INDOOR ENVIRONMENTAL QUALITY ASSESSMENT: A CASE STUDY IN WELLNESS CENTER, ANKARA

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INDOOR ENVIRONMENTAL QUALITY ASSESSMENT: A CASE STUDY IN WELLNESS CENTER, ANKARA

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Submitted by **Abubaker Hassan Ali ALKHABASHI**

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ABSTRACT

INDOOR ENVIRONMENTAL QUALITY ASSESSMENT: A CASE STUDY IN WELLNESS CENTER, ANKARA

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Designing for an acceptable indoor environmental quality (IEQ) is essential due to its health impacts on the space users. The assessment of indoor environmental quality can be performed basically by four main parameters; indoor air quality, thermal comfort, lighting comfort and acoustic comfort. In this research, a healthcare center (Medifit Wellness Centre, Ankara, Turkey) is chosen as a case study in order to assess its indoor environmental quality parameters through objective measurements, subjective users' evaluations (physical perception) and architectural characteristics. Initially, the objective data is compared to the international standards and the findings are discussed in detail. In addition, several statistical tests are carried to set forth correlations and relationships of the chosen parameters between objective subjective and architectural data. The first correlation is established between the objective and subjective data, where a correlation is found between the lighting data in the exercise room. Furthermore, several correlations are also presented between the demographic and space usage data of the participants, and the subjective physical perception and importance assessment of the IEQ parameters in the different spaces. Finally, through ANOVA tests and means comparison, it is concluded that the areas within the case space vary in their indoor environmental quality, as the exercise rooms are found significantly noisier, brighter, cooler and less humid than the treatment rooms.

Keywords: indoor environmental quality, objective measurement, subjective physical perception, environmental perception, wellness center.

ÖZ

İÇ MEKAN ÇEVRESEL FAKTÖRLERİN DEĞERLENDİRİLMESİ: SAĞLIK MRKEZİ ALAN ÇALIŞMASI, ANKARA

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Kabul edilebilir bir iç mekan kalitesinin tasarlanması, mekanda bulunan kullanıcıların üzerindeki sağlık etkileri nedeniyle çok önemlidir. Kapalı alan kalitesinin değerlendirilmesi dört temel parametre ile gerçekleştirilmektedir. Bu parametreler, iç mekan hava kalitesi, ısıl konfor, aydınlatma seviyesi ve akustik konfor olarak örneklenebilir. Bu araştırmada üç temel metot kullanılarak analizler sağlanmıştır. Bunlar, kapalı bir alanda bulunan çevre koşullarının kalitesini yerinde ölçümleme, öznel kullanıcı değerlendirmeleri (fiziksel algılama) ve seçilen alanının mimari analizi olarak belirlenmiş ve alan çalışması için bir sağlıklı yaşam merkezi (Medifit Sağlıklı Yaşam Merkezi, Ankara) seçilmiştir. Objektif veriler uluslararası standartlarla karşılaştırılmış ve detaylı sunulmuştur. Araştırmanın bulguları istatistik testler ile desteklenmiş ve yapılan üç farklı analizin arasında birçok korelasyon ve ilişki saptanmıştır. İlk korelasyon, egzersiz odası için aydınlatma parametresinin nesnel ve öznel verileri arasında kurulmuştur. Ayrıca, katılımcıların demografik ve alan kullanımı verileri ile farklı alanlardaki öznel fiziksel algılama ve önem değerlendirmesi arasında korelasyonlar saptanmıştır. Son olarak, ANOVA testi ve ortalama analizlerinin karşılaştırılması sonucunda, egzersiz odaları, tedavi odalarından çok daha gürültülü, daha aydınlık, daha serin ve daha nemli bulunmuştur.

Anahtar kelimeler: kapalı çevre kalitesi, objektif ölçüm, öznel fiziksel algı, çevre algısı, sağlıklı yaşam merkezi

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I would like also to express my love and gratitude to my mother and brothers; Ali, Al Tahir and Abdulsalam, for their trust and encouragement throughout my life. My mother is a role model in every way affecting me greatly by being such an amazing academician and life teacher. In addition, special thanks to all my family and friends for their love and understanding.

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1. INTRODUCTION

1.1. General Overview

In previous studies regarding indoor environmental quality (IEQ), the main attention was solely focused on the prevention of harsh effects using a methodology that treats each factor in an isolated manner which meant to choose the thermal, sound, air or lighting and treat it separately (Bluyssen, 2013). Nonetheless, including the indoor environment in Vitruvius architectural books in the ancient history, around 100 BC, recognizes the subject as one of the most important issues that has always concerned designers (Hobday, 2011). Therefore, the main concern becomes realizing the significance of the indoor environment especially the aspects that are concerned with the occupants' health and the environmental changes (Alhorr, et al., 2016). Moreover, a lot of efforts were spent in achieving the healthiest indoor environment for occupants. However, the relation between the parameters of the indoor environmental quality (IEQ) was not studied until the early 20th century in order to achieve an overall comfort for the space occupants (Bluyssen, 2013).

Recently, the engineers concerned with the subject realized that the relation between the four components of the IEQ, air quality, lighting quality, thermal comfort and acoustic comfort, should not start by setting standards rather than focusing on the occupants who will use the space (Alhorr, et al., 2016). The more control does the occupant have over the IEQ in his space, the more comfortable is the indoor experience. Moreover, the comfort in any indoor space is not limited to the four parameters of IEQ. The ability of the occupant to function efficiently by providing adequate space and resting zones contributes to the overall comfort. As people spend around 90% of their daily time in indoor environments, Figure 1.1 shows the percentage of time spent by individuals on a daily basis, it is also necessary to study the side effects resulting from unhealthy IEQ in order to create the knowledge about the weight of contribution of each parameter into the overall comfort of the indoor space (Chung, Chiang, Chou, & Lin, 2011). The side effects can include many issues caused to the occupants' health on the short and long terms. For instance, inadequate lighting in a space may cause the occupants to develop optic deficiencies, as well as many lung, ear or skin diseases that might be caused for frequent users of building that do not satisfy the IEQ minimum qualities, which is a phenomenon known as Sick Building Syndrome (SBS) (Apte, Fisk, & Daisey, 2000).

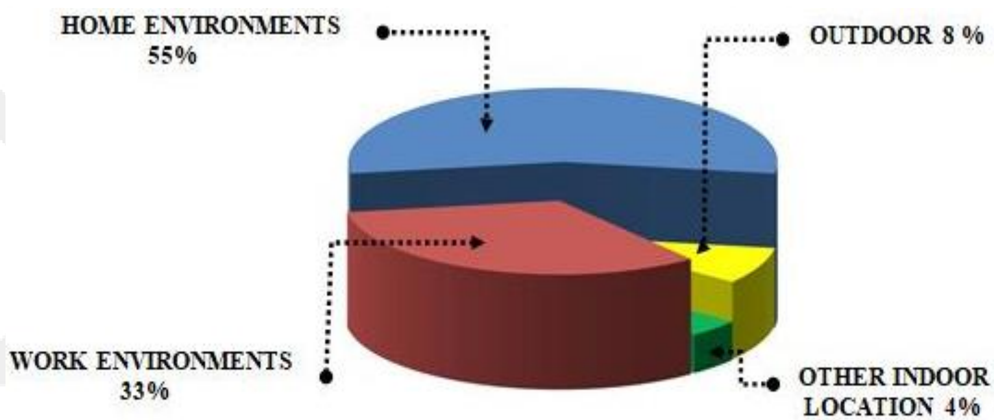

Figure 1.1. Individual's daily time distribution per location (Chung, & Lin, 2011)

As seen in Figure 1.1, time spent in home and working environments are nearly taking 88% of individuals' daily time. In the literature, there are many studies on IEQ of homes and working spaces. However, there are no significant studies that research the IEQ in other indoor spaces, which form 4% of the total individual's time, especially studying recreation oriented spaces in details and in accordance with IEQ parameters.

The study will measure four parameters to evaluate the IEQ at the targeted case study which are:

1. Temperature
2. Humidity
3. Acoustic
4. Lighting

Furthermore, the choice of the case study to be conducted in a wellness center as healthcare facility would be considered significant for the subject due to the high priority of the subject in the space resulting from nature of the occupants who are mainly people in need for recreation and health related treatments. Moreover, the users' perspective is one of the important parameters that will be considered in this research in order to have a complete picture about the IEQ and the ways to enhance it.

Being the capital and one of the major cities in Turkey, Ankara is always exposed to many environmental issues. Moreover, healthcare environments are assumed to comply with IEQ standards due to the nature of its spaces and the type of occupants, which mostly can be health-challenged. Therefore, this research will examine the IEQ parameters at a Wellness Centre in Ankara through a field investigation method. The parameters, which will be considered, are as illustrated in Figure 1.2 below; however, the air quality is considered through the relative humidity levels.

