; **Dsb:** Kışı Şiddetli, Yazı Kurak ve Serin

KÖPPEN-TREWARTHA: Bsao: Yazları sıcak, Kışları soğuk, Yarı Kurak-Step İklim; **Cfak:** Yazları sıcak, Kışları serin, Subtropikal nemli iklim; **Cfbk**: Yazları ılık, Kışları serin, Subtropikal nemli iklim; **Csak**: Yazları sıcak, Kışları serin, Subtropikal kuru yaz iklimi, Akdeniz iklimi; **Cshk:** Yazları çok sıcak, Kışları serin, Subtropikal kuru yaz iklimi, Akdeniz iklimi; **Dcak:** Yazları sıcak, Kışları serin, Ilıman Karasal; **Dcao:** Yazları sıcak, Kışları soğuk, Ilıman Karasal; **Dcbc:** Yazları ılık, Kışları çok soğuk, Ilıman Karasal; **Dcbk:** Yazları ılık, Kışları serin, Ilıman Karasal; **Dcbo:** Yazları ılık, Kışları soğuk, Ilıman Karasal; **Dchk:** Yazları çok sıcak, Kışları serin, Ilıman Karasal; **Dclc:** Yazları Ilıman, Kışları çok soğuk, Ilıman Karasal; **Doak:** Yazları sıcak, Kışları serin, Ilıman Denizsel; **Dobk:** Yazları ılık, Kışları serin, Ilıman Denizsel; **Dohk:** Yazları çok sıcak, Kışları serin, Ilıman Denizsel

C. Climate Maps of Turkey According To Climate Classification Methods

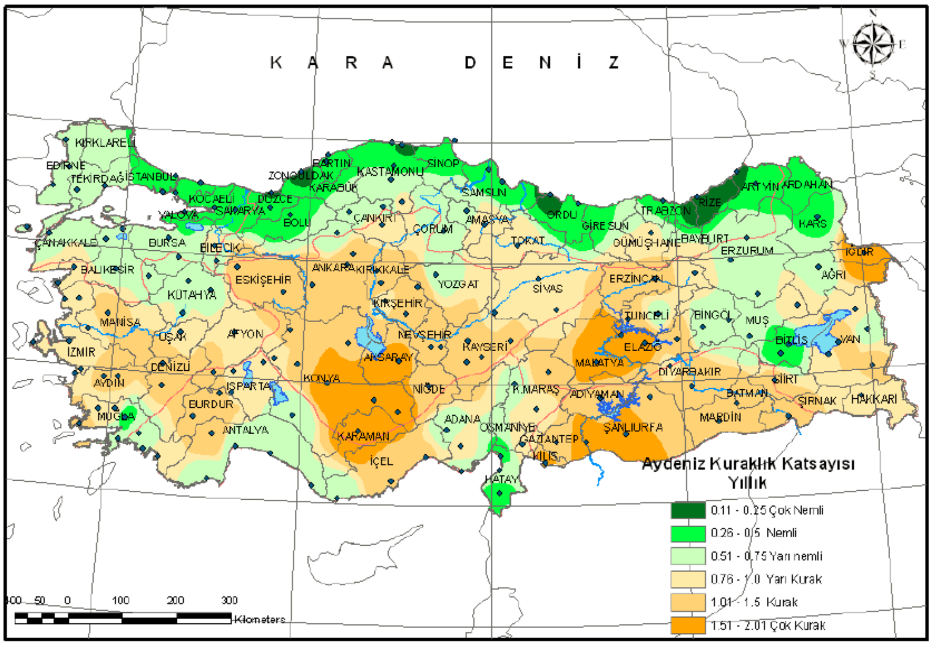


Figure C.1 Climate classifications of Turkey by Aydeniz Method.

Source: Bölük, 2016a

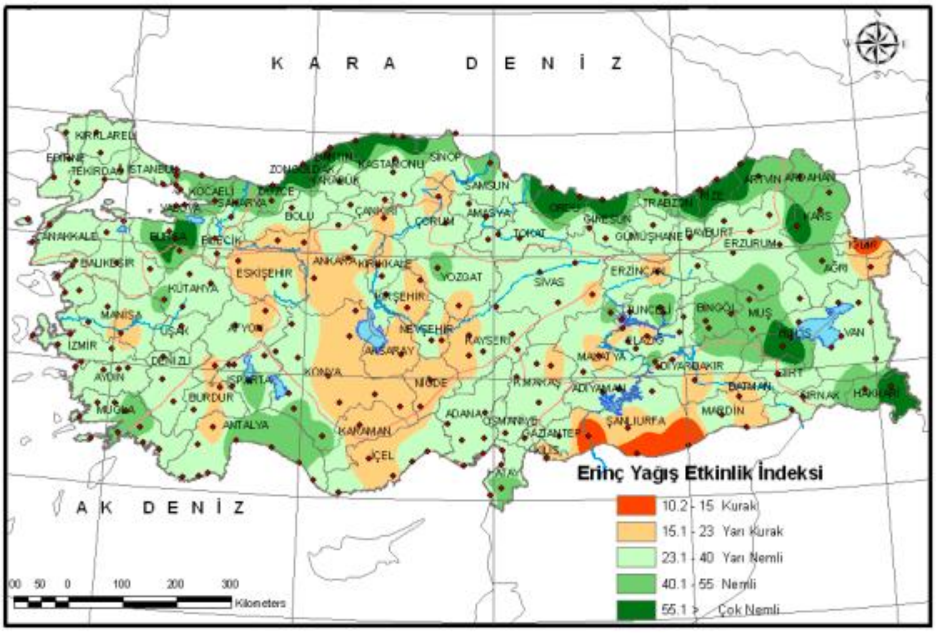


Figure C.2 Climate classifications of Turkey by Erinç Method

Source: Bölük, 2016b

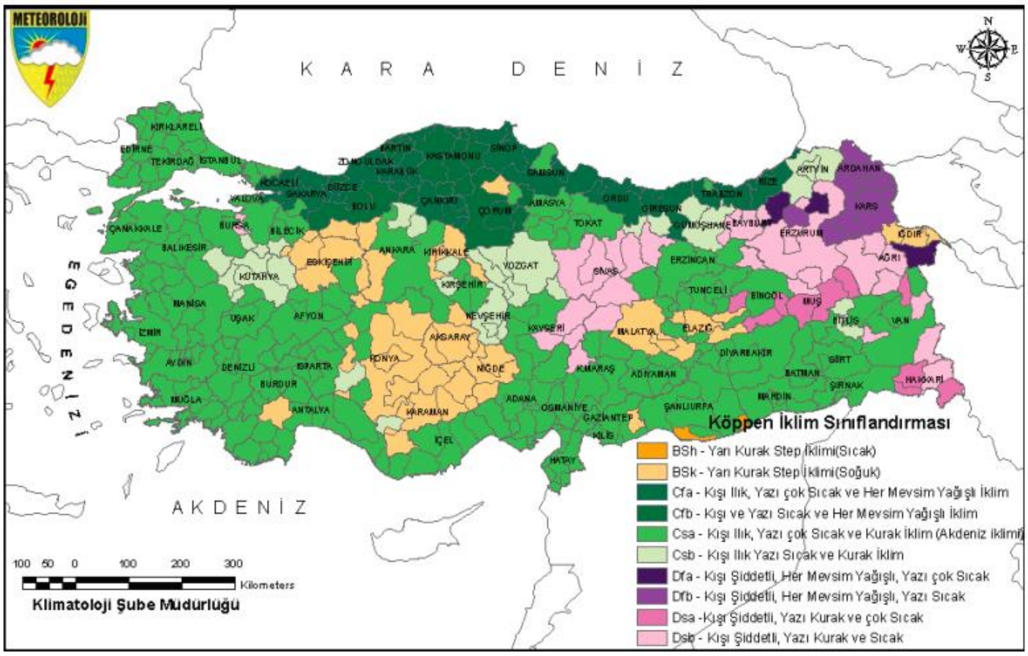


Figure C.3 Climate classifications of Turkey by Köppen Method

Source: Bölük, 2016c

Figure C.4 Climate classifications of Turkey by Köppen-Trewartha Method

Source: Bölük & Kömüşçü, 2018

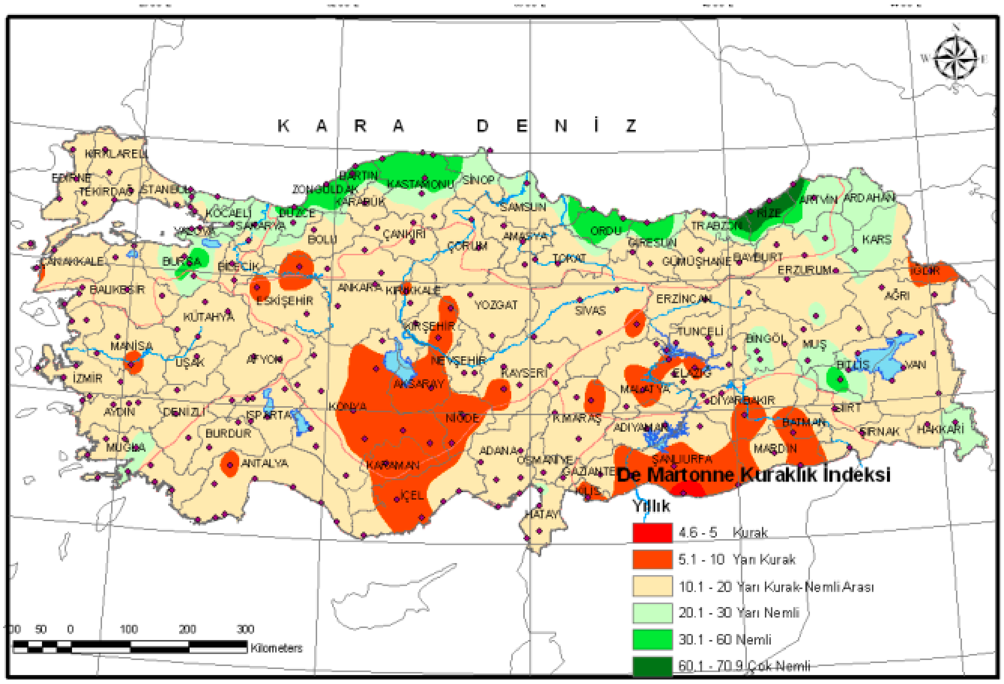


Figure C.5 Climate classifications of Turkey by De Martonne Method

Source: Bölük, 2016d

D. Climate Classification According To The Geographical Region Boundaries

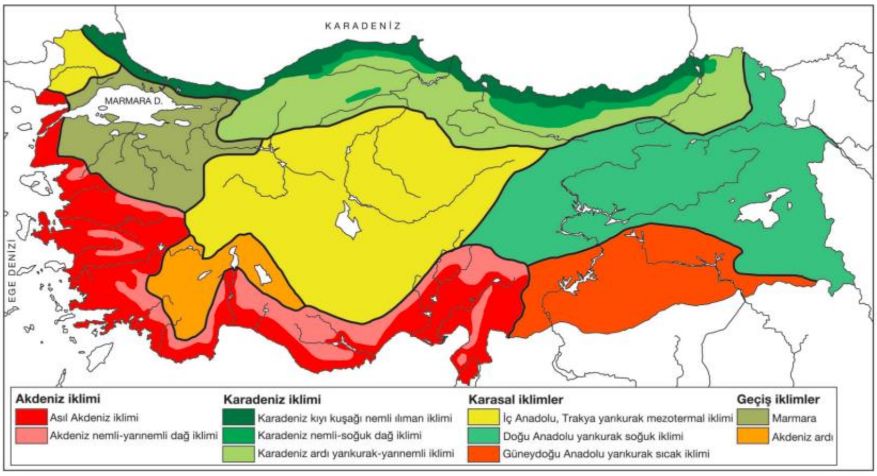


Figure D.1: Turkey climate types according to the Geographical boundaries (Source: Gönençgil et al,2016)

E. Climate Regions and Classifications based on TS 825 and Other Methods

CITY	DDR CLASSIFICATION TS 825, 2013 (Only HDD)	Reclasification * (Both HDD and CDD)	Bioclimatic Classification **	Climatic classification***
ADANA	1st DDR	1st DDR	5 (Hot - Humid)	5 (Hot -Humid)
ADIYAMAN	2nd DDR	3rd DDR	6 (Hot - Dry)	6 (Hot-Dry)
AFYONKARAHİSAR	3rd DDR	3rd DDR	2 (Temperate - Dry)	2 (Temperate - Dry)
AĞRI	5th DDR	5th DDR	1 (Cool)	1 (Cool)
AKSARAY	3rd DDR	3rd DDR	2 (Temperate - Dry)	2 (Temperate - Dry)
AMASYA	2nd DDR	3rd DDR	3 (Temperate)	4 (Temperate – Humid)
ANKARA	3rd DDR	3rd DDR	2 (Temperate - Dry)	2 (Temperate - Dry)
ANTAKYA (HATAY)	1st DDR	1st DDR	5 (Hot -Humid)	5 (Hot -Humid)
ANTALYA	1st DDR	1st DDR	7 (Composite)	5 (Hot -Humid)
ARDAHAN	5th DDR	5th DDR	1 (Cool)	1 (Cool)
ARTVİN	3rd DDR	3rd DDR	4 (Temperate – Humid)	4 (Temperate – Humid)
AYDIN	1st DDR	1st DDR	7 (Composite)	5 (Hot -Humid)
BALIKESİR	2nd DDR	2nd DDR	3 (Temperate)	4 (Temperate – Humid)
BARTIN	2nd DDR	2nd DDR	4 (Temperate – Humid)	4 (Temperate – Humid)
BATMAN	2nd DDR	3rd DDR	6 (Hot-Dry)	6 (Hot-Dry)
BAYBURT	4th DDR	5th DDR	2 (Temperate - Dry)	1 (Cool)
BİLECİK	3rd DDR	3rd DDR	3 (Temperate)	4 (Temperate – Humid)
BİNGÖL	3rd DDR	4th DDR	2 (Temperate - Dry)	1 (Cool)
BİTLİS	4th DDR	4th DDR	1 (Cool)	1 (Cool)
BOLU	3rd DDR	3rd DDR	2 (Temperate - Dry)	1 (Cool)
BURDUR	3rd DDR	3rd DDR	2 (Temperate - Dry)	2 (Temperate - Dry)
BURSA	2nd DDR	2nd DDR	3 (Temperate)	4 (Temperate – Humid)
ÇANAKKALE	2nd DDR	2nd DDR	3 (Temperate)	4 (Temperate – Humid)
ÇANKIRI	3rd DDR	4th DDR	2 (Temperate - Dry)	2 (Temperate - Dry)
ÇORUM	3rd DDR	4th DDR	2 (Temperate - Dry)	2 (Temperate - Dry)
DENİZLİ	2nd DDR	2nd DDR	7 (Composite)	5 (Hot -Humid)
DİYARBAKIR	2nd DDR	3rd DDR	6 (Hot-Dry)	6 (Hot-Dry)
DÜZCE	2nd DDR	2nd DDR	3 (Temperate)	4 (Temperate – Humid)
EDİRNE	2nd DDR	3rd DDR	3 (Temperate)	4 (Temperate – Humid)
ELAZIĞ	3rd DDR	3rd DDR	2 (Temperate - Dry)	2 (Temperate - Dry)
ERZİNCAN	4th DDR	4th DDR	1 (Cool)	2 (Temperate - Dry)