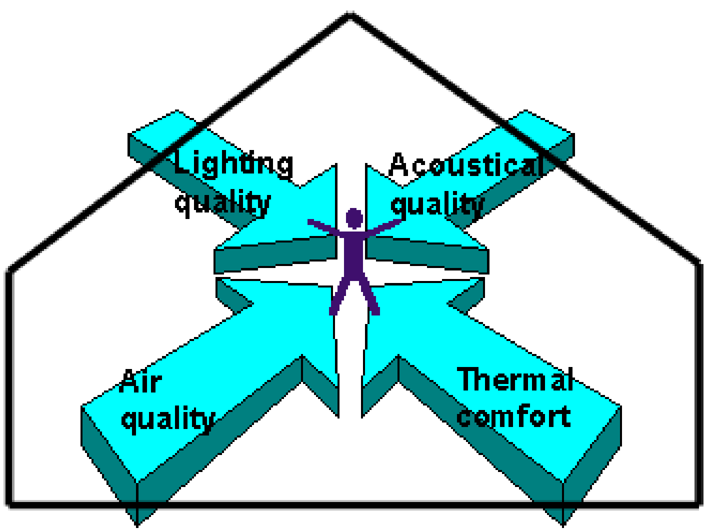

Figure 1.2. The parameters of indoor environmental quality (Bluyssen, 2013)

1.2. Gap in the Literature

There is a lack of research about wellness center. This study focuses on the indoor environmental quality assessment in wellness centers from the user's perspective; thereby initially a detailed literature matrix is prepared by including studies that focus on indoor environmental parameters and related case spaces as shown in Table 1.1. The research was focused on previous studies' results published through research journals.

Table 1.1. Literature matrix

KEYWORDS	Thermal Comfort	Acoustics	Indoor Air Quality	Lighting Levels
Hospital	**1. Nimlyat, P. S. (2015**) Article; researchgate.net **2. Sadek, A.H. (2013)** Article; google scholar	**1. Nimlyat, P. S. (2015)** Article; researchgate.net **2. Sadek, A. H.(2013)** Article; google scholar **3. Balkoçyiğit. (2012)** Article; metu.edu.tr	**1. Nimlyat, P. S. (2015)** Article; researchgate.net **2. Sadek, A. H. (2013)** Article; google scholar	**1. Nimlyat, P. S. (2015)** Article/ researchgate.net **2. Sadek, A. H. (2013)** Article google scholar
Museums				**Kaya, Ş.M. (2015)** YÖK Thesis Database: 395409 http://repository.bilkent.edu.tr
Commercial buildings	**Heinzerling, D. (2013**) Article; http://escholarship.org	**Heinzerling, D. (2013)** Article; http://escholarship.org	**1. Dutton, S. M. (2015)** Article; researchgate.net **2. Heinzerling, D. (2013)** Article; escholarship.org	**Heinzerling, D. (2013)** Article; http://escholarship
Houses	**1. Frontczak, M. (2012)** Article; elsevier journals **2. Arens, E. (2013)** Article; http://escholarship.org **3. Engvall, K. (2003)** diva-portal.org **4. Lai, A. C. K. (2009)** Article; researchgate.net	**1. Frontczak, M. (2012)** Article; elsevier journals **2. Engvall, K. (2003**) diva-portal.org **3. Lai, A. C. K. (2009)** Article; researchgate.net	**1. Frontczak, M. (2012**) Article; elsevier journals **2. McGill, G. (2015**) Article; Science Direct **3. Arens, E. (2013)** Article;http://escholarship.org **4. Engvall, K. (2003)** diva-portal.org **5. Hobday, R. (2011)** Technical paper; seedengr.com **6. Lai, A. C. K. (2009)** Article; researchgate.net **7. Majdan, M. (2012)** Article; nih.gov/ European journal	**1. Frontczak, M. (2012)** Article; elsevier journals **2. Engvall, K. (2003)** diva-portal.org **3. Hobday, R. (2011)** Technical paper; seedengr.com **4. Lai, A. C. K. (2009)** Article; researchgate.net

Sports center	**1. Revel, G. M. (2014)** Article;journals.elsevier.com **2. Revel, G.M., & Arnesano, M. (2014)** Article; Science Direct		**Alves, C. A. etc. (2013)** Article; aaqr.org **Ramos, C.A. (2014)** Article; journals.elsevier.com	
Offices	**1. Corgnati, S. P. (2012)** Article; REHVA journal **2. Frontczak, M. (2012)** Article; Elsevier journals **3. Huizenga, C. (2006)** Article; http://escholarship.org **4. Kim, J., de Dear. (2013)** Article; http://escholarship.org **5. Peretti, C. (2010)** Article; escholarship.org	**1. Frontczak, M. (2012)** Article; Elsevier journals **2. Jensen, K. (2005)** Article;http://escholarship.org **3. Kim,J.,de Dear. (2013)** Article; escholarship.org **4. Peretti, C. (2010)** Article; escholarship.org	**1. Frontczak, M. (2012)** Article; Elsevier journals **2. Huizenga, C. (2006)** Article;http://escholarship.org **3. Kim, J., de Dear. (2013)** Article;http://escholarship.org **4. Öktem, Z. (2013).** Article; researchgate.net **5. Eretti, C.(2010)** Article; escholarship.org	**1. Frontczak, M. (2012)** Article; Elsevier journals **2. Kim, J., de Dear. (2013).** Article;http://escholarship.org **3. Peretti, C. (2010)** Article;http://escholarship.org
Schools & Universities	**1. Fadeyi, M. O. (2014)** Article; Science Direct **2. Al-Sulaihi, I. (2015)** Article; researchgate.net **3. Sulaiman, M. A. (2013)** Article; www.ijsrp.org/ **4. Yee, T. C. (2014)** Article; http://eaas-journal.org	**1. Fadeyi, M. O. (2014)** Article; Science Direct **2. Sulaiman, M. A. (2013)** Article; www.ijsrp.org/ **3. Yee, T. C. (2014)** Article; http://eaas-journal.org	**1. Fadeyi, M. O. (2014)** Article; ScienceDirect **2. Al-Sulaihi, I. (2015)** Article; researchgate.net **3. Sulaiman, M. A. (2013)** Article; http://www.ijsrp.org/ **4. Yee, T.C. (2014)** Article;http://eaas-journal.org	**1. Fadeyi, M. O. (2014)** Article; ScienceDirect **2. Al-Sulaihi, I. (2015)** Article; researchgate.net **3. Sulaiman, M. A. (2013)** Article; http://www.ijsrp.org/ **4. Yee, T. C. (2014).** Article;http://eaas-journal.org

Aging-care-institutions	**Chung, P. R. (2011)** Article; ieeexplore.ieee.org.	**Chung, P. R. (2011)** Article; ieeexplore.ieee.org.	**Chung, P.R. (2011)** Article; ieeexplore.ieee.org.	**Chung, P. R. (2011)** Article; ieeexplore.ieee.org.
Childcare centers		**Evans, G.(2000)**	**1. Oh, H.J.,Nam,I. S. (2014)** Article; researchgate.net **2. Roda,C.,Barral, S. (2011)** Article; researchgate.net **3. de Waard, M. (2014)** Conference Papers;ASHRAE **4. Zuraimi, M.S. (2007)** Article/ researchgate.net	

The importance of this research emerges from the following:

1. There has been very little focus on indoor environmental quality parameters; indoor air quality, thermal quality, acoustic quality, and lighting quality and their overall integration in the evaluation process,
2. There has been a lack of indoor environmental quality research in healthcare facilities and especially wellness centers,
3. There has been a lack of IEQ studies in wellness centers that incorporate the user's perspective and correlate it to objective measurements.

1.3. Aim and Scope

The aim of this thesis is to evaluate the following issues in Medifit wellness center in Ankara in order to achieve well-being and comfort for its users:

1. To evaluate the objective indoor environmental quality parameters (IEQP).
2. To evaluate the subjective assessment of IEQP and spatial characteristics of the case wellness center.
3. To understand the relationship between measured IEQP and the subjective quality assessment by the users of the wellness center.
4. To identify the dependent factors of subjective quality assessment regarding IEQP.
5. To compare the IEQP measurements of the exercise and treatment rooms.
6. To compare the IEQP measurements from the wellness centre with the standards for healthcare facilities.

1.4. Thesis Structure

In order to formulate a full picture about the IEQ and the case study, the structure of the thesis will be as shown in figure 1.3 below. The first chapter of the study provides an overview about the subject, as well as defining the gap in the literature, and the aim and scope of the research. Moreover, the research goes through two parts; the literature review, which defines the IEQ parameters', their international standards and the literature context that they were used for, and methodology, which

Defines the subjective and objective methodologies used to evaluate the IEQ parameters in the case space, as well as designing the research procedures in detail through a questionnaire to evaluate the physical perception of IEQ parameters and their objective measurement procedures. The forth chapter, narrates the results of the architectural analysis, objective measurements and subjective physical perception by the case space users.