ERZURUM	5th DDR	5th DDR	1 (Cool)	1 (Cool)
ESKİŞEHİR	3rd DDR	3rd DDR	2 (Temperate - Dry)	2 (Temperate - Dry)
GAZİANTEP	2nd DDR	3rd DDR	6 (Hot-Dry)	6 (Hot-Dry)
GİRESUN	2nd DDR	2nd DDR	3 (Temperate)	4 (Temperate – Humid)
GÜMÜŞHANE	4th DDR	4th DDR	2 (Temperate - Dry)	1 (Cool)
HAKKARİ	4th DDR	4th DDR	1 (Cool)	1 (Cool)
IĞDIR	3rd DDR	4th DDR	1 (Cool)	2 (Temperate - Dry)
ISPARTA	3rd DDR	3rd DDR	2 (Temperate - Dry)	2 (Temperate - Dry)
İSTANBUL	2nd DDR	2nd DDR	3 (Temperate)	4 (Temperate – Humid)
İZMİR	1st DDR	1st DDR	7 (Composite)	5 (Hot -Humid)
KAHRAMANMARAŞ	2nd DDR	2nd DDR	6 (Hot-Dry)	6 (Hot-Dry)
KARABÜK	3rd DDR	3rd DDR	2 (Temperate - Dry)	4 (Temperate – Humid)
KARAMAN	3rd DDR	3rd DDR	2 (Temperate - Dry)	2 (Temperate - Dry)
KARS	5th DDR	5th DDR	1 (Cool)	1 (Cool)
KASTAMONU	4th DDR	4th DDR	2 (Temperate - Dry)	1 (Cool)
KAYSERİ	4th DDR	4th DDR	1 (Cool)	2 (Temperate - Dry)
KIRIKKALE	3rd DDR	3rd DDR	2 (Temperate - Dry)	2 (Temperate - Dry)
KIRKLARELİ	3rd DDR	3rd DDR	2 (Temperate - Dry)	4 (Temperate – Humid)
KIRŞEHİR	3rd DDR	3rd DDR	2 (Temperate - Dry)	2 (Temperate - Dry)
KİLİS	2nd DDR	2nd DDR	6 (Hot-Dry)	6 (Hot-Dry)
KOCAELİ	2nd DDR	2nd DDR	3 (Temperate)	4 (Temperate – Humid)
KONYA	3rd DDR	3rd DDR	2 (Temperate - Dry)	2 (Temperate - Dry)
KÜTAHYA	3rd DDR	3rd DDR	2 (Temperate - Dry)	2 (Temperate - Dry)
MALATYA	3rd DDR	3rd DDR	2 (Temperate - Dry)	2 (Temperate - Dry)
MANİSA	2nd DDR	2nd DDR	7 (Composite)	5 (Hot -Humid)
MARDİN	2nd DDR	3rd DDR	6 (Hot-Dry)	6 (Hot-Dry)
MERSİN	1st DDR	1st DDR	5 (Hot -Humid)	5 (Hot -Humid)
MUĞLA	2nd DDR	2nd DDR	7 (Composite)	5 (Hot -Humid)
MUŞ	4th DDR	4th DDR	1 (Cool)	1 (Cool)
NEVŞEHİR	3rd DDR	4th DDR	2 (Temperate - Dry)	2 (Temperate - Dry)
NİĞDE	3rd DDR	3rd DDR	2 (Temperate - Dry)	2 (Temperate - Dry)
ORDU	2nd DDR	2nd DDR	3 (Temperate)	4 (Temperate – Humid)
OSMANİYE	1st DDR	1st DDR	3 (Temperate)	5 (Hot -Humid)
RİZE	2nd DDR	2nd DDR	4 (Temperate – Humid)	4 (Temperate – Humid)
SAKARYA	2nd DDR	2nd DDR	3 (Temperate)	4 (Temperate – Humid)

SAMSUN	2nd DDR	2nd DDR	3 (Temperate)	4 (Temperate – Humid)
SİİRT	2nd DDR	3rd DDR	1 (Cool)	6 (Hot-Dry)
SİNOP	2nd DDR	2nd DDR	4 (Temperate – Humid)	4 (Temperate – Humid)
SİVAS	4th DDR	4th DDR	1 (Cool)	1 (Cool)
ŞANLIURFA	2nd DDR	2nd DDR	6 (Hot-Dry)	6 (Hot-Dry)
ŞIRNAK	2nd DDR	3rd DDR	6 (Hot-Dry)	6 (Hot-Dry)
TEKİRDAĞ	2nd DDR	2nd DDR	3 (Temperate)	4 (Temperate – Humid)
TOKAT	3rd DDR	3rd DDR	3 (Temperate)	4 (Temperate – Humid)
TRABZON	2nd DDR	2nd DDR	4 (Temperate – Humid)	4 (Temperate – Humid)
TUNCELİ	3rd DDR	4th DDR	2 (Temperate - Dry)	1 (Cool)
UŞAK	3rd DDR	3rd DDR	2 (Temperate - Dry)	2 (Temperate - Dry)
VAN	4th DDR	4th DDR	1 (Cool)	1 (Cool)
YALOVA	2nd DDR	2nd DDR	3 (Temperate)	4 (Temperate – Humid)
YOZGAT	4th DDR	4th DDR	1 (Cool)	1 (Cool)
ZONGULDAK	2nd DDR	2nd DDR	4 (Temperate – Humid)	4 (Temperate – Humid)
* Source: Tükel, Tunçbilek, Komerska, Keskin, & Arıcı, 2021 **Source: Özdeniz, 1991 ***Source: Ovalı, 2019				

F. Climate Regions Maps Of Turkey Classifying Different Methods

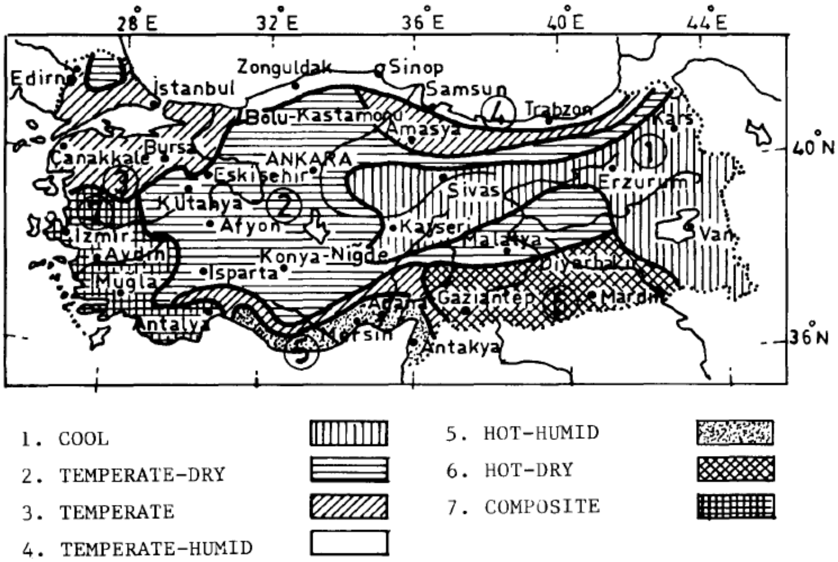


Figure F.1 The climatic map of Turkey according to the bioclimatic analysis

Source: Özdeniz, 1991

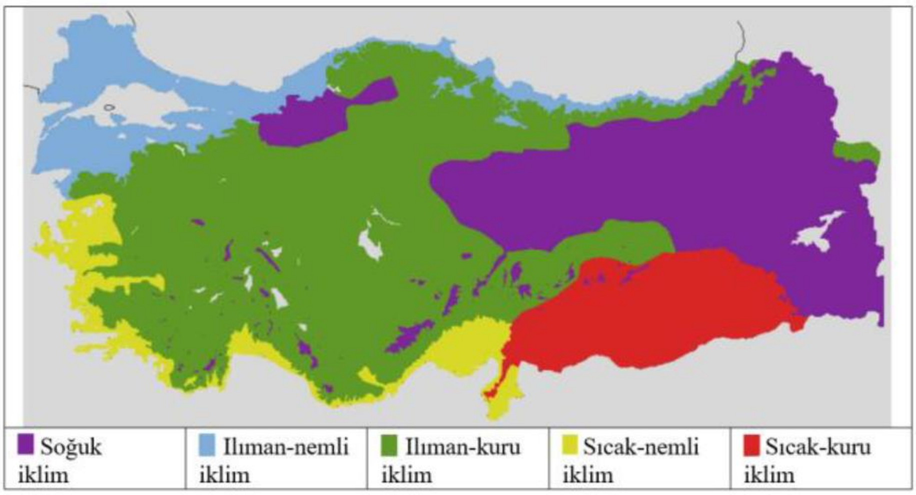


Figure F.2 The climatic map of Turkey

Source: Ovalı, 2019

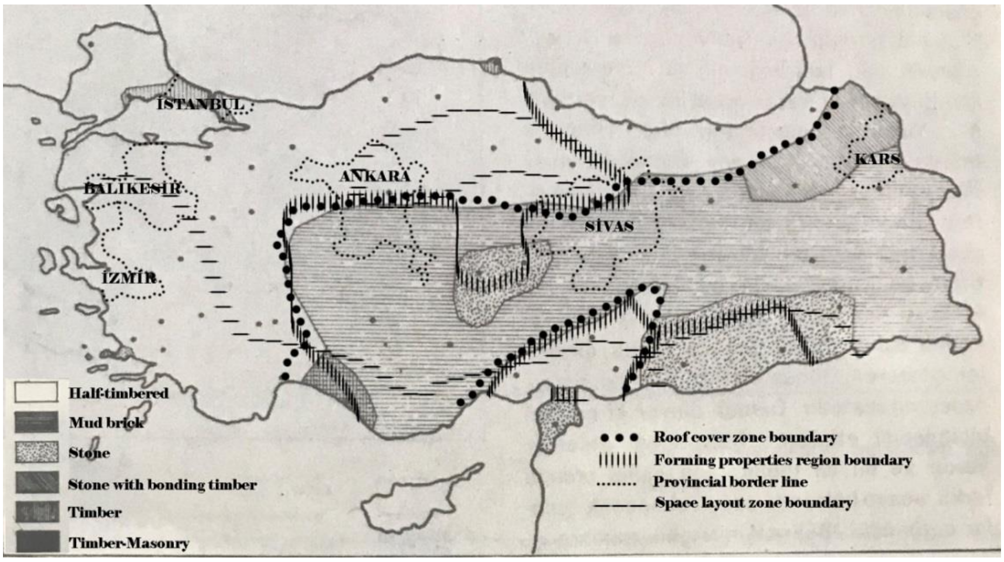


Figure F.3 Regions that differ in Anatolian Turkish residential architecture.
(Source: Kazmaoğlu & Tanyeli, 1978 as cited in Karagülle, 2009)

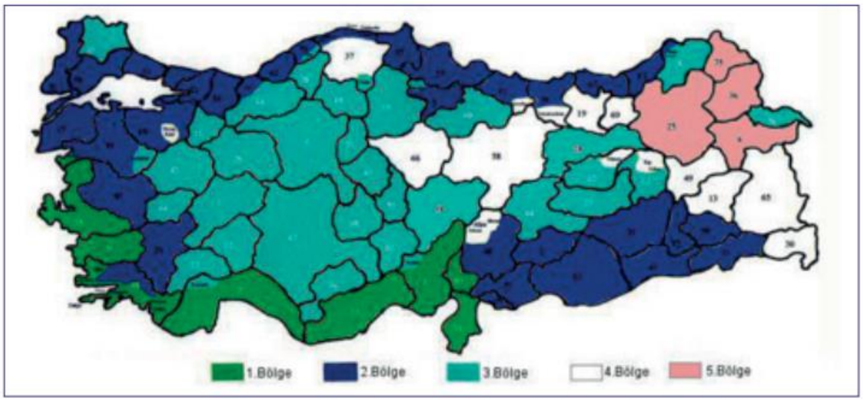


Figure F.4 Provinces according to DDR in TS 825

(Source: TS 825, 2013)

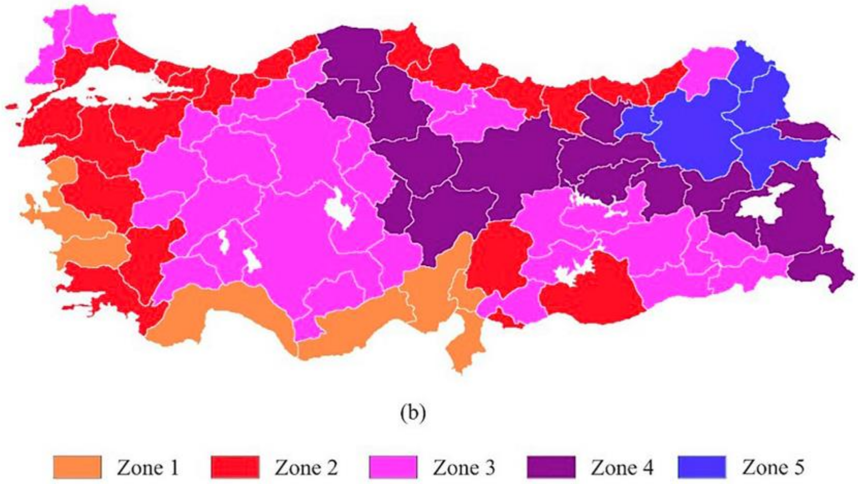


Figure F.6 Provinces according to HDD and CDD
(Source: Tükel, Tunçbilek, Komerska, Keskin, & Arıcı, 2021)

G. Ethics Approval for Questionnaire and Self-Report Surveys

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06 Nisan 2016

Gönderilen: Prof. Dr. Soofia-Tahira Elias- OZKAN
Mimarlık Bölümü

Gönderen: Prof. Dr. Canan SÜMER
İnsan Araştırmaları Kurulu Başkanı

İlgi: Etik Onayı

Sayın Prof. Dr. Soofia-Tahira Elias- OZKAN'un danışmanlığını yaptığı doktora öğrencisi Özün Taner DÜZYOL'Un "Kullanıcı davranışı ve enerji tüketimi" başlıklı araştırması İnsan Araştırmaları Komisyonu tarafından uygun görülerek gerekli onay **2016-FEN-026** protokol numarası ile **15.03.2016-30.04.2016** tarihleri arasında geçerli olmak üzere verilmiştir.

Prof. Dr. Canan SÜMER
Uygulamalı Etik Araştırma Merkezi
İnsan Araştırmaları Kurulu Başkanı

BU BÖLÜM, İLGİLİ BÖLÜMLERİ TEMSİL EDEN İNSAN ARAŞTIRMALARI ETİK ALT KURULU TARAFINDAN DOLDURULACAKTIR.

Protokol No: 2016-FEN-026

İAEK DEĞERLENDİRME SONUCU

Sayın Hakem,

Aşağıda yer alan üç seçenekten birini işaretleyerek değerlendirmenizi tamamlayınız. Lütfen "<u>Revizyon Gereklidir</u>" ve "<u>Ret</u>" değerlendirmeleri için gerekli açıklamaları yapınız.

Değerlendirme Tarihi: 02.04.2016

Ad Soyad: Metin girmek için tıklayın

☒ **Herhangi bir değişikliğe gerek yoktur. Veri toplama/uygulama başlatılabilir.**

☐ **Revizyon gereklidir**

- ☐ Gönüllü Katılım Formu yoktur.
- ☐ Gönüllü Katılım Formu eksiktir.
  - Gerekçenizi ayrıntılı olarak açıklayınız:
- ☐ Katılım Sonrası Bilgilendirme Formu yoktur.
- ☐ Katılım Sonrası Bilgilendirme Formu eksiktir.
  - Gerekçenizi ayrıntılı olarak açıklayınız:
- ☐ Rahatsızlık kaynağı olabilecek sorular/maddeler ya da prosedürler içerilmektedir.
  - Gerekçenizi ayrıntılı olarak açıklayınız:
- ☐ Diğer.
  - Gerekçenizi ayrıntılı olarak açıklayınız:

☐ **Ret**

Ret gerekçenizi ayrıntılı olarak açıklayınız:

H. Questionaire Survey

Tarih/Date ……..……...………. Şehir/City……………………………. Üniversite/University……………………………….

GENEL BİLGİLER/ GENERAL INFORMATION

Bu bölümde yer alan soruların tamamı genel demografik yapı ile ilgili bilgi edinme amaçlı olup doğru ve eksiksiz doldurulması bu anket çalışması için önemlidir / All of the questions in this section are for the purpose of obtaining information about the general demographic structure and it is important for this survey to be filled in correctly and completely

1. Cinsiyetiniz/Gender

   ☐ Kadın /Female ☐ Erkek/Male

2. Doğum yılınız/Year of birth: ……………………………………………………………………
3. Doğduğunuz İlçe/il/Place of birth: ……………………………………………………………
4. Üniversite/Bölüm/University/Department……………………….…………………/…………………..
5. Şuanda devam etmekte olduğunuz eğitimi belirtiniz/Continuing education

   ☐ Lisans/Undergraduate ☐ Master/Graduate ☐ Doktora/PhD

6. Yukarıda belirtmiş olduğunuz eğitime başlama yılınız: ………………............
   The year you started the education you mentioned above
7. Şuanda bulunduğunuz şehire geldiğiniz yıl: ……………………...................
   The year you came to your current city
8. Birden fazla yer değiştirdiyseniz en uzun sureli kaldığınız ili ve kaç yıl kaldığınızı belirtiniz.
   If you have moved more than once, please indicate the province you have stayed in for the longest time and how many years you have stayed

   ☐ Evet ise/If yes İl/City: …………….……….Hangi yıllar arası kaldınız?/What years did you stay?
   ☐ Hayır/If no

9. Üniversite döneminden once en son yaşamış olduğunuz köy/ilçe/il: ……………
   The village/district/province where you last lived before university
10. Bu köy/ilçe/il de hangi yıllar arasında yaşadınız? ....……...........
    Between which years did you live in this village/district/province?
11. Bu köy/ilçe/il de kiminle yaşıyordunuz?
    Who did you live with in this village/district/province?

    ☐ Ailemle/Family ☐ Aile yakınımla /Close Family ☐ Yatılı okulda/Boarding school ☐ Diğer/Other………

1. YURT ODASI DORMITORY ROOM

*Bu bölümün tamamı şuanda kalıyor olduğunuz yurt odası ile ilgili sorulardan oluşmakta olup sizden beklenen değerlendirmeler sadece **kış** dönemini kapsamaktadır /This entire section consists of questions about the dormitory room you are currently staying in, and the evaluations expected from you only cover the winter period.*

1. Ne kadar süredir şuanki yurtta kalıyorsunuz?
   How long have you been living in your current dormitory?

   ☐ 1 yıldan az/less than 1 year ☐1 – 2 yıl /year ☐ 3 – 5 yıl/year ☐ 5 yıldan fazla/more than 5 year

2. Şuandaki odayı sizinle birlikte kaç kişi paylaşıyorsunuz? ....
   How many people do you share the current room with?

3. **Kış dönemi** süresince odanızda zamanınızı çoğunlukla hangi saat aralıklarında geçirdiğinizi (odanızın içerisinde çalışma alanı ve yemek alanı gibi ayrılmış alanlarda dahil) aşağıda verilen seçeneklerden uygun olanları işaretleyerek belirtiniz. *(Birden fazla seçeneği işaretleyebilirsiz). (Lütfen işaretlemeyi aşağıda sıralandığı gibi Hafta içi, Cumartes ve Pazar olarak üç alanda da yapınız)* Indicate the time intervals in which you spend most of your time in your room during the winter period (including the separated areas in your room such as the working area and dining area) by ticking the appropriate options below. *(You can tick more than one option). (Please mark in all three areas as Weekdays, Saturdays and Sundays as listed below)*

   Hafta içi /Weekdays
   ☐08:00 - 11:00 ☐11:30 - 13:00 ☐13:30 - 18:00 ☐18:30 - 20:00 ☐20:30 - 07:30

   Cumartesi/Saturday
   ☐Tüm gün ☐08:00 - 11:00 ☐11:30 - 13:00 ☐13:30 - 18:00 ☐18:30 - 20:00 ☐20:30 - 07:30

   Pazar/Sunday
   ☐Tüm gün ☐08:00 - 11:00 ☐11:30 - 13:00 ☐13:30 - 18:00 ☐18:30 - 20:00 ☐20:30 - 07:30

4. Odanızı aşağıda sıralanan her bir konu için 1 den 5 e kadar değerlendiriniz. (*5 çok memnun olduğunuzu 1 ise çok memnuniyetsiz olduğunuzu belirtmektedir)*. Rate your room on a scale of 1 to 5 for each of the topics listed below. *(5 indicates that you are very satisfied, 1 indicates that you are very dissatisfied)*.

(Çok memnun/very satisfied	1	2	3	4	5	Çokmemnuniyetsiz/very dissatisfied
Oda yeteri kadar gün ışığı alıyor mu?/ Does the room get enough daylight?	☐	☐	☐	☐	☐	
Binada ses yalıtımı yeterli mi? Is sound insulation sufficient in the building?	☐	☐	☐	☐	☐	
Oda sıcaklığı yeterli mi? Is the room temperature sufficient?	☐	☐	☐	☐	☐	
Odayı yeteri kadar havalandırabiliyor musunuz? Able to ventilate the room adequately do you?	☐	☐	☐	☐	☐	
Genel olarak odanızın fiziksel koşullarından memnun musunuz?/Are you satisfied with the physical conditions of your room in general?	☐	☐	☐	☐	☐	

5. Şuanki odanız hangi zaman aralığında güneş alıyor? What time period does your current room get the sun?

   ☐ Sadece sabah güneşi alıyor ☐ Sadece öğleden sonra güneşi alıyor ☐ Tüm gün güneş alıyor ☐ Hiç güneş almıyor
   Just getting the morning sun Just getting the afternoon sun Getting sun all day No any sun

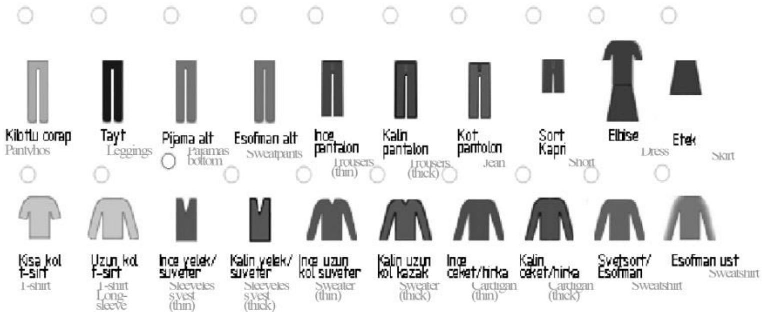
6. **Kış döneminde** odanızı çok sıcak hissettiğinizde aşağıdaki davranışları ne kadar sıklıkla yaparsınız? *(Her bir davranış için sıklık tercihinizi belirtiniz).* How often do you do the following behaviors when you feel very warm in your room during the winter period? (Please indicate your frequency preference for each behavior)

	Her zaman Always	Çoğunlukla Often	Bazen Sometimes	Nadiren Rarely	Hiç Never
Pencere açarım Open a window	☐	☐	☐	☐	☐
Daha ince kıyafet giyerim Dress thinner	☐	☐	☐	☐	☐
Radyatörü vanadan kapatırım Turn of valve	☐	☐	☐	☐	☐
Hareket eder posizyonumu değiştiririm Changing position	☐	☐	☐	☐	☐
☐ Diğer/Other	………………………………………………………………………				
☐ Hiç birşey yapmam/Do nothing					
☐ Çok sıcak hiç olmadı/Nerver been too hot					

7. En son odanın penceresini ne amaçla açtınız? For what purpose did you open the window of the last room?

☐ Serinlemek için/To cool off
☐ Temiz hava almak için/To get fresh air
☐ Oda arkadaşım istedi/My roommate asked
☐ Tam o saatlerde herzaman pencerem açıktır/Always open at those hours
☐ Sürekli açıktır/Always open
☐ Diğer/Other ....…………………………………

8. **Kış dönemi** odanızda vakit geçirdiğiniz zaman genel olarak nasıl giyinmeyi tercih edersiniz? Lütfen en uygun kombinasyonu işaretleyiniz. *(Ör: Evde giyiminiz genellikle külotlu çorap, elbise ve üzeri ince ceket ise bu üçlü kombinasyonun hepsi işaretlenir. Yapacağınız kombinasyon için işaretlemeyi her bir resmin üzerine veya sol üst köşesindeki baloncuğa yapınız).* How do you generally prefer to dress when you spend time in your room in winter? Please tick the most suitable combination. *(If your home wear is usually pantyhose, a dress and a thin jacket, all of these three combinations are marked. Mark for the combination you will make on each picture or on the bubble in the upper left corner).*



9. Odanız ile ilgili aşağıda belirtilen problemleri yaşıyor musunuz? *(Birden fazla seceneği işaretleyebilirsiniz).* Are you experiencing the following problems with your room? *(You can tick more than one option).*

☐ Kış dönemi oda çok soğuk oluyor.
The room gets very cold in winter
☐ Kış dönemi oda çok nemli oluyor.
The room is very humid in winter
☐ Oda yeteri kadar gün ışığı almıyor.
The room is not getting enough daylight.
☐ Kış dönemi hava kirliliğinden dolayı odayı yeteri kadar havalandıramıyorum.
I cannot ventilate the room enough due to the air pollution in the winter period
☐ Kış dönemi oda soğuduğu için yeteri kadar havalandıramıyorum.
I cannot ventilate enough because the room gets cold in winter
☐ Kış dönemi pencere kapalı olduğu halde içeriye rahatsız edecek kadar soğuk hava sızıyor.
Even though the window is closed during the winter period, the infiltrating air is uncomfortably cold
☐ Yukarıda belirtilen problemlerden hiç birini yaşamıyorum.
I am not experiencing any of the problems above

10. Çalışma masanız pencerenin tam önünde mi? Is your desk right in front of the window?

☐ Evet Yes ☐ Hayır No

11. Yatağınız pencerenin tam önünde mi? Is your bed right in front of the window?

☐ Evet Yes ☐ Hayır No

12. Pencere aç/kapatmak için ulaşılabilir mi? Is the window reachable to open/close?

☐ Evet Yes
☐ Hayır, No Çünkü Because: ☐ Mobilya var There is Furniture ☐ Çok yukarda Too above
☐ Sabit pencere Fixed window ☐ Bozuk Broken ☐ Diğer Other……...............

2. EV HOUSE

Bu bölümün tamamı üniversite eğitimine başlamadan önce yaşamış olduğunuz ev ile ilgili sorulardan oluşmakta olup cevaplarken ev içerisindeki tüm fertlerin davranışlarını da göz önünde bulundurarak genel davranış eğilimini yansıtmanız beklenmektedir. Yine soruların içeriği bir önceki bölümden farklı olarak hem yaz hem de kış dönemini içermektedir. (Üniversite öncesi dönemde yatılı okuduysanız, lütfen bu bölümü boş bırakınız). All of this section consists of questions about the house you lived in before you started your university education, and you are expected to reflect the general behavioral tendency by taking into account the behavior of all individuals in the house while answering them. Again, the content of the questions includes both summer and winter periods, unlike the previous section. (Please leave this section blank if you studied boarding school before university)

1. Üniversite öncesi yaşadığınız evin bulunduğu il. The city where you live in before university:……......................

2. Yukarıda belirttiğiniz şehirde yaklaşık olarak yaşamaya başlama yılınız. Your approximate year of living in the city you mentioned above: …………………………………………………………………………………

3. Yukarıda belirttiğiniz şehirdeki evinizde birlikte yaşadığınız toplam kişi sayısı. The total number of people you live house in the city you mentioned above: …………………………………………………………………

4. Bu evde yaşadığınız kişilerle yakınlık dereceniz (düzenli ve sürekli olarak evi kullanan birlikte yasadığınız kişiler). How close you are to the people you live in this house (people who live permanently)

   ☐ Aile Family ☐ Aile yakını Close family ☐ Ev arkadaşı Roomate ☐ Yanlız Alone ☐ Diğer Other…….

5. Evin yaklaşık olarak m2 sini belirtiniz. Specify the approximate square meter of the house

   ☐ 60 m2 den küçük Smaller than 60 m2 ☐ 61-90 m2 ☐ 91-130 m2 ☐ 131 m2 den büyük Larger than 131 m2

6. Yaşadığınız evin mülkiyet durumunu belirtiniz. State the ownership status of the house you live in.

   ☐ Ev sahibi Homeowner ☐ Kiracı Tenant ☐Bilmiyorum Donot know

7. Evin hangi tip olduğunu belirtiniz. Specify what type of house it is

   ☐ Apartman dairesi Flat ☐ Dubleks apartman dairesi Dublex Flat ☐ Müstakil tek katlı ev One-storey detached house
   ☐ Müstakil çok katlı ev Multi storey detached house ☐ Gece kondu Shanty house ☐ Köy evi Country house ☐ Diger ………………. Other

8. Evde bakıma muhtaç biri var ise aşağıda işaretleyiniz ve kişi sayısını belirtiniz. If there is someone in need of care at home, please mark below and indicate the number of people.

   ☐ Yaşlı ise Kaç kişi If old, the number …..... ☐ Bebek ise Kaç kişi If the baby, the number …......
   ☐ Hasta (sürekli) ise Kaç kişi If sick (continuously), the number ……… ☐ Diğer Other ....

9. **Kış dönemi** hafta içi ve hafta sonu evinizde genel olarak **<u>kimsenin olmadığı</u>** saat aralıklarını yaklaşık olarak belirtmek için aşağıdaki seçeneklerden uygun olanları işaretleyiniz. *(Birden fazla seçeneği* işaretleyebilirsiz). In order to indicate the approximate time intervals when there is no one in your house during the weekdays and weekends during **the winter period**, please tick the appropriate options below. *(You can tick more than one option)*.

   Hafta içi Weekdays
   ☐ 07:00 – 12:00 ☐ 12:30 – 18:00 ☐18:30 – 07:00 ☐ Evde genelde birileri var / usually in use

   Cumartesi Saturday
   ☐ 07:00 – 12:00 ☐ 12:30 – 18:00 ☐18:30 – 07:00 ☐ Evde genelde birileri var / usually in use

   Pazar Sunday
   ☐ 07:00 – 12:00 ☐ 12:30 – 18:00 ☐18:30 – 07:00 ☐ Evde genelde birileri var / usually in use

10. **Kış döneminde** evinizin ısısını genel olarak nasıl tanımlardınız? How would you describe the usual temperature of your home during the winter period?

    ☐ Çok soğuk/Too cold ☐ Soğuk/Cold ☐ Konforlu/Comfortable ☐ Sıcak/Hot ☐ Çok sıcak/Too hot

11. **Kış döneminde** evinizde kullandığınız **<u>temel</u>** ısıtma sistemini belirtiniz. Please specify the basic heating system in your home used during the winter period

    ☐ Soba/Stove ☐ Merkezi ısıtma/Kalorifer/Central heating ☐ Elektrikli ısıtıcı/Electric heater ☐ Klima/AC ☐ Kombi/DomesticCombi boiler ☐ Diğer/Other ....…..........