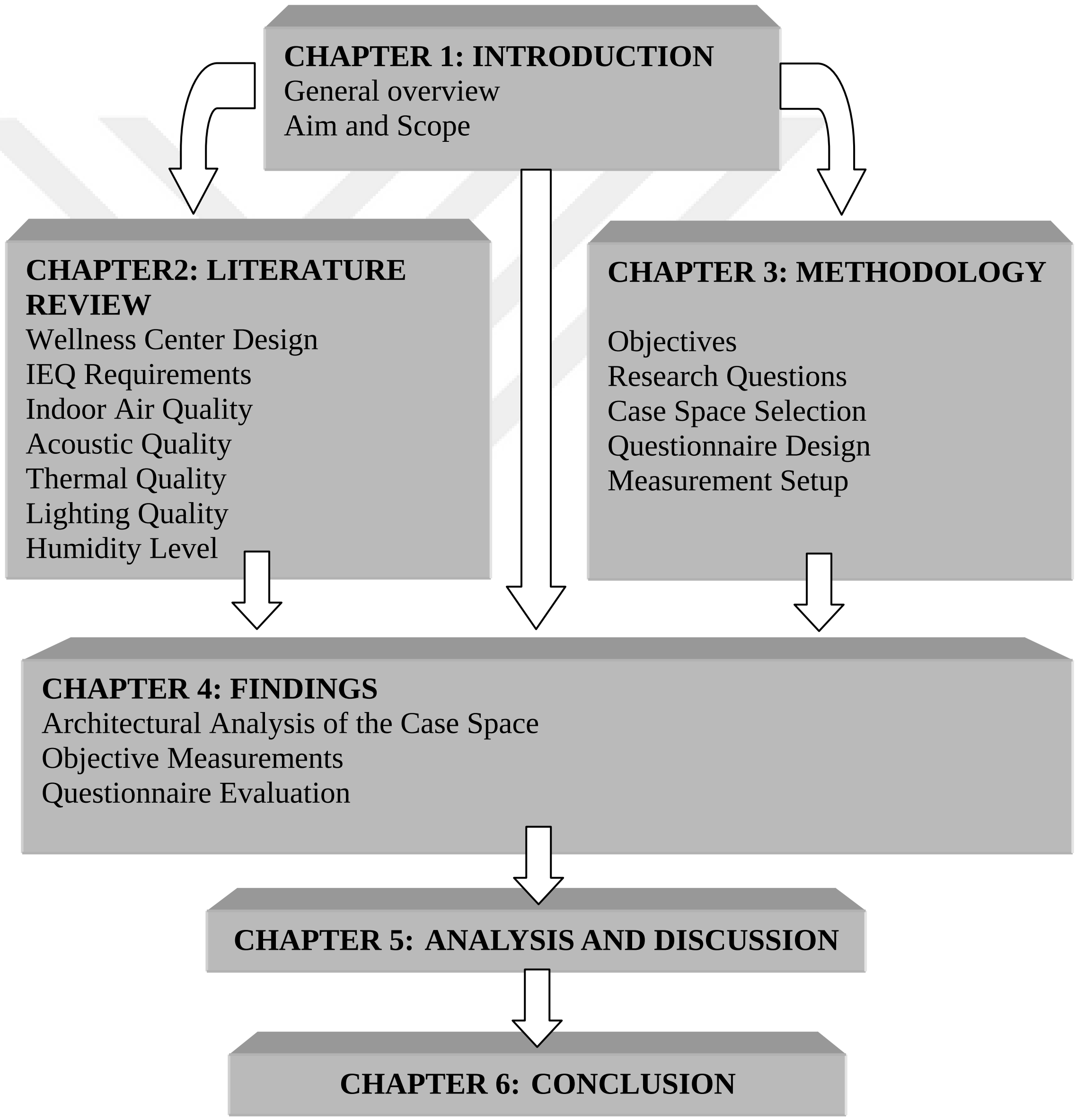

Figure .1.3. Thesis Structure

Furthermore, the fifth chapter tests the correlation between the different aspects of the study including; the subjective and objective measurements, the demographical and space use with the subjective evaluation, and the objective measurements and subjective users' evaluation between the treatment and exercise rooms. Finally, the conclusion chapter includes the hypotheses testing in accordance with the correlations tested in the previous chapter.

2. LITERATURE REVIEW

This chapter investigates the different parameters, as specified in the introduction chapter, of indoor environmental quality separately and collectively. Moreover, results are reviewed from the literature, as well as international standards, for comparison and discussion of the case study. The chapter presents the impact of IEQ on human well-being, health and wellness, and shows the relation between its parameters.

2.1. The Wellness Center Design and User Needs

To establish the relation between the interior design and the IEQ of a wellness center, it would be significant to understand the definition of wellness in general. The term itself may mean several things depending on people’s perspective. For instance, wellness that is focused on exercise, diet and nutrition will eventually target the physical aspect of the term, while if it is focused on the mind and mental health, the term describes the spiritual aspect. Moreover, in the corporate perspective, the spa, healthcare and insurance providers may use the term for the specific benefit of their products and objectives (Benson, 2013). However, in interior design, no specific wellness definition was related to the field which requires further understanding to establish the relation.

Therefore, the focus in interior design is to provide the best indoor environment for the occupants in order to achieve wellness, which is better understood as a process rather than a measurable parameter which may position the term under the understanding the self-well-being status and the effect of the surrounding environment, personal relationships, stress, health matters, and other related factors on the human which is mainly related to the quality of life. Moreover, the Oxford dictionary defines wellness as “the state of being in good health, especially as an actively pursued goal” (Oxford, 2016). Therefore, since health is the key parameter of wellness, its definition according to World Health Organization (WHO) is, “health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO, 2005).

Nonetheless, the indoor environmental Quality (IEQ) parameters do not take psychological factors, age or diseases into account due to the difficulty in measurement for such parameters. Therefore, the main measurement of IEQ depends on the air, acoustic, thermal and lighting qualities as major parameters which could determine to a great extent the overall IEQ of any space (Bluyssen, 2013).

2.2. Indoor Environmental Quality Requirements

There are many factors that affect the indoor environmental quality such as temperature, humidity, air flow, availability of pollutants, the noise level in a space and the lighting level and type depending on the functionality needed for the space. Therefore, this leads the IEQ concept to be very broad which makes it necessary to group the IEQ parameters into thermal, visual, and acoustic comfort in addition to indoor air quality (Almeida, De Freitas, & Delgado, 2015).

Indoor environmental quality has basic four parameters as illustrated in Figure 2.1 and the combination of these parameters at any space determines the overall IEQ for it. For instance, the darker the combination zone, the higher the IEQ in the space (Bluyssen, 2013).

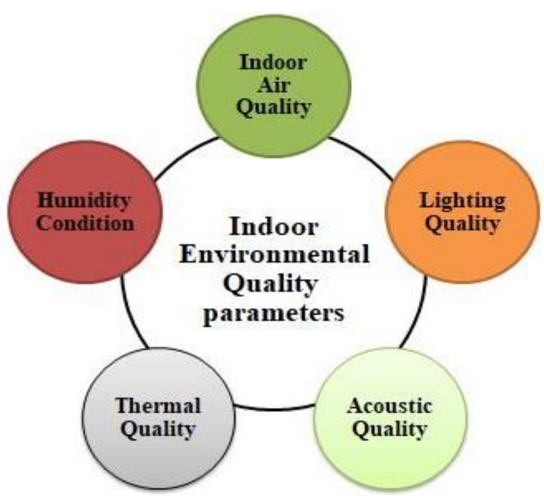

Figure .2.1. The combination zones between the IEQ parameters (Bluyssen, 2013)

The IEQ assessment includes many sub-factors such as the external environment conditions, the building assemblies, the buildings mechanical and electrical services, and the occupants' functions of the space (Raimondo, Corgnati, & Olesen, 2012). The various sub-factors get incorporated through the environmental design as part of the aesthetic qualities of the design. Dean Hawkes (2007) comments on the IEQ parameters interaction with the building design as, "the interaction of light and air and sound with the form and materiality of architectural space is of the very essence of the architectural imagination" (pg. 16). Another philosophy is adopted by Juhani Pallasmaa (2005) about the relation between the building design and the occupant's feel consideration; "architecture is the art of reconciliation between ourselves and the world, and this mediation takes place through the senses" (pg. 19).