12. **Yaz dönemi** evinizde kullandığınız **temel** soğutma sistemini belirtiniz. Please specify the basic cooling system in your home used during the summer period

☐ Vantilatör/Household type fan ☐ Klima/AC ☐ Hiç biri/None ☐ Diğer/Other.................

13. Oturma odanızın hangi zaman aralığında güneş aldığını belirtiniz. Indicate in what time period your living room receives
the sun

☐ Hiç güneş almıyor/Doesn't get any sun ☐ Sadece sabah güneşi alıyor/Just getting the morning sun

☐ Sadece öğleden sonra güneşi alıyor/ Just getting the afternoon sun ☐ Tüm gün güneş alıyor/Getting sun all day

14. Genel olarak evinizi aşağıda sıralanan her bir konu için 1 den 5 e kadar değerlendiriniz. *(5 çok memnun olduğunuzu 1 ise çok memnuniyetsiz olduğunuzu belirtmektedir).* Rate your home on a scale of 1 to 5 for each of the topics listed below. *(5 indicates that you are very satisfied, 1 indicates that you are very dissatisfied).*

	(Çok memnuniyetsiz) 1 Very dissatisfied	2	3	4	5 (Çok memnun) Very satisfied
Evin yeteri kadar gün ışığı alıyor olması The house gets enough sunlight	☐	☐	☐	☐	☐
Binada ses yalıtımının yeterli olması Adequate sound insulation in the building	☐	☐	☐	☐	☐
Kış dönemi evin yeterli ısınması Adequate heating of the house in the winter period	☐	☐	☐	☐	☐
Yaz dönemi evin yeteri kadar serin olması The house is cooled naturally enough in summer	☐	☐	☐	☐	☐
Kış dönemi evin yeteri kadar havalandırabiliyor olması The house is ventilated naturally enough in winter	☐	☐	☐	☐	☐

15. Evinizde ısıl konfor açısından aşağıda belirtilen problemlerden hangilerini yaşıyorsunuz? (Birden fazla işaretleyebilirsiniz). Which of the following problems did you experience in terms of thermal comfort in your home? (You can mark more than one)

☐ Kış dönemi ev çok soğuk / The house is very cold in the winter period
☐ Kış dönemi ev çok nemli / The house is very humid in the winter period
☐ Yaşam alanları yeteri kadar gün ışığı almıyordu / Living areas do not get enough daylight
☐ Kış dönemi hava kirliliğinden ev yeteri kadar havalandırılmıyor/not ventilated enough due to winter air pollution
☐ Kış dönemi ev soğuduğu için yeteri kadar havalandırılmıyor/ not ventilated enough due to cold air in winter
☐ Kış dönemi duvar yüzeyleri çok soğuk oluyor / The wall surfaces get very cold in winter
☐ Kış dönemi duvar yüzeylerinde rutubet oluyor / Moisture occurs on the wall surfaces in winter
☐ Yerler kış dönemi çok soğuk olur / Floor surfacecs get too cold in winter
☐ Evde ısıl konfor açısından hiç bir problem yaşamıyorum / No any problems in terms of thermal comfort at home

16. **Kış döneminde** evinizi **sıcak** hissettiğinizde aşağıdaki davranışları ne kadar sıklıkla yaparsınız? *(Her bir davranış için sıklık tercihinizi belirtiniz).* How often would you do the following behaviors when you feel too hot at home during the winter period? *(Please indicate your frequency preference for each behavior)*

	Her zaman Always	Çoğunlukla Often	Bazen Sometimes	Nadiren Rarely	Hiç Never
Pencere açarım I open the window	☐	☐	☐	☐	☐
Daha ince kıyafet giyerim I wear thinner clothes	☐	☐	☐	☐	☐
Kullandığımız ısıtmanın sıcaklığını azaltırım I reduce the temperature of the heater we use	☐	☐	☐	☐	☐
Hareket eder pozisyonumu değiştiririm I move and change my position	☐	☐	☐	☐	☐
☐ Sıcak hiç olmadı It is never been too hot					
☐ Diğer Other	……………………………………………………........................				

17. **Kış döneminde** evinizi **soğuk** hissettiğinizde aşağıdaki davranışları ne kadar sıklıkla yaparsınız? *(Her bir davranış için sıklık tercihinizi belirtiniz).* How often do you do the following behaviors when you feel too cold at home during the winter period? *(Please indicate your frequency preference for each behavior)*

	Her zaman Always	Çoğunlukla Often	Bazen Sometimes	Nadiren Rarely	Hiç Never
Kullandığımız ısıtmanın sıcaklığını artırırım I increas the temperature of the heating we use	☐	☐	☐	☐	☐
Daha kalın kıyafet giyerim I wear thicker clothes	☐	☐	☐	☐	☐
Üzerime battaniye alırım I take a blanket over me	☐	☐	☐	☐	☐
☐ Soğuk hiç olmadı It is never been too cold					
☐ Diğer Other	……………………………………………………………..				

18. **Kış dönemi** evinizde hangi odalar hangi zaman aralıklarında ısıtılır? Evinizdeki oda sayısına gore mevcut odalar için gerekli işaretlemeleri yapınız. Which rooms are heated at what time intervals in your house during the winter period? Make the necessary markings for the existing rooms according to the number of rooms in your house.

	Tüm Gün Allday	Sabah-Öğlen Morning-Noon	Öğlen-Akşam Noon- Evening	Akşam-Gece Evening-Night	Gece-Sabah Night-Morning
Oturma odası Living room	☐	☐	☐	☐	☐
Salon Salon	☐	☐	☐	☐	☐
Yatak odası Bed Room	☐	☐	☐	☐	☐
Mutfak Kitchen	☐	☐	☐	☐	☐
Misafir odası/ları Guest Room	☐	☐	☐	☐	☐
Çocuk odası Child room	☐	☐	☐	☐	☐
Çalışma Odası Study Room	☐	☐	☐	☐	☐
Tüm odalar All rooms	☐	☐	☐	☐	☐

19. **Yaz döneminde** evinizi çok **sıcak** hissettiğinizde aşağıdaki davranışları ne kadar sıklıkla yaparsınız? *(Her bir davranış için sıklık tercihinizi belirtiniz).* How often do you do the following behaviors when your home feels very hot during the
summer period? (Please indicate your frequency preference for each behavior)

	Her zaman Always	Çoğunlukla Often	Bazen Sometimes	Nadiren Rarely	Hiç Never
Pencere açarım I open the window	☐	☐	☐	☐	☐
Daha ince kıyafet giyerim I wear thinner clothes	☐	☐	☐	☐	☐
Klima açarım I open AC	☐	☐	☐	☐	☐
Vantilatör kullanırım I use household type fan	☐	☐	☐	☐	☐
Güneşlikleri kapatırım I close the blinds	☐	☐	☐	☐	☐
Duş alırım I have a shower	☐	☐	☐	☐	☐
Dışarı çıkarım I go out	☐	☐	☐	☐	☐
☐ Çok sıcak hiç olmadı Never been too hot					
☐ Diğer Other	…………………………………………………………………………………				

20. Evinizin dış duvarlarında ısı yalıtımı var mı? Do you have thermal insulation on the outer walls of your house?

☐ Evet Yes ☐ Hayır No ☐ Bilmiyorum Do not know

21. Pencereleriniz çift cam mı? Are your windows double glazed?

☐ Evet Yes ☐ Hayır No ☐ Bilmiyorum Do not know

22. Evin balkonu camekanla kapatılmış durumda mı? Is the balcony of the house covered with window?

☐ Evet Yes ☐ Hayır No ☐ Evin balkonu yok No balcony

23. Yaşadığınız eve giren **toplam aylık gelir** yaklaşık ne kadardır? What is the approximate total monthly income in the house you live

☐ 0-1300 TL ☐ 1301-3500 TL ☐ 3501- 6500TL ☐ 6501-10000TL
☐ 100001TL'den fazla More than ☐ Diğer Other…………… ☐Bilmiyorum Do not know

24. Evin ortalama **aylık** elektrik faturası hangi fiyat aralığında olduğunu belirtiniz. Please indicate in which price range the average monthly electricity bill of the house is

☐ 50TL 'de az Less than ☐ 51TL-100TL ☐ 101TL-150TL

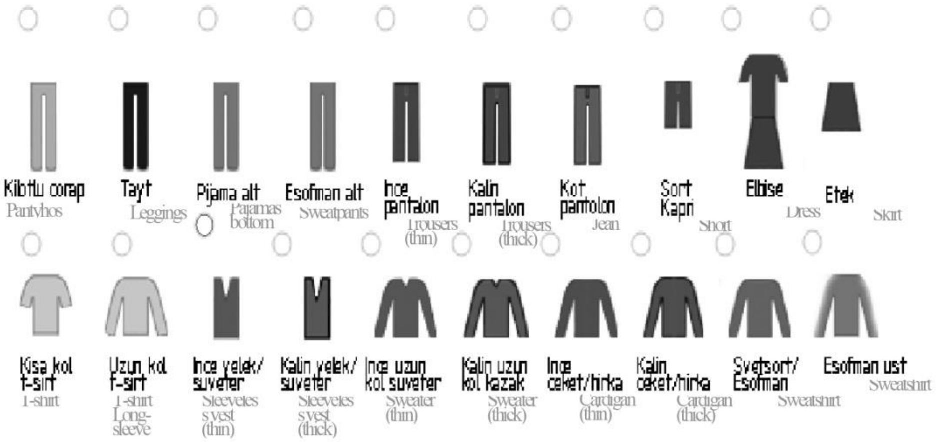
☐ 150TL'den fazla More than ☐ Bilmiyorum Do not know

25. Evin ortalama **yıllık** ısınma gideri hangi fiyat aralığında olduğunu belirtiniz (Doğalgaz, odun, kömür, vs). Please indicate
in which price range the average annual heating cost of the house is (Natural gas, wood, coal, etc.).

☐ 500TL 'den az Less than ☐ 501TL-1000TL ☐ 1001TL-2000TL ☐ 2001TL'den fazla More than

☐ Bilmiyorum Do not know

26. **Kış dönemi** evde vakit geçireceğiniz zaman genel olarak nasıl giyinmeyi tercih ediyorsunuz? Lütfen en uygun kombinasyonu işaretleyiniz. How do you generally prefer to dress when you spend time at home during the winter period? Please tick the most suitable combination.



27. Aşağıda sıralanan her bir durum için değerlendirme yapınız. Evaluate each situation listed below.

	Her zaman Always	Çoğunlukla Often	Bazen Sometimes	Nadiren Rarely	Hiç Never
Evde kimse olmadığı zamanlar kullandığımız ısıtma sistemini kapatırız. We turn off the heating system we used when no one was home.	☐	☐	☐	☐	☐
Evde kimse olmadığı zamanlar kullandığımız ısıtmanın sıcaklığını azaltırız We reduce the temperature of the heating we use when there is no one at home	☐	☐	☐	☐	☐
Uyku saatinde gece ısıtmanın sıcaklığını azaltırız. We reduce the temperature of night heating at bedtime	☐	☐	☐	☐	☐
Uyku saatinde gece ısıtmanın sıcaklığını artırırız. We increase the temperature of night heating at bedtime	☐	☐	☐	☐	☐
İhtiyaç olmayan ışıkları kapatırım I turn off the lights that are not needed	☐	☐	☐	☐	☐
Kullanılmayan elektronik cihazları fişlerinden kapatırım I turn off unused electronic devices from their plugs	☐	☐	☐	☐	☐
Çamaşır makinesi ve bulaşık makinesini tam dolu iken çalıştırırız We run the washing machine and dishwasher when they are fully loaded	☐	☐	☐	☐	☐
Cihaz almadan önce enerji tüketim sınıfına bakarım I check the energy consumption class before buying a device.	☐	☐	☐	☐	☐

İ. Classification of The Questions in The Survey for The Objective of The Study

* Gender	demographic data
* Date of year:	
* Place of birth	
* University/Department	
* The year you started the education you mentioned above	
* If you have moved more than once, please indicate the province you have stayed in for the longest time and how many years you have stayed	
* The village/district/province where you last lived before university	

* How many people do you share the current room with?	physıcal condition of living space
* What time period does your current room get the sun?	
* Is your desk right in front of the window?	
* Is your bed right in front of the window?	
* Is the window reachable to open/close?	
* Indicate in what time period your living room receives the sun	
* Which rooms are heated at what time intervals in your house during the winter period? Make the necessary markings for the existing rooms according to the number of rooms in your house.	
* Do you have thermal insulation on the outer walls of your house?	
* Are your windows double glazed?	
* Is the balcony of the house covered with window?	

* Indicate the time intervals in which you spend most of your time in your room during the winter period (including the separated areas in your room such as the working area and dining area) by ticking the appropriate options below. (You can tick more than one option). (Please mark in all three areas as Weekdays, Saturdays and Sundays as listed below)	national patterns of occupancy activities in family house and dormitory
* In order to indicate the approximate time intervals when there is no one in your house during the weekdays and weekends during the winter period, please tick the appropriate options below. (You can tick more than one option).	

* Does the room get enough daylight?	data of respondent's satisfaction evaluation
* Is sound insulation sufficient in the building?	
* Is the room temperature sufficient?	
* Able to ventilate the room adequately do you?	
* Are you satisfied with the physical conditions of your room in general?	
* Are you experiencing the following problems with your room? (You can tick more than one option)	
* How would you describe the usual temperature of your home during the winter period?	
* The house gets enough sunlight	
* Adequate sound insulation in the building	
* Adequate heating of the house in the winter period	
* The house is cooled naturally enough in summer	
* The house is ventilated naturally enough in winter	
* Which of the following problems did you experience in terms of thermal comfort in your home? (You can mark more than one)	

* How often do you do the following behaviors when you feel very warm in your room during the winter period? (Please indicate your frequency preference for each behavior)	occupant adaptive behavior data

* How do you generally prefer to dress when you spend time in your room in winter? Please tick the most suitable combination. (If your home wear is usually pantyhose, a dress and a thin jacket, all of these three combinations are marked. Mark for the combination you will make on each picture or on the bubble in the upper left corner).	
* For what purpose did you open the window of the last room?	
* How often would you do the following behaviors when you feel too hot at home during thewinter period? (Please indicate your frequency preference for each behavior)	
* How often do you do the following behaviors when you feel too cold at home during the winter period? (Please indicate your frequency preference for each behavior)	
* How often do you do the following behaviors when your home feels very hot during the summer period? (Please indicate your frequency preference for each behavior)	
* How do you generally prefer to dress when you spend time at home during the winter period? Please tick the most suitable combination.	
* Which rooms are heated at what time intervals in your house during the winter period? Make the necessary markings for the existing rooms according to the number of rooms in your house.	

* The total number of people you live house in the city you mentioned above.	socio-economic data
* How close you are to the people you live in this house (people who live permanently)	
* Specify the approximate square meter of the house	
* State the ownership status of the house you live in.	
* Specify what type of house it is	
* If there is someone in need of care at home, please mark below and indicate the number of people.	
* Please specify the basic heating system in your home used during the winter period	
* Please specify the basic cooling system in your home used during the summer period	
* What is the approximate total monthly income in the house you live	

* Please indicate in which price range the average monthly electricity bill of the house is	data on energy consumption pattern
* Please indicate in which price range the average annual heating cost of the house is (Natural gas, wood, coal, etc.).	

* We turn off the heating system we used when no one was home.	awareness on domestic energy use
* We reduce the temperature of the heating we use when there is no one at home	
* We reduce the temperature of night heating at bedtime	
* We increase the temperature of night heating at bedtime	
* I turn off the lights that are not needed	
* I turn off unused electronic devices from their plugs	
* We run the washing machine and dishwasher when they are fully loaded	
* I check the energy consumption class before buying a device	

J. District-Based Natural Gas Supply Map for 2017

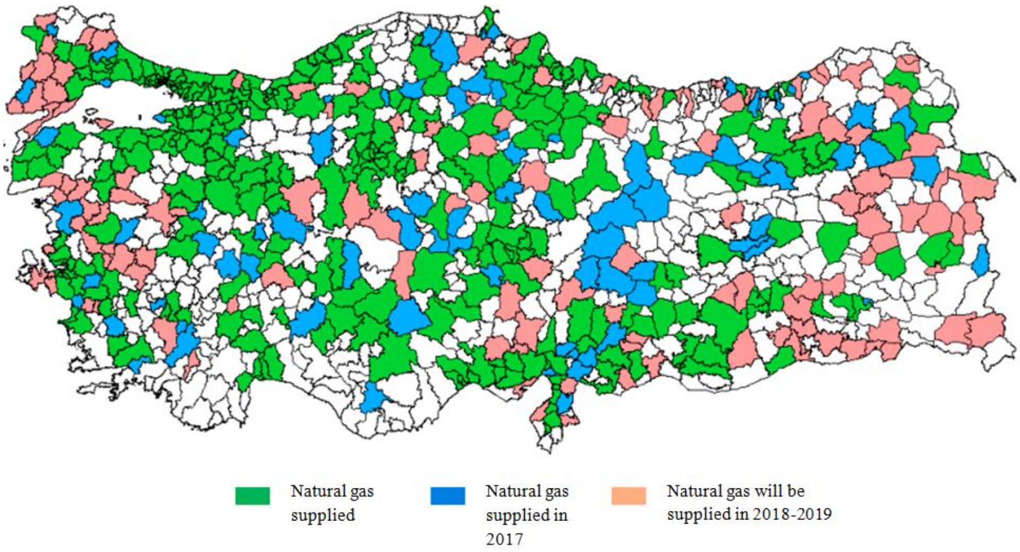


Figure J: Natural Gas Distributors Association of Turkey

Source: Natural Gas Distribution in 2017 Industry Report.

(https://www.gazbir.org.tr/uploads/page/2017-Yili-Dogal-Gaz-Dagitim-Sektoru-Raporu.pdf)

K. Proportion of Households By Heating Type Of Dwelling In 2011

Source: TUİK 2011

Province	Climatic Region	Heating Type of Dwelling (%)				
		Stove (Natural gas stove included)	Central heating for one dwelling	Central heating for one or more buildings	Air conditioner, electric heater and other systems	No heating system
Total		**57.1**	**25.6**	**11.4**	**5.9**	**0.1**
İzmir	1	56.1	9.7	6.6	27.4	0.2
Antalya	1	57.4	0.6	0.9	40.8	0.3
Mersin	1	71.4	1.1	0.9	26.3	0.2
Adana	1	73.1	0.6	1.5	24.5	0.2
Hatay	1	84.3	0.7	5.3	9.6	0.1
İstanbul	2	27.3	60.1	10.6	1.9	0.1
Kocaeli	2	51.5	38.7	8.2	1.5	0.0
Bursa	2	52.6	38.8	7.4	1.1	0.1
Yalova	2	53.6	38.7	4.6	2.9	0.1
Tekirdağ	2	58.6	27.9	12.1	1.4	0.0
Zonguldak	2	67.3	12.9	19.5	0.3	0.0
Muğla	2	68.2	1.8	6.7	23.0	0.3
Edirne	2	68.5	4.8	26.0	0.6	0.0
Denizli	2	68.7	17.7	12.7	0.8	0.0
Balıkesir	2	68.8	16.5	11.9	2.7	0.1
Sakarya	2	69.6	25.2	4.2	0.9	0.0
Aydın	2	71.9	1.8	10.2	16.0	0.1
Samsun	2	73.1	16.3	9.2	1.4	0.1
Amasya	2	74.3	11.9	13.6	0.2	0.0
Gaziantep	2	74.9	2.4	22.6	0.1	0.0
Trabzon	2	75.9	2.1	21.1	0.8	0.0
Çanakkale	2	76.7	9.4	13.1	0.8	0.0
Batman	2	76.7	0.3	23.0	0.1	0.0
Bartın	2	78.0	1.6	20.2	0.2	0.0
Siirt	2	78.0	0.0	21.8	0.1	0.0
Kahramanmaraş	2	78.1	9.5	12.0	0.4	0.0
Manisa	2	78.5	8.9	6.2	6.4	0.0
Mardin	2	79.7	0.8	13.7	5.7	0.1
Sinop	2	79.7	2.4	15.4	2.4	0.0
Diyarbakır	2	80.7	8.8	10.0	0.5	0.0
Şanlıurfa	2	80.8	5.8	7.4	5.9	0.1
Rize	2	81.1	8.7	9.5	0.6	0.0
Düzce	2	84.9	11.1	3.9	0.2	0.0
Kilis	2	86.0	1.4	11.1	1.4	0.2
Giresun	2	86.9	1.9	10.7	0.4	0.0
Adıyaman	2	88.0	3.2	8.8	0.1	0.0
Ordu	2	88.4	1.6	9.6	0.4	0.0
Şırnak	2	89.0	0.7	6.4	3.8	0.0
Osmaniye	2	91.8	0.4	2.3	5.5	0.0
Ankara	3	20.3	65.1	14.3	0.2	0.0
Eskişehir	3	32.9	39.7	27.2	0.2	0.0

Kırıkkale	3	56.0	33.8	10.0	0.2	0.0
Kırşehir	3	57.5	30.9	11.4	0.1	0.0
Konya	3	61.0	18.2	20.7	0.1	0.0
Karabük	3	62.8	25.0	11.5	0.2	0.4
Kütahya	3	63.2	24.2	12.5	0.1	0.0
Elazığ	3	64.5	7.2	28.3	0.0	0.0
Çorum	3	64.9	25.2	9.8	0.1	0.0
Kırklareli	3	66.3	13.0	19.3	1.3	0.1
Malatya	3	66.6	29.3	4.0	0.1	0.0
Isparta	3	66.7	12.4	20.8	0.1	0.0
Bilecik	3	67.5	21.0	11.3	0.2	0.0
Nevşehir	3	68.8	10.7	20.4	0.0	0.0
Çankırı	3	69.1	12.0	18.9	0.1	0.0
Bolu	3	70.8	12.3	16.7	0.2	0.0
Bingöl	3	72.0	2.1	25.9	0.0	0.0
Afyonkarahisar	3	72.2	5.5	22.2	0.1	0.0
Aksaray	3	73.8	19.5	6.6	0.1	0.0
Niğde	3	74.7	8.3	16.9	0.1	0.0
Karaman	3	74.8	13.9	11.2	0.2	0.0
Uşak	3	77.0	9.2	13.6	0.2	0.0
Artvin	3	78.6	0.7	20.4	0.3	0.0
Tokat	3	78.8	9.8	11.2	0.2	0.0
Tunceli	3	79.1	0.4	20.4	0.1	0.0
Burdur	3	81.7	4.0	14.2	0.2	0.0
Iğdır	3	85.5	0.5	13.9	0.1	0.0
Kayseri	4	54.7	19.5	25.7	0.1	0.0
Sivas	4	60.5	24.2	15.2	0.1	0.0
Bayburt	4	73.2	20.9	5.8	0.1	0.0
Erzincan	4	76.2	11.3	12.5	0.1	0.0
Yozgat	4	76.3	16.7	6.9	0.0	0.0
Kastamonu	4	80.3	6.0	13.6	0.2	0.0
Bitlis	4	82.1	0.8	17.0	0.1	0.0
Hakkari	4	82.9	0.2	16.7	0.1	0.0
Gümüşhane	4	83.6	1.2	15.1	0.0	0.0
Van	4	87.6	2.2	10.2	0.0	0.0
Muş	4	88.9	0.1	11.0	0.0	0.0
Erzurum	5	64.0	17.1	18.9	0.0	0.0
Kars	5	82.4	2.0	15.6	0.1	0.0
Ağrı	5	84.5	0.2	15.3	0.0	0.0
Ardahan	5	88.0	0.9	11.1	0.0	0.0

L. Clothing Insulation Values in Ashrae Standard 55

TABLE B1 5.2.2.2A Clothing Insulation Values for Typical Ensembles[a]

Clothing Description	Garments Included[b]	I_{cl} (clo)
Trousers	1) Trousers, short-sleeve shirt	0.57
	2) Trousers, long-sleeve shirt	0.61
	3) #2 plus suit jacket	0.96
	4) #2 plus suit jacket, vest, T-shirt	1.14
	5) #2 plus long-sleeve sweater, T-shirt	1.01
	6) #5 plus suit jacket, long underwear bottoms	1.30
Skirts/Dresses	7) Knee-length skirt, short-sleeve shirt (sandals)	0.54
	8) Knee-length skirt, long-sleeve shirt, full slip	0.67
	9) Knee-length skirt, long-sleeve shirt, half slip, long-sleeve sweater	1.10
	10) Knee-length skirt, long-sleeve shirt, half slip, suit jacket	1.04
	11) Ankle-length skirt, long-sleeve shirt, suit jacket	1.10
Shorts	12) Walking shorts, short-sleeve shirt	0.36
Overalls/Coveralls	13) Long-sleeve coveralls, T-shirt	0.72
	14) Overalls, long-sleeve shirt, T-shirt	0.89
	15) Insulated coveralls, long-sleeve thermal underwear tops and bottoms	1.37
Athletic	16) Sweat pants, long-sleeve sweatshirt	0.74
Sleepwear	17) Long-sleeve pajama tops, long pajama trousers, short 3/4 length robe (slippers, no socks)	0.96

TABLE B2 5.2.2.2B Garment Insulation[a]

Garment Description[b]	I_{clu}(clo)	Garment Description[b]	I_{clu}(clo)
Underwear		**Dress and Skirts[c]**	
Bra	0.01	Skirt (thin)	0.14
Panties	0.03	Skirt (thick)	0.23
Men's briefs	0.04	Sleeveless, scoop neck (thin)	0.23
T-shirt	0.08	Sleeveless, scoop neck (thick), i.e., jumper	0.27
Half-slip	0.14	Short-sleeve shirtdress (thin)	0.29
Long underwear bottoms	0.15	Long-sleeve shirtdress (thin)	0.33
Full slip	0.16	Long-sleeve shirtdress (thick)	0.47
Long underwear top	0.20	**Sweaters**	
Footwear		Sleeveless vest (thin)	0.13
Ankle-length athletic socks	0.02	Sleeveless vest (thick)	0.22
Panty hose/stockings	0.02	Long-sleeve (thin)	0.25
Sandals/thongs	0.02	Long-sleeve (thick)	0.36
Shoes	0.02	**Suit Jackets and Vests[d]**	
Slippers (quilted, pile lined)	0.03	Sleeveless vest (thin)	0.10
Calf-length socks	0.03	Sleeveless vest (thick)	0.17
Knee socks (thick)	0.06	Single-breasted (thin)	0.36
Boots	0.10	Single-breasted (thick)	0.44
Shirts and Blouses		Double-breasted (thin)	0.42
Sleeveless/scoop-neck blouse	0.12	Double-breasted (thick)	0.48
Short-sleeve knit sport shirt	0.17	**Sleepwear and Robes**	
Short-sleeve dress shirt	0.19	Sleeveless short gown (thin)	0.18
Long-sleeve dress shirt	0.25	Sleeveless long gown (thin)	0.20
Long-sleeve flannel shirt	0.34	Short-sleeve hospital gown	0.31
Long-sleeve sweatshirt	0.34	Short-sleeve short robe (thin)	0.34
Trousers and Coveralls		Short-sleeve pajamas (thin)	0.42
Short shorts	0.06	Long-sleeve long gown (thick)	0.46
Walking shorts	0.08	Long-sleeve short wrap robe (thick)	0.48
Straight trousers (thin)	0.15	Long-sleeve pajamas (thick)	0.57
Straight trousers (thick)	0.24	Long-sleeve long wrap robe (thick)	0.69
Sweatpants	0.28		
Overalls	0.30		
Coveralls	0.49		

a. Data are from Chapter 9 in the 2009 *ASHRAE Handbook – Fundamentals*.3
b. "Thin" refers to garments made of lightweight, thin fabrics often worn in the summer; "thick" refers to garments made of heavyweight, thick fabrics often worn in the winter.
c. Knee-length dresses and skirts.
d. Lined vests.

M. Self-Report Questionaire

CİHAZ NO: ………… BAŞLAMA: ………… BİTİŞ: ………… ODA ………… KULLANICI SAYISI: ……….
DIVICE NUMBER….. START………………. FINISH……….. ROOM……….... NUMBER OF PERSON………

Bölüm 1 (Demografik Yapı)
Section 1 (Demographic Structure)

Bu bölümde yer alan soruların tamamı genel demografik yapı ile ilgili bilgi edinme amaçlı olup doğru ve eksiksiz doldurulması bu anket çalışması için önemlidir. All of the questions in this section are for the purpose of obtaining information about the general demographic structure, and it is important for this survey to be filled in correctly and completely.

12. Cinsiyetiniz Gender

☐ Kadın Female ☐ Erkek Male

13. Doğum yılınız Year of birth: ……………………………………………………………………………………..
14. Doğduğunuz İlçe/il City of birth: ……………………………………………………………………………………
15. Üniversite/Bölüm University/Department...……………………………/……………………………………………
16. Şuanda devam etmekte olduğunuz eğitimi belirtiniz Please indicate the education you are currently continuing

☐ Lisans Undergraduate ☐ Master Graduate ☐ Doktora PhD

17. Yukarıda belirtmiş olduğunuz eğitime başlama yılınız : ………………………………………………
The year you started the education you mentioned above: …………………………………………….
18. Şuanda bulunduğunuz şehire geldiğiniz yıl: ………………………………………………….....…….
The year you came to your current city: ………………………………………………………………..
19. Birden fazla yer değiştirdiyseniz en uzun sureli kaldığınız ili ve kaç yıl kaldığınızı belirtiniz. If you have moved more than once, please indicate the province where you have stayed for the longest time and how many years you have stayed.

☐ Evet ise If yess İl City: …………………….Hangi yıllar arası kaldınız? What years did you stay ....

☐ Hayır No

20. Üniversite döneminden önce en son yaşamış olduğunuz köy/ilçe/il: …………………………………..
The village/district/city where you last lived before the university period: ………………………….....
21. Bu köy/ilçe/il de yaşamaya başladığınız yıl The year you started living in this village/district/city …………….......
22. Bu köy/ilçe/il de kiminle yaşıyordunuz? With whom did you live in this village/district/city?

☐ Ailemle With family ☐ Aile yakınımla With close family ☐ Yatılı okulda In boarding school

☐ Diğer Other………………………......

Bölüm 2 (Isı Algısı)
Section 1 (Demographic Structure)

Aşağıda toplamda a dan g ye kadar 7 farklı bölüm yer almakta olup yine toplamda 7 gün olmak üzere her bir gün için bu bölümlerin günlük şeklinde doldurulması gerekmektedir. 1 gün içerisinde birkaç defa değerlendirme yapabilmeniz için a dan f ye kadar olan tablolarda saat bölümüne 3 satır ayrılmıştır. Below are 7 different sections from a to g in total. These sections must be filled in as a diary for each day, 7 days in total.In order to fill questionnaire several times a day, 3 lines are reserved in each question from a to f.