Therefore, in addition to the basic parameters of indoor environmental quality parameters such as; air quality, acoustic, thermal and visual comfort, other sensitive elements shall be considered during the building environment design which affects the overall well-being for all the space's occupants. Physiological comfort elements such as chemical, toxins and electromagnetic allergies could be relatively significant to consider during the IEQ design consideration (Raipancholia, 2013).

There is a certain complexity that ties the indoor environmental quality of a space and the well-being of its occupants which has long and short-term impacts on the concerned individuals. The combination of all the factors can be noticed through phenomena such as *sick building syndrome* (SBS) which not only affects the health of the space users, but also their productivity in work spaces (Apte, Fisk, & Daisey, 2000). Nonetheless, many other issues that could be or could not be measured in the short-term basis may eventually affect the occupants with serious issues on the long term such as asthma and obesity (Houtman, et al., 2008).

2.2.1. Indoor Air Quality

The indoor air quality (IAQ) is one of the most important factors that could be measured through knowing the concentration of pollutants, temperature and humidity in the indoor environment. Therefore, the less contaminated is the indoor air by chemical and biological particles, the healthier it is considered for the space occupants. The significance of indoor air quality emerges in the first place from being one of the major determinate factors of the health and comfort of the humans. Moreover, a decline in the IAQ can cause many diseases and influence the productivity and living experience of the space occupants (Raipancholia, 2013).

Studying the pollutants of the indoor air is highly significant when considering the Indoor Air Quality (IAQ) due to their direct effect on occupants' health and their overall well-being (Chung, Chiang, Chou, & Lin, 2011). One of the major IAQ indicators is the carbon dioxide (CO_2) content in the indoor environment, where its safe and unsafe levels are illustrated in Table 2.1 below (Al-Sulaihi, Al-Gahtani, Alsugair, & Tijani, 2015).

Table 2.1. Classifications of CO_2 levels (Hobday, 2011).

CO_2 Level (ppm)	Classification
Below 1000	Harmless
1000 to 2000	Elevated
More than 2000	Hygienically Unacceptable

Furthermore, IAQ is one of the most concerning issues for facilities managers who are always trying to raise awareness to the air quality and its related problems in their buildings (Spengler & Chen, 2000). In order to determine an acceptable indoor air quality, the American Society of Heating, Refrigerating and Air-Conditioning

Engineers (ASHRAE) has set many criteria in its standards which the following are a preview of the most relative ones:

1. Minimum ventilation rate for any space should be 8 Ls^{-1}. This standard keeps the CO2 level in the space steady at 870 ppm, assuming that each person generates 0.31 $Lmin^{-1}$ while the minimum ventilation rate increases for office spaces to 10Ls-1 (Apte, Fisk, & Daisey, 2000).
2. There should be no dangerous contaminants concentrations, which should be in accordance with the authorities' regulations. Moreover, the indoor air quality is deemed acceptable if a minimum of 80% of the space occupants do not have any dissatisfactions or health issues resulting from the IAQ (Almeida, De Freitas, & Delgado, 2015).

Nonetheless, a clean air can be standardized by studying the quality of the air in the countryside areas or over the oceans which are away from any pollution sources (Zhang Y. , 2004). Moreover, due to the enhancements in the air tightness in buildings constructed in the past 40 years in order to conserve energy, this increased the ventilation issues and the internal pollutants' concentrations in the indoor spaces resulting from many sources including people functions and poorly maintained HVAC systems (Almeida, De Freitas, & Delgado, 2015). Therefore, many indoor air pollutants can be identified as per (Harrison, 2002) and (Lee & Chang, 2000) which include but not limited to:

1. Heating and cooking appliances
2. Open fires
3. Insulation and building material
4. Fabrics
5. Glue, painting and sealant material
6. Cleaning products
7. Dust mites
8. Fungus

9. Bacteria
10. Tobacco smoke
11. Human functions

While people might think that the pollution in the outdoor air is more dangerous than the indoor air pollution, researches have proved a contrary point of view (Jones, 1999). This finding can be enforced by knowing the USA government has ranked the indoor air pollution as one of the most dangerous environmental hazards (Hess-Kosa, 2011). Moreover, a report by the United States Environmental Protection Agency (USEPA) have marked that regardless of the type or the size of the city, the indoor air in the US buildings is more polluted than the outdoor air (USEPA, 1995).

The term *volatile organic compounds* (VOCs) describe a group of chemical compounds that emit causing contamination, which affect human health through inhalation. The VOCs form a toxic effect on humans, especially if they existed in high concentrations in the indoor air environment. Moreover, there are hundreds of VOCs that can be found in indoor air environments, where some of them can be noticed using the simple smelling sense, if high concentrations are present. However, most of the VOCs are odorless, which could be fatal if not tested regularly (Myatt, 2015).

According to (Raipancholia, 2013), the term VOC is used to describe all the poisonous contaminants and airborne chemicals that could affect the human health in anyway. Furthermore, there are three main ways that VOCs could affect the human health; inhalation through breathing, absorption through skin contact, and digestion through eating. There are many VOCs that could be narrated; however, formaldehyde, radon, lead, benzene and carbon monoxide are the most common ones, which are used in many chemical products. Moreover, the VOC’s are present in many daily use products such as cleaning products, air fresheners, paints, sealants, and pesticides. Table 2.2 below shows the most common VOC’s, their sources and common existing locations.

Nonetheless, the VOC's can be a result of human activities and the many chemical reactions that accompany the daily activities. Therefore, it is essential to use products that are compliant with safety regulations, as well as adopt healthy practices in the daily life activities (Raipancholia, 2013).

Table 2.2. Typical Indoor Contaminants (VOCs), sources and common existing locations (Raipancholia, 2013).

Contamination Sources	**Emission Source**	**Common VOC's**
Human Being	Breath	Acetone, Ethanol, Isoprene,
	Skin Respiration & Perspiration	Nonanal, Decanal, alpha-Pinene
	Flatulence	Methane, Hydrogen
	Cosmetics	Limonene, Eucalyptol
Consumer Products	Household Supplies	Alcholos, Esters, Limonene
Office Equipment	Printers, Copiers, Computers	Benzene, Styrene, Phonole
Combustion	Engines, Appliances, Smoke	Unburnt Hydrocarbons
Building Materials	Paints, Adhesives, Solvents, Carpets	Formaldehyde, Akanes, Alcohols, Aldehydes, Ketones, Siloxanes
Furniture	Poly Vinyl Chloride (PVC)	Touleme, Xylene, Decane

The spread of VOCs in indoor environments can be caused by many factors, which include but not limited to (Raipancholia, 2013):

1. Cleaning and maintenance material and activities.
2. Fabrics, textiles and new furniture.
3. Xerox machines (Printers and inks)
4. Bacterial actions.

5. Cosmetics and exhalation.
6. Construction activities.
7. Studios and painting workshops.
8. Pesticides.

Furthermore, VOC's can cause many serious health impacts starting with symptoms such as (Raipancholia, 2013):

1. Eye irritation and visual disorders.
2. Respiratory system reactions.
3. Headaches, dizziness and nausea.
4. Memory damage and fainting.

2.2.2. Acoustic Quality

The importance of the acoustic comfort, as part of the indoor environmental quality, is not less than the air quality parameter. Many studies around the world have proven that noise and temperature are the main parameters that have the majority of the weights in determining the satisfaction of the occupants in the indoor spaces. Therefore, indoor spaces with noise pollution highly affect the occupants' productivity at work or their living experiences at their homes (Huang, Zhu, Ouyang, & Cao, 2012). According to the Institute for Scientific Information (ISI) the maximum outdoor and indoor noise level in residential areas should not exceed 45 dB, which is the same level used for healthcare facilities in Turkey (Kakada, 2012;Koçyiğit, 2012).

Thus, the acoustic comfort is the ability of the building to prevent its occupants to be affected from the outside or inside noises which eventually provides an acoustic level that empowers the targeted functionality in its design. For instance, it was found that offices with acoustic comfort issues have reduced productivity rates than those with acceptable acoustic comfort levels and privacy (Alhorr, et al., 2016). Therefore, whenever acoustic comfort is not part of the priority design criteria of a building, surveys show low productivity levels in its spaces, which proves the importance of the acoustic parameter in the design process (Andersen, 2009). Moreover, there are several acoustic issues that identified in buildings according to ASHRAE (2010), which include but not limited to:

1. Outdoor noise,
2. Noise from neighboring spaces,
3. Office equipment noises,
4. Airborne sounds,
5. Noises from adjacent facilities.

Furthermore, many health and well-being issues may be caused by the uncomfortable noise levels in a building including stress, sleep disturbance, hypertension that can even lead to sudden death (Evans & Johnson, 2000). Moreover, studies have showed that the majority of workplace users recognize noise as the main issue that hinders their productivity (ASID, 1996). Figure 2.2 below shows the contribution of the noise to the overall distraction factors as per ASID survey.

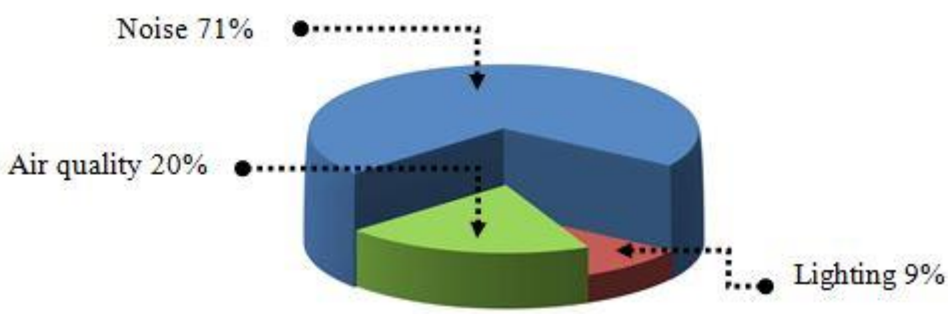

Figure 2.2. The weight of distractions in the workplace (ASID, 1996).

Furthermore, there are many studies proving that acoustical privacy is one of the most important factors in an office environment and offices without acoustical privacy suffer from productivity reduction up to 40% and more work errors occur up to 27% (El-Zeiny, 2012). Moreover, noise at all levels was found to have proven adverse effects on the health of the space occupants including increased stress and heart disease (ASHA, 2015). Nonetheless, employees with more acoustically private offices were found more productive, open to more interaction with their colleagues, more focused in their jobs, and overall happy with their work environment (ASID, 2004). Moreover, studies in healthcare facilities in Turkey show the readings of the tested buildings exceed the local and international standards with 5dB, which did not show direct effects on the occupants but may have adverse effects on the long-term (Koçyiğit, 2012).

2.2.3. Thermal Quality

The easiness of defining the thermal comfort as part of the indoor environmental quality parameters is directly proportional to its importance. Nevertheless, this parameter may vary from one person to another depending on their gender, ethnicity, age and body preferred climate as the human body is in continuous adaptation to the surrounding environment temperature (Quang, 2013). The thermal comfort and the factors that influence it are divided into two main categories (Katafygiotou & Serghides, 2014):

1. Environmental factors: including air temperature, radiant temperature, relative humidity and air velocity,
2. Human factors: including body metabolism and clothing.

Furthermore, the main standards to measure and standardize thermal comfort are the ASHRAE, introduced earlier in this literature review, which the designers from all over the world use in order to achieve the optimal thermal comfort according to the climate and geographic location of the building (Nicol & Humphreys, 2002). Nonetheless, using technologies that consumes less energy such as ambient conditioning has proven to achieve better thermal comfort depending on the region used (Zhang, et al., 2009).

Likewise, the thermal comfort varies from one climatic region to another in which the cultural background plays a main role (Lovins, 1992). This mainly depends on the adaption of people to their indoor environments which has two influential factors (Nikolopoulou & Steemers, 2003):

1. Physical adaption,
2. Physiological adaption.

Measuring thermal comfort can vary in methodology as some researchers depend on the temperature variation, where others depend on reaching the ideal temperature. However, there are measures such as *predicted mean vote* (PMV), which can be used for all types of indoor spaces, and *predicted percentage of dissatisf*ied (PPD), where both measurements use certain factors in measuring the thermal comfort of the indoor environment (Olanipekun, 2014).

2.2.4. Lighting Quality

This parameter is one of the essential IEQ parameters**.** However, the lighting quality has more input to the interior design of a space due to its impacts on the energy consumption. As artificial lighting that works using electric power uses around 40% of the total energy in any commercial building, there is a recent preference from all designers globally to employ the natural sunlight as part of the Green Building strategy and also due to its positive impact on the occupants' comfort (O'Connor, Lee, Rubinstein, & Selkowitz, 1997). Therefore, the new designs are focused on the window size and the brightness of the wall finishes depending on the amount of sunlight required and the functionality of the space.

For instance, studies confirmed that the learning ability of the students in schools with more sunlight. Results show 20% to 25% more improvement in mathematics and reading skills compared to students with artificial classroom lighting (Heschong Mahone Group, 1999). Nonetheless, studies also proved that offices with less sunlight affected their occupants with depression, stress and tension. Therefore, there is a lux level specified for each space in order to support its comfort and empower its functionality. Since this study is mainly concerned about a healthcare facility, Table 2.3 shows the minimum lux level (illumination) required at the different areas (LARA, 1998).

Table 2.3. Minimum lux level at healthcare facilities' areas (LARA, 1998)

Area	Minimum Illumination (Lux)
Corridors Day	215
Corridors Night	110
Critical Care (ICU) General – Full room	215
Critical Care (ICU) Examination - Fixed	1615
Emergency General – Full room	540
Emergency Examination - Fixed	1615
Examination & Treatment Rooms	540
Hand wash areas	225
Nursing Stations – General	225
Nursing Stations – Desk	540
Nursing Stations - Medical	810
Physical Therapy Treatment	225
Stairways	215
Toilets	225
Operating Room	1615

The source of the light specified in the Table 2.2 above can be from either natural or artificial sources. However, light plays a major role in architecture. Vision is the primary sense through which we experience architecture and light is the medium that reveals space, form, texture and colour to the eyes (Bluyssen, 2013). The parameter visual or lighting quality comprises of aspects such as illuminance, luminance ratios and colours and aspects that would rather be prevented such as reflections on floor or other surfaces, such as light shelves can solve such issues especially in year times when sunlight can produce uncomfortable glare into the space as shown in Figure 2.3 below. (Altan, Ward, Mohelnikova, & Vajkay, 2008).

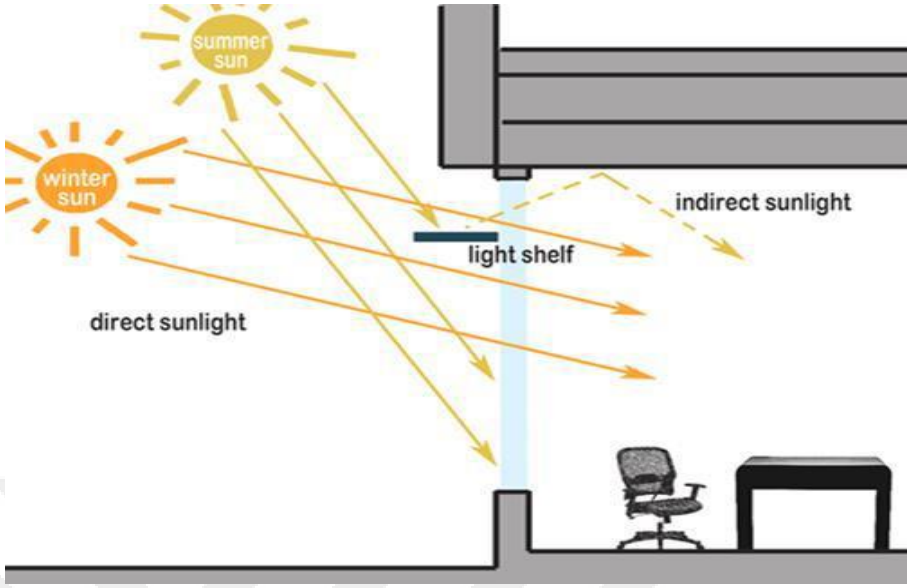

Figure2.3. Light-shelf functionality (Superhomes, 2012)

2.2.5. Humidity Level

As humans are always surrounded with water vapor as part of the atmospheric air, the humidity level that is required to achieve thermal comfort should be between 40 to 70 percent in any space (Levin, 1995). Moreover, the humidity level varies in indoor spaces depending on the functions. For instance, humidity in industrial spaces are higher than offices or homes due to the heat generated from machines which increases the evaporation from the human body and result into discomfort (Harrison, 2002).

Nonetheless, low humidity may have adverse effects on the space occupant such as the *Sick Building Syndrome* (SBS) (Reinikainen, Aunela-Tapola, & Jaakkola, 1997). Many governmental regulations specify the dampness load for indoor environments to a maximum of 3 g/m3 and a maximum humidity of 7 g/m3 due to health issues that may arise from high humidity such as fungus and dust mites (Harving, Korsgaard, & Dahl, 1994). Therefore, this translates into humidity level around 45% and above.

3. METHODOLOGY

3.1. Research Questions

The main research question of this study is structured as, ‘what is the effect of indoor environmental quality on users of the case wellness center?’

In order to formulate a complete answer to this question, five sub-questions are needed to be answered as the following:

1. What is the level of IEQ parameters in the case wellness center?
2. What is the impact of the IEQ parameters on the users of the case space?
3. What is the relation between measured levels of IEQ parameters and users’ ratings of IEQ parameters?
4. How the IEQ measurements between the exercise and treatment areas are related?
5. How do the IEQ measurements compare with the international standards of healthcare facilities?