1. Gün 1st Day Tarih Date:………………

a) Isıl hissiyat Thermal Sense Şuanda nasıl hissediyorsunuz? How are you feeling right now	Saat Hour	Çok soğuk Cold	Soğuk Cool	Hafif serin Slightly Cool	Nötr Neutral	Hafif ılık Slightly warm	Sıcak Warm	Çok sıcak Hot
Değerlendirme yaptığınız saati belirtiniz.	…/…	☐	☐	☐	☐	☐	☐	☐
Specify the time you evaluate	…/…	☐	☐	☐	☐	☐	☐	☐
	…/…	☐	☐	☐	☐	☐	☐	☐

b) Isıl kabul	Saat Hour	EVET Yes	HAYIR No
Thermal acceptance Şuanda oda sıcaklığı konforlumu?	…/…	☐	☐
Is the room temperature comfortable right now?	…/…	☐	☐
	…/…	☐	☐

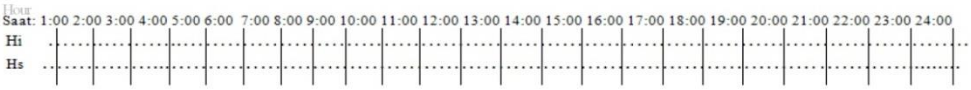
c) Isıl tercih	Saat Hour	Daha sıcak olmasını To be warmer	Sıcaklık gayet iyi No change	Daha soğuk olmasını To be colder
Thermal preference Şuanda odanız için hangisini tercih ederdiniz	…/…	☐	☐	☐
Which would you prefer to be your room right now?	…/…	☐	☐	☐
	…/…	☐	☐	☐

d) Aktivite Activity Bu ankete başlamadan son 15 dakika hangi aktiviteyi yaptınız?	Saat Hour	Dinlenme/ Uyuyor olma Relaxing/sleeping	Yemek yeme/okuma/Tv izleme/Bilgisayar vs Eating /Reading/Typing	Düşük aktivite (Yemek yapma vs) Low activity (Cooking etc)	Yüksek aktivite (egzersiz yapma vs) High activity (exercise etc)	Diğer(belirtin) Otther
What activity did you do in the last 15 minutes before starting this survey?	…/…	☐	☐	☐	☐	☐.................
	…/…	☐	☐	☐	☐	☐.................
	…/…	☐	☐	☐	☐	☐.................

e) Isıl kontrol Thermal control Son 5 dakikada ısıl konforunuzu sağlamak için hangi değişiklikleri yaptınız?	Saat7 Hour	Pencereyi açtım Window open	Kapıyı açtım Door close	Daha ince giyindim Wear thinner	Radyatör ü vanadan kapadım Valve turn off	Daha kalın giyindim Wear thicker	Değişikliğe ihtiyaç duymadım No need any change
What changes have you made to ensure your thermal comfort in the last 5 minutes?	…/…	☐	☐	☐	☐	☐	☐
	…/…	☐	☐	☐	☐	☐	☐
	…/…	☐	☐	☐	☐	☐	☐

Isıl kabul Thermal acceptance	Saat Hour	Kombinasyon Kombination
Şuanda giydiğiniz kıyafet kombinasyonunu tabloda verilen harfleri kullanarak kombinasyon sutununa yazarak belirtiniz Indicate the combination of clothes you are currently wearing, writting the letters given in the table in the combination column	…/…	
	…/…	
	…/…	

g) Bu gün için odayı hangi saatlerde kullandığınızı aşağıdaki çizelgeyi kullarak belirtiniz. Çizelgede sutunlar saatleri satırlar ise hafta içi (Hİ) ve hafta sonunu (HS) göstermektedir. (Ör: Hafta içi akşam 20:00 ile sabah 07:00 arası ve 13:00 ile 15:00 arası odanızda iseniz aşağıdak, gibi gösterilir; veya bu gün hafta sonu ise bu işaretlemeyi haftasonu (Hs) satırına yapılır). Indicate what times you use the room for this day using the chart below. In the table, the columns show hours and the rows show weekdays (HI) and weekends (HS). (For example: If you are in your room between 20:00 in the evening and 07:00 in the morning and between 13:00 and 15:00 on weekdays, it is shown as below; or if it is a weekend, this mark is made on the weekend (Hs) line.)



N. Metabolic Rates (Met) in Ashrae Standard-55

TABLE A1 Metabolic Rates for Typical Tasks

Activity	Metabolic Rate		
	Met Units	W/m^2	$(Btu/h \cdot ft^2)$
Resting			
Sleeping	0.7	40	(13)
Reclining	0.8	45	(15)
Seated, quiet	1.0	60	(18)
Standing, relaxed	1.2	70	(22)
Walking (on level surface)			
0.9 m/s, 3.2 km/h, 2.0 mph	2.0	115	(37)
1.2 m/s, 4.3 km/h, 2.7 mph	2.6	150	(48)
1.8 m/s, 6.8 km/h, 4.2 mph	3.8	220	(70)
Office Activities			
Reading, seated	1.0	55	(18)
Writing	1.0	60	(18)
Typing	1.1	65	(20)
Filing, seated	1.2	70	(22)
Filing, standing	1.4	80	(26)
Walking about	1.7	100	(31)
Lifting/packing	2.1	120	(39)

O. Indoor Air Temperatures in TS 2164 Using To Plan The Heating System

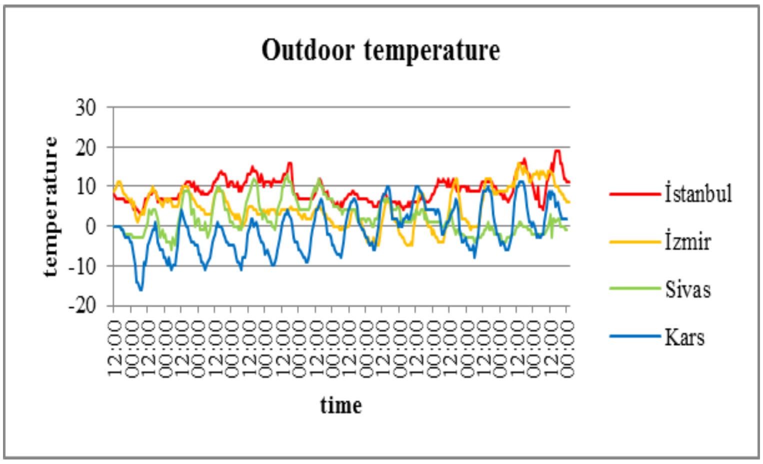
ISITILACAK ORTAMIN ADI	SICAKLIĞI* (°C)	ISITILACAK ORTAMIN ADI	SICAKLIĞI* (°C)
1- KONUTLAR		**5- FABRİKA YAPILARI**	
- Oturma odası (Salonlar)	+22	- Ağır iş yapan atölye ve montaj yeri	+15
- Yatak odası	+20	- Hafif iş yapan atölyeler	+18
- Antre, hela, mutfak	+18	- Kadın işçilerin çalıştığı örgü, biçki ve dikiş atolyeleri	+20
- Banyo	+26	**6- CEZAEVİ VE TUTUKEVİ**	
- Merdiven	+10	- Tek odalar, yatak odaları	+20
2- İŞ VE İDARE BİNALARI		- Hafif iş atölyesi ve koğuş	+18
- Berber, terzi dükkanı	+20	- Banyo, duş, soyunma hacimleri	+26
- Lokanta, otel, pansiyon odası	+20	- Hela	+15
- Bekleme odası	+20	**7- ÇEŞİTLİ YERLER**	
- İş atölyesi oturarak çalışma	+20	- Sergi evleri, müzeler, genel gardoplar	+15
- Tesviye, torna, marangoz vb. atölye	+18	- Sinema ve tiyatro salonları	+18
- Demir, döküm ve pres vb. atölyeler	+18	- Garajlar	+10
- Elektrik, bobinaj vb. atölyeler	+20	- Ahır ve ağıl	+12
- Motor ve yenileştirme atölyesi	+20	**Yüzme havuzu**	
- Kaporta, boya vb. iş atölyesi	+18	- Bekleme salonu	+18
- Merdiven ve asansör boşluğu	+15	- Banyo ve duş odalarına geçiş yolu	+20
- Koridor, hela	+15	- Soyunma ve giyinme odaları	+22
- Toplantı salonu	+20	- Kurna ve duş odaları	+20÷22
- Sinema, tiyatro, diskotek, gazino vb. eğlence salonları	+18	- Yüzeme havuzu hacmi	+22÷25
- Büro hacimleri (Md. Memur odası)	+20	**Roma hamamı ve sauna**	
- Arşiv hacimleri	+15	- Soyunma ve son terleme odası	+22
3- OKULLAR**		- Birincil terleme hacmi	+40÷ 50
- Derslik, doğal bilim öğretimi için özel hacimler, pedagoji merkezleri, çeşitli amaçlar için kullanılan salonlar, öğretmen, yönetici ve kreş odaları	+22	- İkincil terleme hacmi	+50÷60
		- Yıkanma ve duş hacmi	+26
		- Sıhhi banyo hacmi	+26
- Dersli öğretim mutfağı ve iş atölyesi	+15÷18	**Sera binaları**	
- Öğretim aracı deposu, laboratuar, vestiyer	+15	- Normal çiçek ve bitkiler	+15
- Duş, soyunma ve giyinme odaları	+26	- Sıcak iklim bitkileri	+25
- Revir, doktor ve muayene odaları	+24		
- Koridor, merdiven ve asansör boşluğu, kapalı teneffüs salonları ve helalar	+10÷15	- Büro hacmi	+20
		- Merdiven ve asansör boşluğu	+18
- Kreşlerde koridor, merdiven ve asansör boşluğu hela	+15	- Jimnastik Salonu	+18
- Okullarda konferans salonları	+18	- Kütüphane ve okuma salonu	+10
- Jimnastik (spor) salonu	+15	- Ambar ve depolar	+18
- Ortopedik jimnastik salonu	+20	- Çoğunluklu dükkanlar	+18
4- HASTANE YAPILARI			
- Hasta yatak ve poliklinik odası	+20		
- Banyo, duş, ameliyat, röntgen ve röntgen soyunma odaları	+22		
- Eczane, laboratuar hacimleri	+20		
- Merdiven ve asansör boşluğu, koridor, bekleme salonu, hol ve helalar	+18		

(*) Projeyi yaptıran tarafından başka bir değer istenmedikçe projesi düzenlenecek yapının ısı gereksinimi bu iç ortam sıcaklıklarına göre hesaplanacaktır.

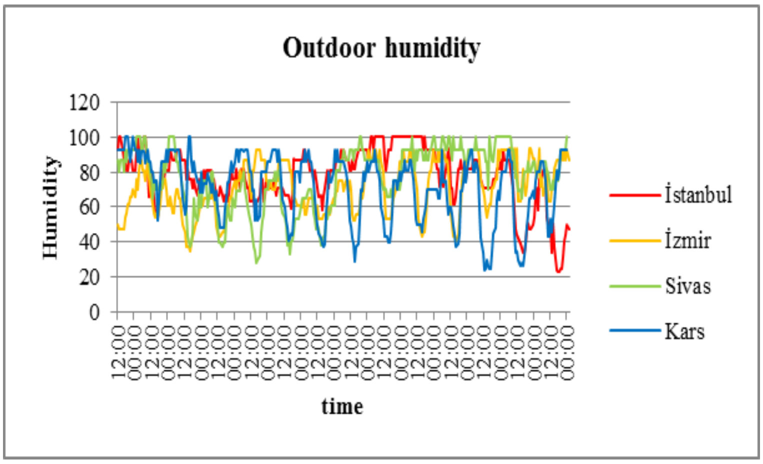
(**) Dersliklerin sıcaklıkları, normal pencere havalandırmasıyla dinlenme sıralarında (teneffüslerde) 18°C altına düşürülebilir.

NOT : Hastane, fabrika, cami, tiyatro vb. gibi yapıların hacim iç sıcaklıkları projeyi yaptıranla birlikte saptanmalıdır.

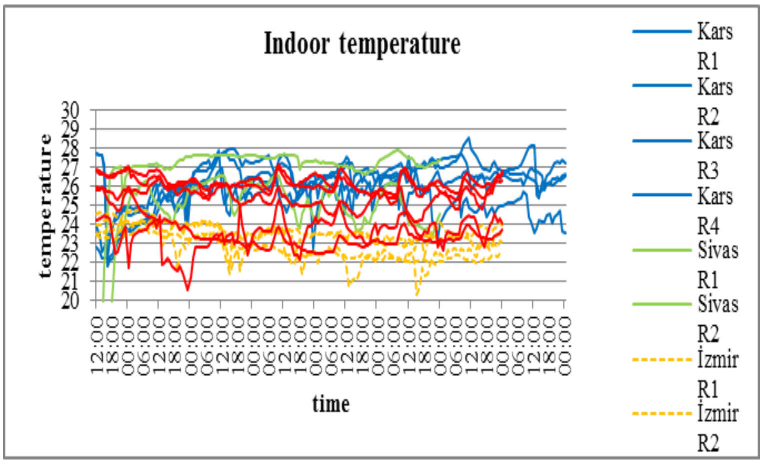
P. Environmental and Behavioral Monitoring Data



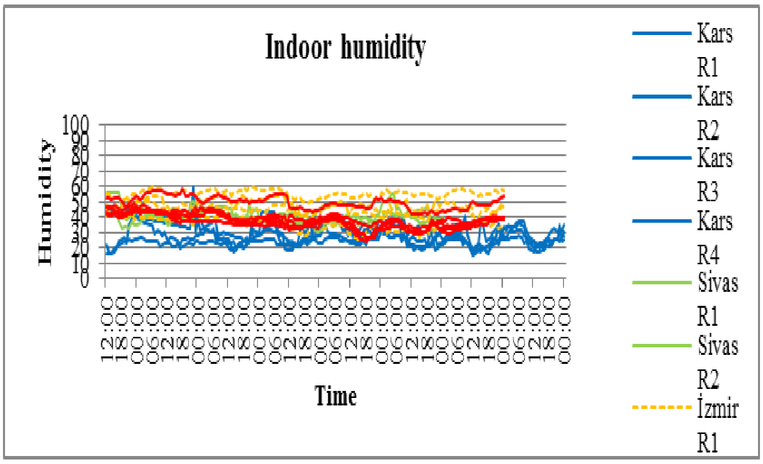
(a)



(b)

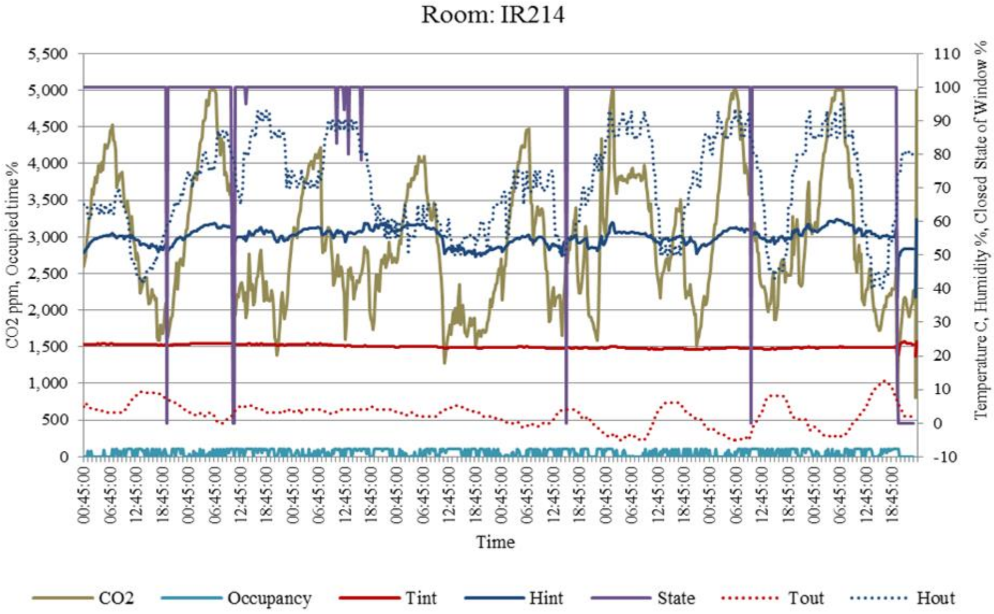


(c)