3.2. Objectives

The main objective of this study is to analyze the indoor environmental quality (IEQ) of the case wellness center; Medifit located in Ankara through measurements and questionnaire findings. The main objectives of this study are:

1. To learn the relationship between indoor environment and human perception.
2. To analyze the design of the indoor environment for increasing the well-being of the users in the space.
3. To measure the indoor environmental quality parameters (IEQP) of wellness center, which are thermal quality, lighting quality, acoustic quality, and humidity level.

4. To assess the subjective evaluation of the indoor environmental quality parameters that are thermal quality, lighting quality, acoustic quality, and humidity level.
5. To examine the relationship between the objective measurements and the subjective evaluation of the indoor environmental quality parameters (IEQP).
6. To compare the indoor environmental quality parameters (IEQP) between the exercise and treatment areas of the wellness center.
7. To compare the indoor environmental quality parameters (IEQP) of the wellness center with international standards of healthcare facilities.
8. To discuss possible design solutions or implications in the case space to increase the quality assessment of IEQP.

Moreover, the parameters and components of the IEQ will be evaluated through the objective measurements in relation with the questionnaire ratings in the case space as follows:

1. The temperature in the different spaces of the wellness center in order to relate these measurements with the thermal comfort subjective ratings in the wellness center.
2. The lighting illumination (Lux Level) in the different spaces of the wellness center in order to relate these measurements with the visual comfort subjective ratings in the wellness center.
3. The sound pressure levels in the different spaces of the wellness center in order to relate these measurements with the acoustic comfort subjective ratings of the case study.
4. The relative humidity levels in the different spaces of the wellness center in order to relate its levels to the humidity condition comfort subjective ratings in the wellness center.

3.3. Hypotheses

This section presents the hypotheses that are tested through the case study of this research, which are as the following:

H1: The wellness center acoustic measurements are within the acceptable limits as per the IEQ requirements (International Standards) and space functionality.

H2: The wellness center temperature measurements are within the acceptable limits as per the IEQ requirements (International Standards) and space functionality.

H3: The wellness center humidity measurements are within the acceptable limits as per the IEQ requirements (International Standards) and space functionality.

H4: The wellness center lighting measurements are within the acceptable limits as per the IEQ requirements (International Standards) and space functionality.

H5: There is a relation between the IEQ measurements and the user's assessment of the IEQ in the case study wellness center.

H6: There is a relation between the IEQ subjective assessments and the demographic and usage data of the participants.

H7: There are variations between the measurements of the exercise and treatment areas of the wellness center

H8: There are variations between the subjective ratings of the exercise and treatment areas of the wellness center

3.4. Case Study Selection

Medifit wellness center in Ankara is selected as the case space for this study in order to examine the indoor environmental quality parameters. The case space is selected with a certain function because present situation is examined on the case space to specify necessities and requirements for such spaces. Therefore, this case study will enable the researcher to understand the extent of IEQ implementation at wellness center facilities and buildings with related functions. Table 3.1 below shows the general information of the case study target. Furthermore, Appendix 2 presents the floor plans of the First and second floors of the wellness center, as well as photographs from different sections of the case study.

The building complex is located on the outskirts of Ankara and consists of 3 separate buildings in a 'U' shape forming a semi-enclosed atrium in between the buildings. The buildings are 4-storey high and the case wellness center is located in the upper 2 floors.

Table 3.1. General Information of the Wellness Center.

Parameter	**Info**	**Parameter**	**Info**
Number of Floors	2	Average Daily Visitors	15
Total Floor Area	464 m^2	Peak Daily Visitors	25
Number of Staff	9	Daily Operating Hours	Open: 08:00 Close: 21:00

3.5. Questionnaire Design

By using the questionnaire structure of Raipancholia (2013), which evaluated the indoor environment of residential and commercial space, and Prakash (2005), which performed a survey on interior environment of the office spaces, education spaces, the questionnaire for this research was designed in order to ensure a referenced subjective methodology to such previous research.

First method of indoor environmental quality assessment is through a field survey of the center's users including staff and visitors. The survey is divided into six main parts. The first part is on the demographics and general information and the other parts include five main questions about the evaluation of the IEQ parameters. The questionnaire parts are as follows:

1. Part one on demographics and general information: the participants are asked about their gender, age, the part of the facility that they use, and the date and time of their visit and usage.
2. Part two: Participants are asked to state the average daily hours they spend in the wellness center.
3. Part three: Participants are asked to state the number of weekly visits to the wellness center.
4. Part four: Participants are asked to state their expectation about the IEQ parameters in general at the wellness center which includes indoor air, acoustic, thermal, lighting and humidity comfort levels in a six point scale ranging from (1) very low, (2) low, (3) slightly low, (4) slightly high, (5) high, to (6) very high.
5. Part five: Participants are asked to evaluate the IEQ parameters in general at the wellness center, which include indoor air, acoustic, thermal, lighting and humidity conditions in a six-point scale ranging from (1) very low, (2) low, (3) slightly low, (4) slightly high, (5) high, to (6) very high.
6. Part six: Participants are asked to evaluate their physical perception of the IEQ parameters on a six-point scale as shown in Table 3.2 below.

Table 3.2. Likert scale for participants' physical perception evaluation of the IEQ parameters.

Parameter	1	2	3	4	5	6
Indoor Air Quality	Very stale	Stale	Slightly stale	Slightly fresh	Fresh	Very fresh
Acoustic Quality	Very noisy	Noisy	Slightly noisy	Slightly quiet	Quiet	Very quiet
Thermal Quality	Very cold	Cold	Slightly cold	Slightly hot	Hot	Very hot
Lighting Quality	Very dull	Dull	Slightly dull	Slightly bright	Bright	Very bright
Humidity Condition	Very dry	Dry	Slightly dry	Slightly humid	Humid	Very Humid

An even scale is chosen throughout the survey in order to force the choice of the participants towards a certain tendency during their evaluation of the indoor environment quality or importance of IEQ parameters. Therefore, no middle choices are provided through an odd scale, which provides more decisive answers and results (Croasmun & Ostrom, 2011).

3.6. Measurement Setup

The second method of indoor environmental quality assessment will be through measurement of four main parameters which are:

1. Temperature,
2. Relative humidity,
3. Lighting level and brightness,
4. Sound level.

A multi-function environmental meter is used in the measurement of the four parameters. The information about the device is illustrated in Table 3.3 and picture of the device is shown in Figure 3.4 below.

Table 3.3. Measuring device information

Brand	CEM
Model Number	DT8820
Device Number	150106824
Parameters Measured	Light, Temperature, Humidity and Sound Level
Display	Digital LCD
Power	9V Rechargeable Battery

Figure 3.1. CEM DT8820 (Multi-function Environmental Meter).

After selecting the spaces of the wellness center according to their functions, four measurements are taken as the following (see Appendices 3 and 4):

1. Temperature: measurements are taken for each space which are in two different days and during vacant and full times. The measurements are taken in the middle of the space away from windows and light sources in order to get the most average reading possible.
2. Relative humidity: measurements are taken for each space which are in two different days and during vacant and full times. The measurements are taken in the middle of the space.
3. Light illumination: Number of measurements varies for each space depending on area and functionality. However, two sets of measurements are taken; one in daytime and one in the evening to evaluate the sunlight contribution into the lighting. Moreover, the locations of the readings are one meter above floor level under the light source, at the surfaces of the action areas, i.e. doctor tables, reception desk, examination table, study tables, etc.

4. Noise: measurement sets are taken in the day, evening, vacant, and full times during the day at the middle of each space to evaluate the noise level of each space separately.

For further clarity, Appendix 3 represents the case study tool which is used to survey the different parts of the wellness center in terms of material and IEQ measurements in each part. Furthermore, results are mapped on the floor plans of the wellness center and compared to the international standards for IEQ and healthcare facilities requirements as reviewed in the second chapter. Moreover, due to the unavailability of the required measurement devices, IAQ parameters such as VOC, CO and CO_2 levels were not measured, which could be part of a future research.

4. CASE STUDY FINDINGS

This chapter presents the results of the case study performed at Medifit wellness centre in Ankara, Turkey. The analysis includes four main sections, which are:

1. An architectural analysis of the interior of the centre in terms of material used, area distribution and function.
2. Objective IEQ measurements distributed around the centre to collect the most representative data.
3. Subjective IEQ perception through questionnaire methodology of the space users.
4. Establishing the relationship between the subjective IEQ parameters in the different spaces of the wellness centre.
5. Establishing the relationship between the exercise and treatment rooms considering both objective measurements and subjective evaluation.

4.1. Architectural Analysis of the Case Space

The case space is distributed over two floors and divided into main facilities and supporting facilities. The main facilities are the treatment rooms and the exercise rooms, while the supporting facilities are the reception areas, corridors, toilets, waiting lobby, and kitchen. The total area of the case space is 464.2 square meters, which is distributed as 303 square meters for the first floor and 161.2 square meters for the second floor. Table 4.1 shows the distribution of the areas among the treatment, exercise and supporting facilities. The plans in Appendix 2 can be used for guidance to understand the architectural dimensions of the facility.

Table 4.1. Case Space floor area details

Facilities	Floors	Area (Square Meters)	Percentage of total floor area (%)
Treatment Rooms	First Floor	66.05	14.23
	Second Floor	12.5	2.69
Exercise Rooms	First Floor	86.8	18.70
	Second Floor	89	19.17
Supporting Areas	First Floor	87.5	18.85
	Second Floor	27.9	6.01
Other Areas (Stairs, Lifts, voids)	First Floor	62.65	13.50
	Second Floor	31.8	6.85
Total		**464.2**	**100**

In studying the material used in the different spaces of the case space, the wall material is categorized under two types, which are the painted gypsum board used in the majority of the areas, and the glass façade walls used in the west side in the exercise rooms. The main advantage of using the glass façade is allowing the natural light to enter the exercise space and increasing the illuminance level and taking advantage of natural light related health benefits. For the ceiling, one material is used across the facility which is suspended gypsum ceiling. For the floors, two flooring types are used, which are the wood laminate flooring used in most of the wellness center, as well as the PVC linoleum flooring used in the exercise rooms. Table 4.2 shows the material finishes in the different parts of the case space. Coding for the different areas are presented in the plans compiled in Appendix 2. Light color tones of warm white, beige, grey and grey-blue are dominant in the case space, except for few parts were darker red color is used for contrast. Therefore, the reflection on the case space surfaces can be considered high in the areas where lighter colors are dominant.

Table 4.2. Finishing materials of case spaces (Appendix 2).

<table>
<tr><th>Area Code</th><th>Type</th><th>Floor</th><th>Wall Finish</th><th>Ceiling Finish</th><th>Floor Finish</th></tr>
<tr><td>COR. 1</td><td>Corridor</td><td rowspan="18">First Floor</td><td rowspan="13">Paint on gypsum board</td><td rowspan="24">Suspended gypsum ceiling</td><td rowspan="13">Wood laminate</td></tr>
<tr><td>COR. 2</td><td>Corridor</td></tr>
<tr><td>K1</td><td>Kitchen</td></tr>
<tr><td>R1</td><td>Reception</td></tr>
<tr><td>WC1</td><td>Toilet</td></tr>
<tr><td>T.1</td><td rowspan="5">Treatment Rooms</td></tr>
<tr><td>T.2</td></tr>
<tr><td>T.3</td></tr>
<tr><td>T.4</td></tr>
<tr><td>T.5</td></tr>
<tr><td>R2</td><td>Reception</td></tr>
<tr><td>E.R.R</td><td>Exercise Room</td></tr>
<tr><td>WC2</td><td>Toilet</td></tr>
<tr><td>E.1</td><td rowspan="5">Exercise Room</td><td rowspan="9">70% paint on gypsum boards and mirrors,30% glass facade</td><td rowspan="11">PVC Linoleum</td></tr>
<tr><td>E.2</td></tr>
<tr><td>E.3</td></tr>
<tr><td>E.4</td></tr>
<tr><td>E.5</td></tr>
<tr><td>E.R1</td><td rowspan="4">Exercise Room</td><td rowspan="6">Second Floor</td></tr>
<tr><td>E.R2</td></tr>
<tr><td>E.R3</td></tr>
<tr><td>E.R4</td></tr>
<tr><td>K2</td><td>Kitchen</td><td rowspan="2">Paint on gypsum board</td></tr>
<tr><td>W.L</td><td>Waiting Lobby</td></tr>
</table>

4.2. Objective Measurements

Readings for temperature, humidity, sound level and illuminance were taken using CEM DT8820 in 6 different days between 06.04.2017 and 11.04.2017 under two weather conditions; sunny and cloudy. The measurements were taken over four main time periods, which are (P1) morning (8:00-11:00), (P2) Noon (11:00-14:00), (P3) afternoon (14:00-17:00) and (P4) Evening (17:00-20:00). Table 4.3 shows the minimum, maximum and average readings for all the IEQ parameters in the treatment and exercise rooms. The full set of the measurements in the case space are presented in Appendix 4.

Table 4.3. IEQ measurement findings in the case spaces.

Area Code	Period	Illuminance (Lux)	Sound Level (dBA)	Relative Humidity (%)	Temperature (°C)
Treatment Rooms (First Floor)	Minimum	206 (P1)	33 (P3)	29.4 (P3)	20.8 (P1)
	Maximum	313 (P1)	51.4 (P1)	**39.8 (P1)**	**26.6 (P2)**
	Average	259.1	43.4	32.5	23.8
Exercise Rooms (First Floor)	Minimum	74 (P1)	36.3 (P4)	26 (P3)	18.9 (P1)
	Maximum	1578 (P3)	**92.5 (P1)**	31.6 (P1)	24.5 (P3)
	Average	536.8	56.1	29	22.5
Exercise Rooms (Second Floor)	Minimum	172 (P4)	34.6 (P2)	26.3 (P3)	18.9 (P1)
	Maximum	**1973 (P2)**	47.4 (P3)	30.7 (P1)	25.5 (P3)
	Average	1033.8	41	28.6	22.7

* (P1) morning (8:00-11:00), (P2) Noon (11:00-14:00), (P3) afternoon (14:00-17:00) and (P4) Evening (17:00-20:00) – Representing the period where the measurements were taken.

Considering the treatment and exercise areas and through the collected data, it is noted that the maximum illuminance value occurs during the noon period in the Exercise rooms near the glass façade area, while the lowest illuminance value occurs in the morning period in the inner areas to as low as 74 lux. Moreover, the sound level measurements have a maximum of 92.5 dBA that occurred in the morning period in the exercise room in the first floor, which was occurring next to sound speakers in the exercise room of the first floor, while the average sound level in the combined treatment and exercise area is 46.7 dBA. Furthermore, the maximum values of humidity occur during the morning period, while the maximum values for the temperature occur during the afternoon period. Table 4.4 shows the Average values for the studied IEQ parameters in the treatment and exercise areas according to different time periods.

Table 4.4. Average IEQ parameters measurements during different time periods.

Time Slots	Rooms	Illuminance (Lux)	Sound Level (dBA)	Relative Humidity (%)	Temperature (°C)
Morning (P1)	Treatment	273.8	46.3	36.6	21.2
	Exercise	628.6	**54.0**	31.2	19.2
Noon (P2)	Treatment	242.4	40.7	**32.3**	23.9
	Exercise	931.4	48.6	29.6	23.6
Afternoon (P3)	Treatment	246.4	42.4	29.9	24.8
	Exercise	**1043.3**	53.2	26.7	24.6
Evening (P4)	Treatment	273.6	44.1	31.1	**25.2**
	Exercise	338.9	44.3	28.0	22.9

4.3. Questionnaire Evaluation

A total of 95 questionnaires were collected from the users of the case space in March and April 2017. For the internal reliability, the Cronbach's alpha is calculated as 0.628, which is considered to be acceptable. The following sections represent the evaluation of the questionnaire results.

4.3.1. Demographics and Wellness Centre Usage Patterns

The distribution of the gender of the participants is 54.7% and 45.3% for males and females, respectively, as shown in Figure 4.1. The distribution of the participation between both genders is nearly even, which supports the normality of the sample.

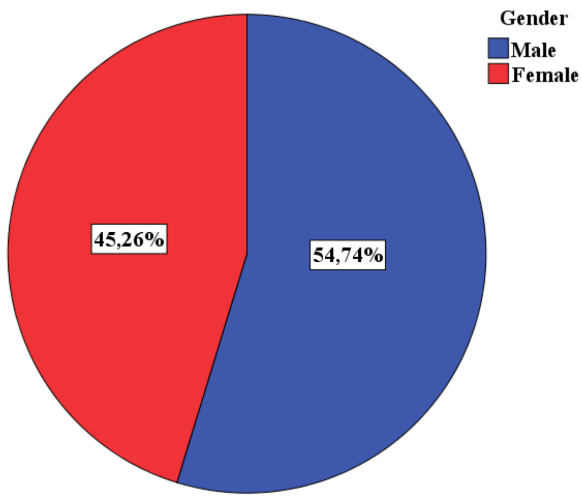

Figure 4.1. Gender distribution of questionnaire participants.