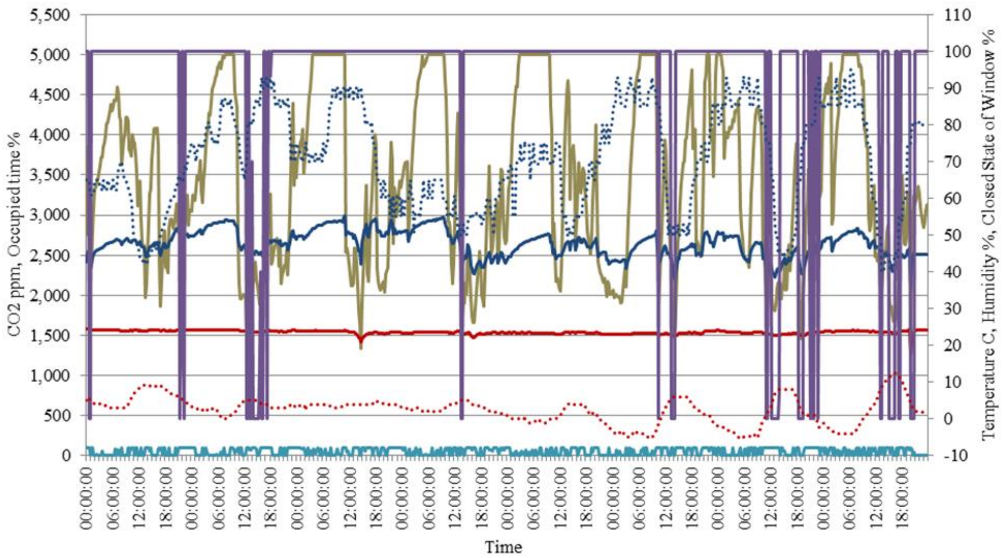
(d)

Figure P.1 Comparative data of indoor and outdoor temperature and humidity for four monitored cities (a, b, c, d)



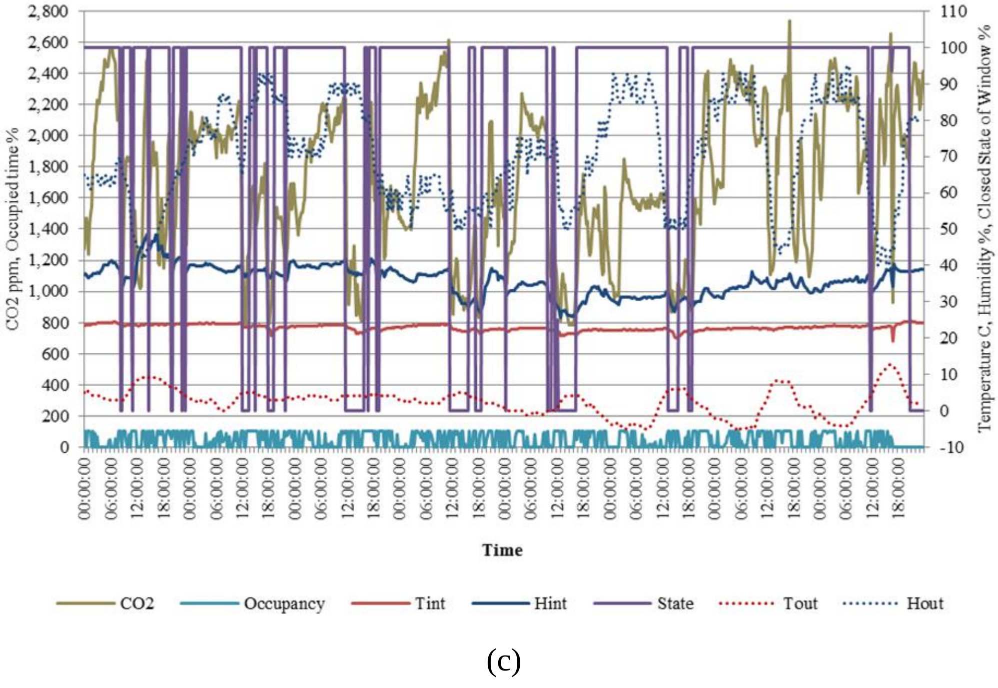
(a)

Room: IR215



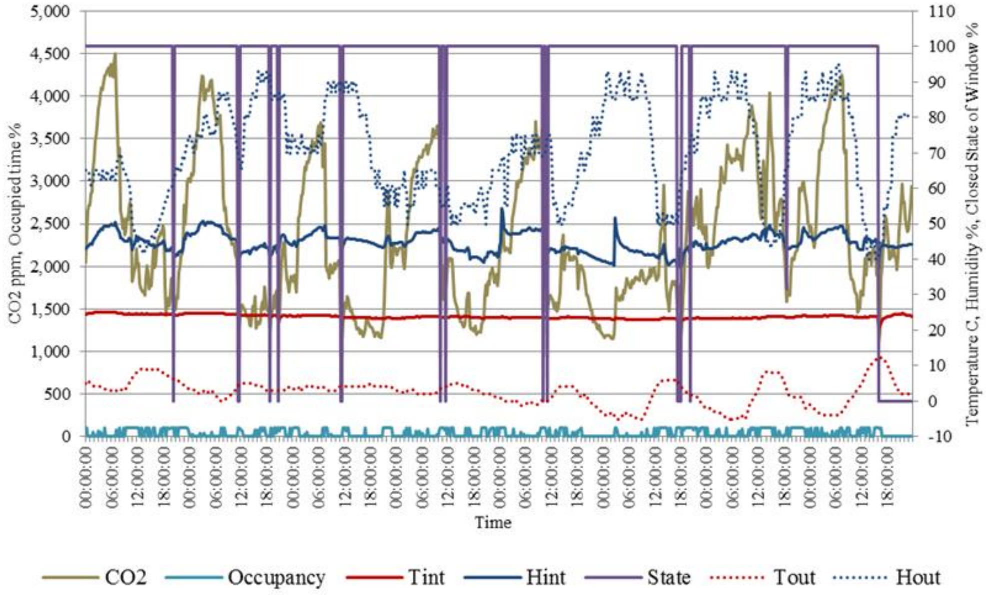
(b)

Room: IRZ06



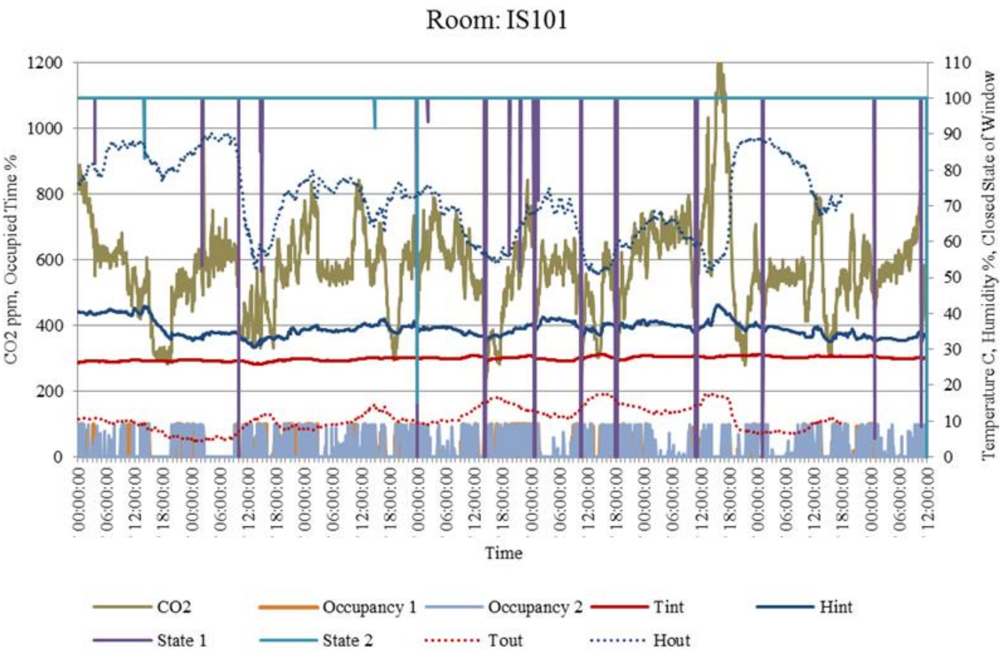
(c)

Room: IR113



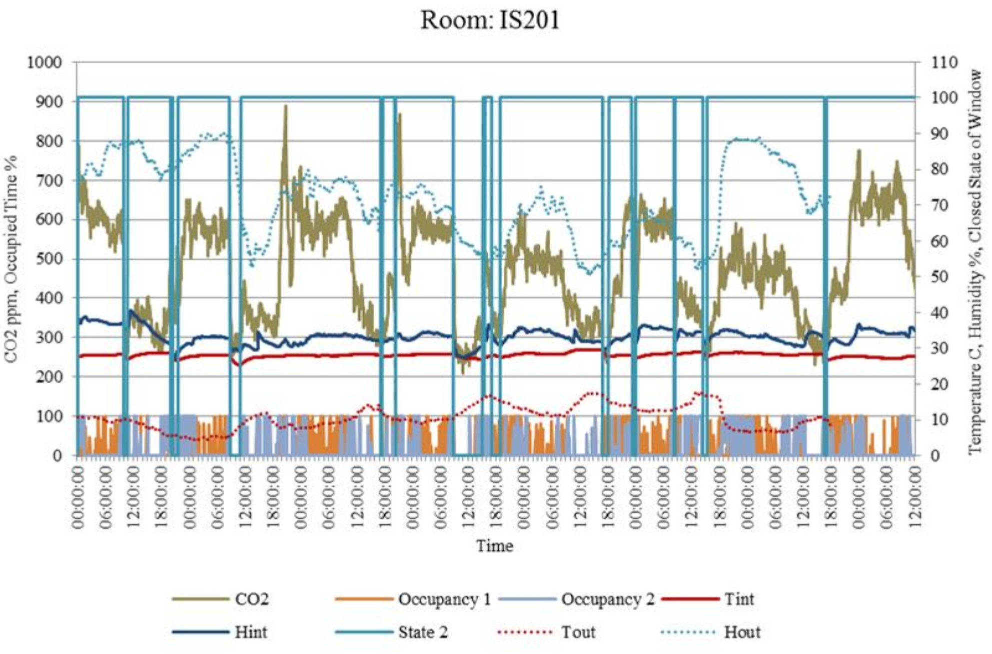
(d)

Figure P.2 recorded data in the rooms in the 1st Climatic Region (İzmir) (a, b, c, d)



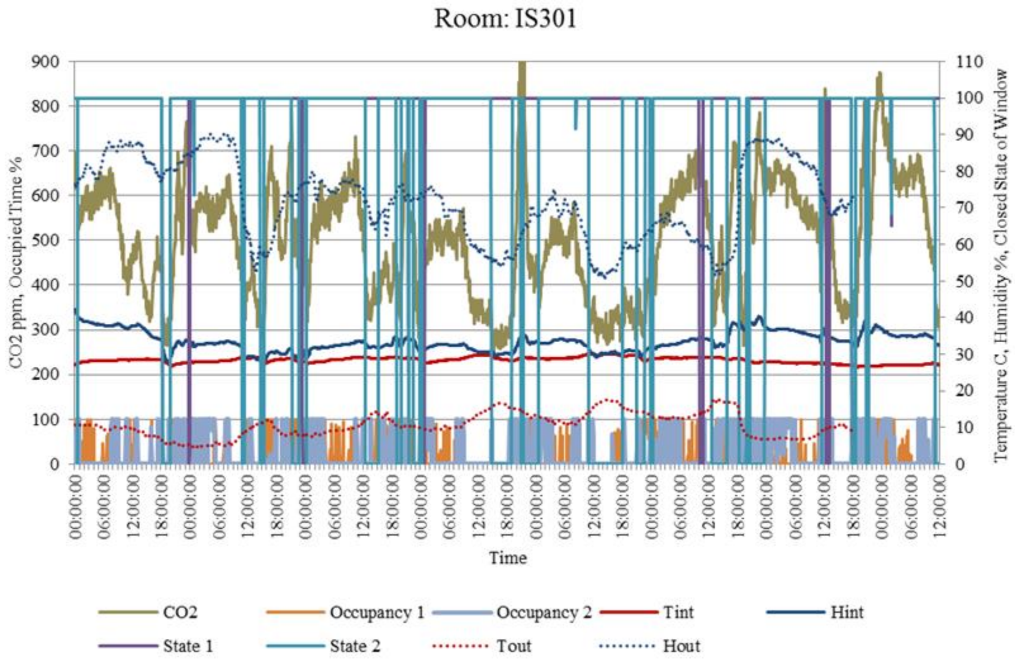
Room: IS101
CO2 ppm, Occupied Time %
Temperature C, Humidity %, Closed State of Window
Time
CO2
Occupancy 1
Occupancy 2
Tint
Hint
State 1
State 2
Tout
Hout

(a)

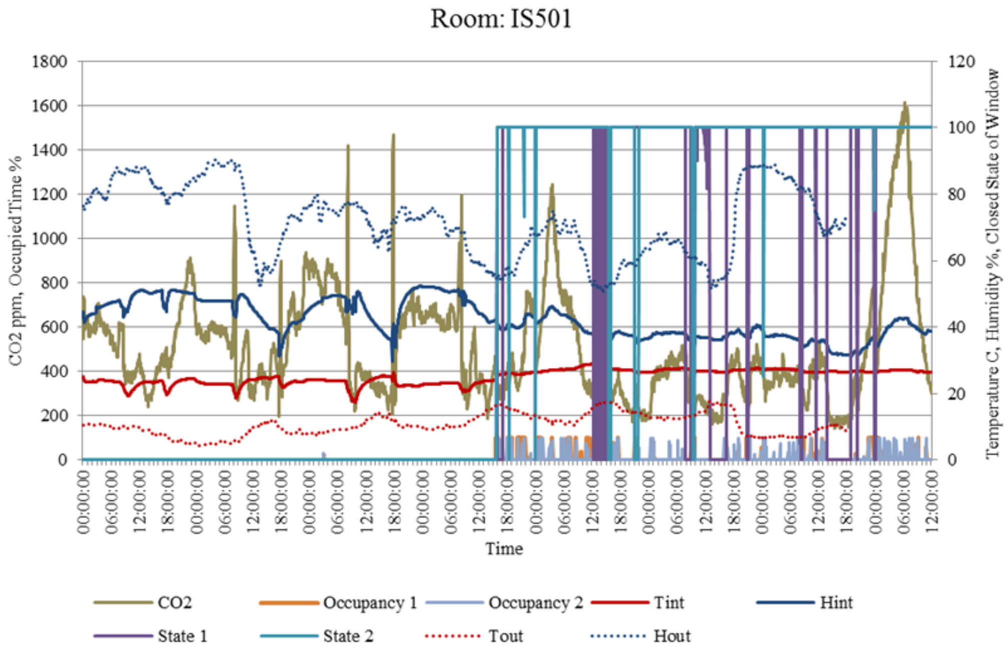


Room: IS201
CO2 ppm, Occupied Time %
Temperature C, Humidity %, Closed State of Window
Time
CO2
Occupancy 1
Occupancy 2
Tint
Hint
State 2
Tout
Hout

(b)

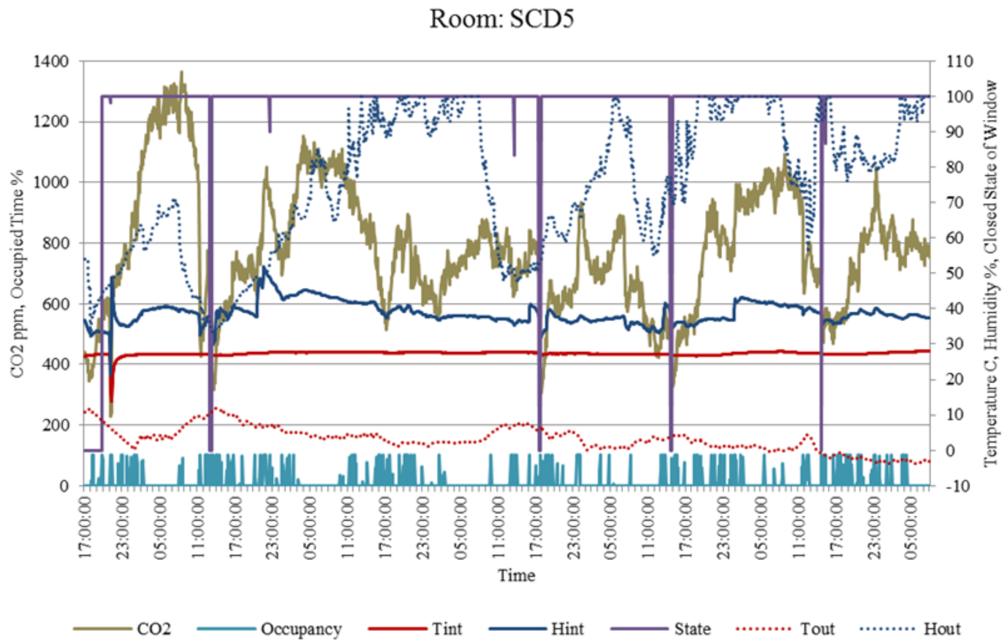


(c)

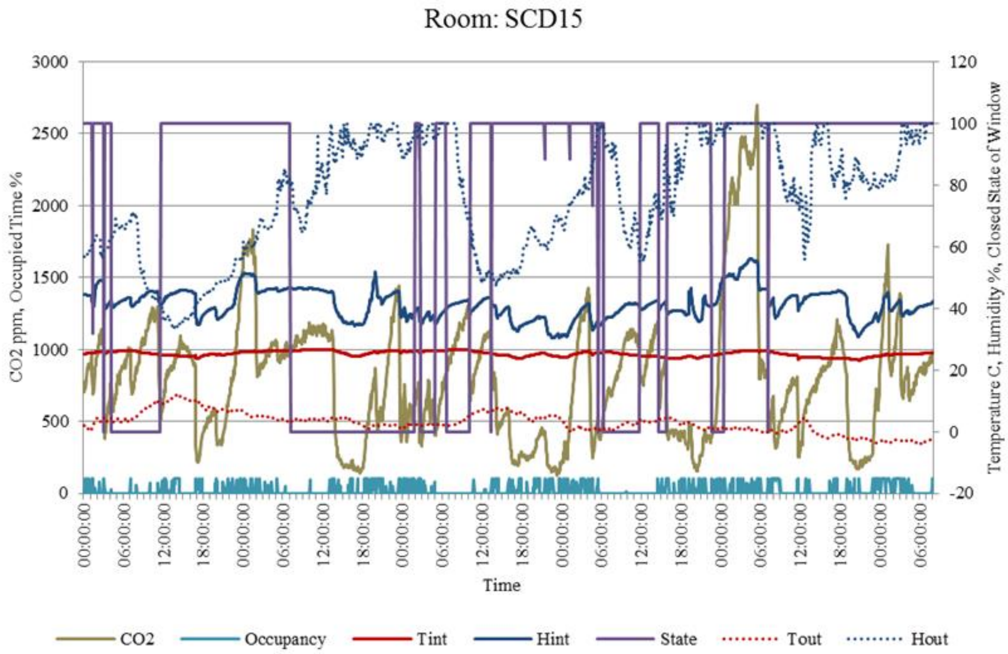


(d)

Figure P.3 recorded data in the rooms in the 2nd Climatic Region (Istanbul) (a, b, c, d)

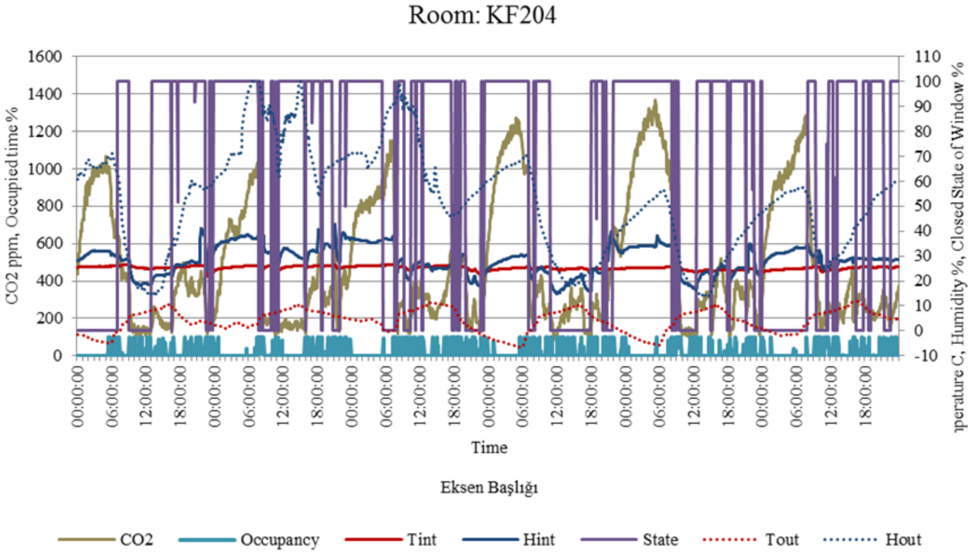


(a)

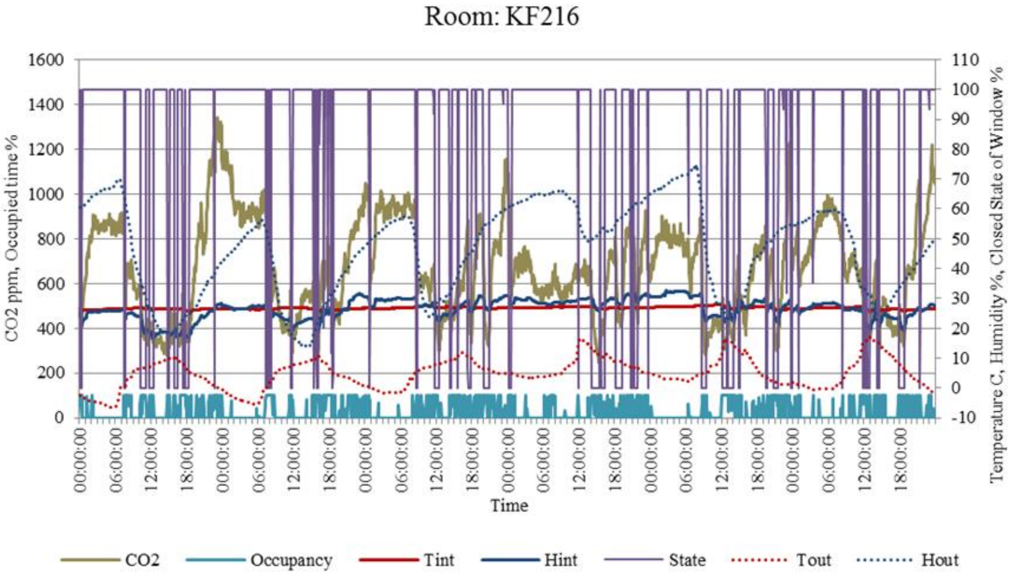


(b)

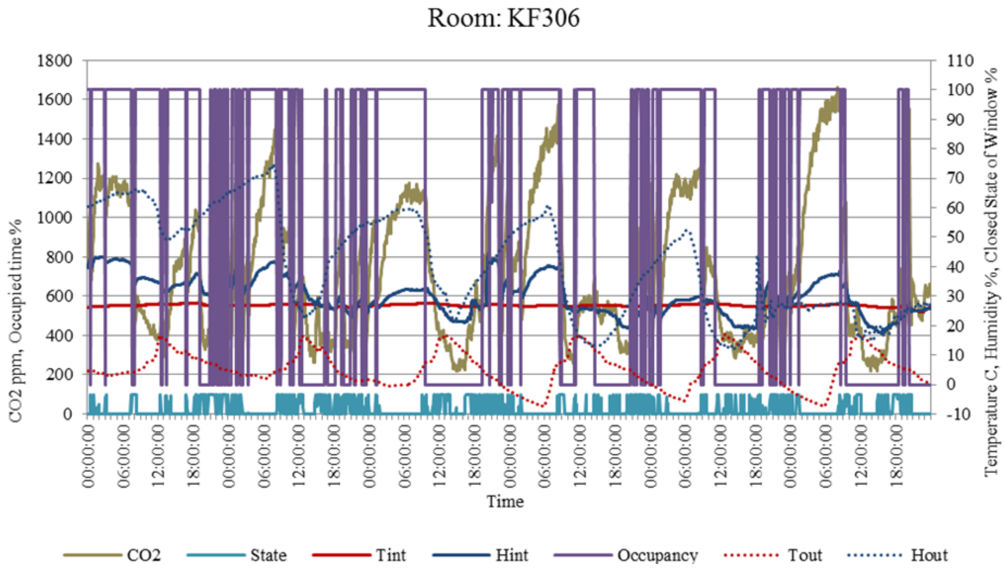
Figure P.4 recorded data in the rooms in the 4th Climatic Region (Sivas) (a, b)


Room: KF204
1600
1400
1200
1000
800
600
400
200
0
CO2 ppm, Occupied time %
110
100
90
80
70
60
50
40
30
20
10
0
-10
perature C, Humidity %, Closed State of Window %
00:00:00
06:00:00
12:00:00
18:00:00
Time
Eksen Başlığı
CO2
Occupancy
Tint
Hint
State
Tout
Hout

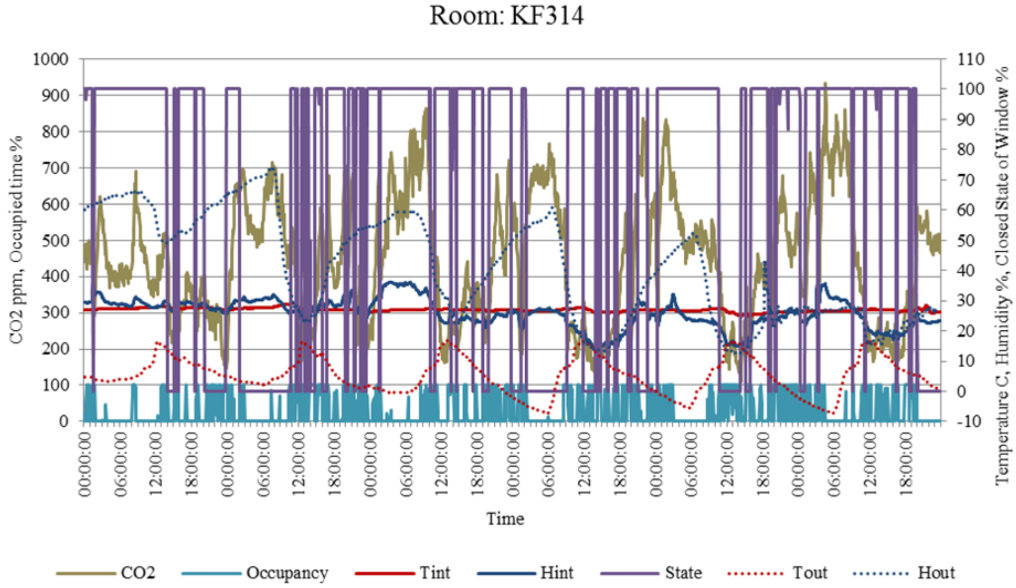
(a)


Room: KF216
1600
1400
1200
1000
800
600
400
200
0
CO2 ppm, Occupied time %
110
100
90
80
70
60
50
40
30
20
10
0
-10
Temperature C, Humidity %, Closed State of Window %
00:00:00
06:00:00
12:00:00
18:00:00
Time
CO2
Occupancy
Tint
Hint
State
Tout
Hout

(b)



(c)



(d)

Figure P.5 recorded data in the rooms in the 5th Climatic Region (Kars) (a, b, c, d)

CURRICULUM VITAE

Surname, Name: Taner Düzyol, Özün

EDUCATION

Degree	Institution	Year of Graduation
MS	METU Building Science	2008
BS	ITU Architecture	2005
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FOREIGN LANGUAGES

Advanced English

PUBLICATIONS

Papers

1. Elias-Ozkan, S.T., F.Summers, T.Karaguzel and O.Taner, "Analyzing environmental performance of AAC blocks, strawbales and mud-plaster in hybrid wall construction", 25th International Passive and Low Energy Architecture Conference – Towards Zero Energy Building, Dublin, Ireland, October, 2008. Eds. P.Kenny, V.Brophy & J.O.Lewis. (ISBN: 78-1-905254-34-7)
2. Elias-Ozkan, S.T., F.Summers and O.Taner, "Energy efficiency of buildings with a solar space: two case studies from the Anatolian plateau", 26th International PLEA Conference – Architect, Energy & the Occupant's Perspective, Montreal, Canada, June, 2009. Eds. C.Demers & A.Potvin (ISBN: 978-2-7637-8939-2)

Editor:

1. Elias-Ozkan, S.T., B.Z. Çakmaklı & Ö.Taner, 1. Uluslararası Lisansüstü Araştırmaları Sempozyumu: Yapılı Çevre, Vol.2, METU-FAC, Ankara, Turkey. 2010. ISBN: 978-975-429-286-2 (2.c)

Research Projects:

1. ERANET-Cofund Project - Smart bioclimatic low-carbon urban areas as innovative energy isles in the sustainable city, 2016-18, (359,800 TL) TÜBİTAK project no. 116M030

2. Impact of Occupant Behaviour on Energy Consumption in Buildings (METU-BAP-02-01-2016-001) (24,665TL)

3. Thermal Performance of Buildings with Passive Solar Gains, Insulation and Energy Efficient Heating Systems (METU-BAP-02-01-2014-001) (29,500TL)

4. Measuring infiltration in building envelopes (METU-BAP-02-01-2013-001) (7,300TL)

5. Energy Efficient Design of Buildings (METU-BAP-02-01-2013-002) (20,500TL)

6. Indoor Air Quality in Classrooms: Comparing simulated and recorded data (METU-BAP-02-01-2011-003) (Ofis Binalarında İç hava kalitesinin doğal havalandırma yoluyla iyileştirilmesi)

WORK EXPERIENCE

Architect	Boğaziçi University, Directorate of Construction and Technical Works	2014-…
Specialist	METU Department of Architecture	2009-2013
Project Research Assistant	METU Kerkenes Eco-Center Research Project;	2008-2009
Junior Architect	PEB Mimarlık	2005-2007