Through the analysis of the age categories of the questionnaire participants, Figure 4.2, 60% of the participants are under the age of 30, which reflects the majority of the wellness centre users are from a young age. Furthermore, 64.2% of the participants indicated that they spend 1 to 2 hours in each visit to the wellness center, as shown in Figure 4.3. Moreover, Figure 4.4 shows the number of days that the participants use the wellness centre during the week period, where the majority (47.4%) visit the center from 2 to 3 times per week.

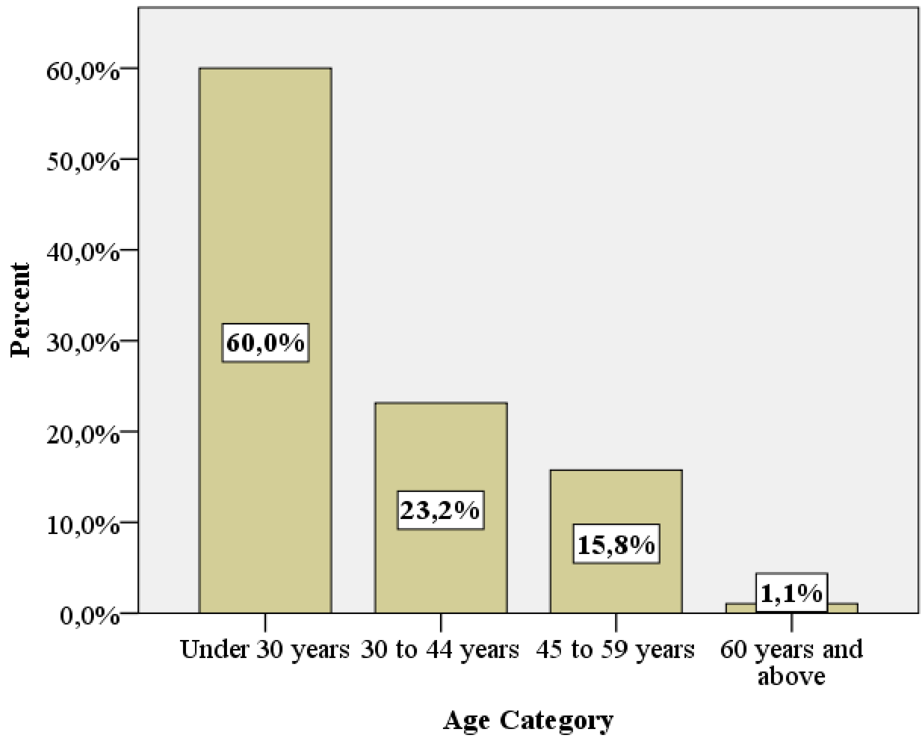

Figure 4.2. Age distribution of the questionnaire participants.

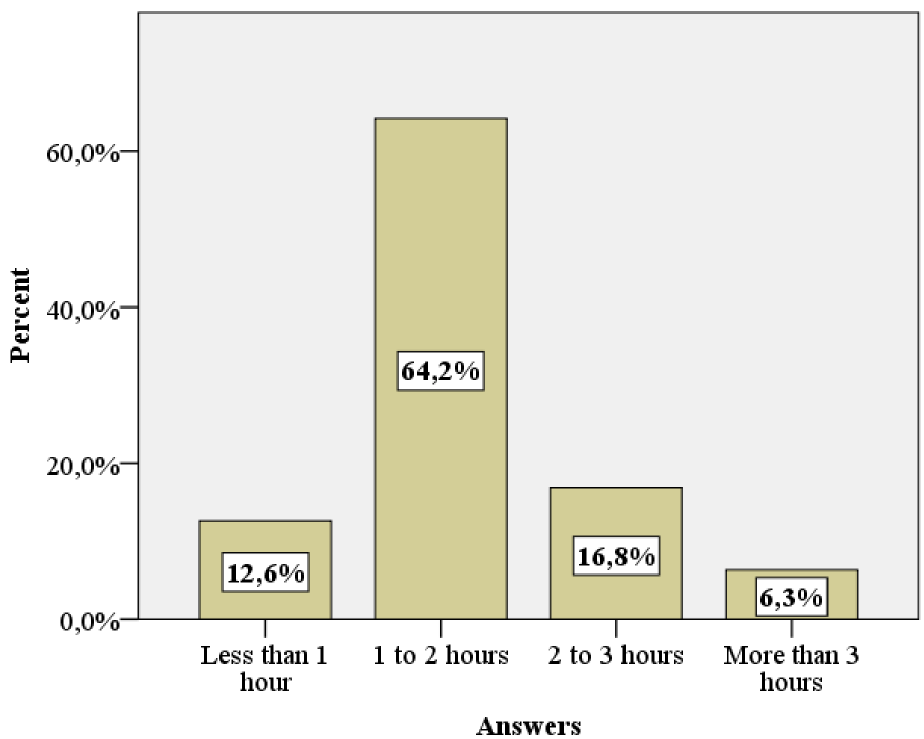

Figure 4.3. Usual time spent by the users of the wellness centre in each visit.

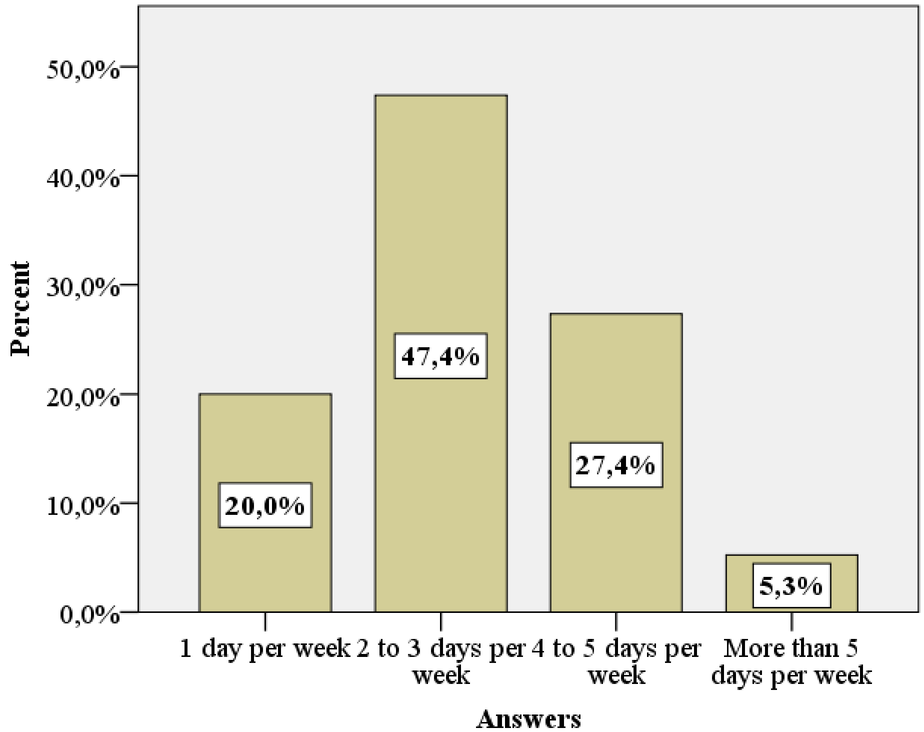

Figure 4.4. Frequency of visiting the wellness centre by the users per week.

The participants were asked about the usual purpose for visiting the wellness centre, where 64.2% said that they visit the facility for physical treatment and 35.8% said that their purpose of the visit is to exercise, as shown in Figure 4.5. Moreover, the participants indicated that they mostly visit the wellness center between 11:00 and 17:00, with 36.8% for 11:00 to 14:00 and 35.8% for 14:00 to 17:00, as shown in Figure 4.6.

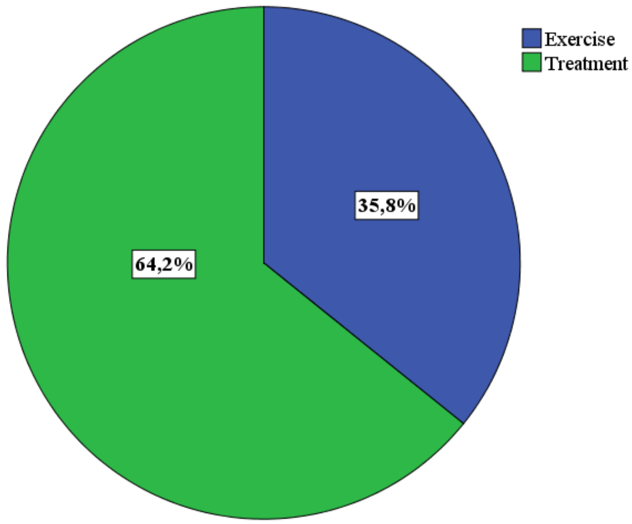

Figure 4.5. Purpose of users at the wellness centre.

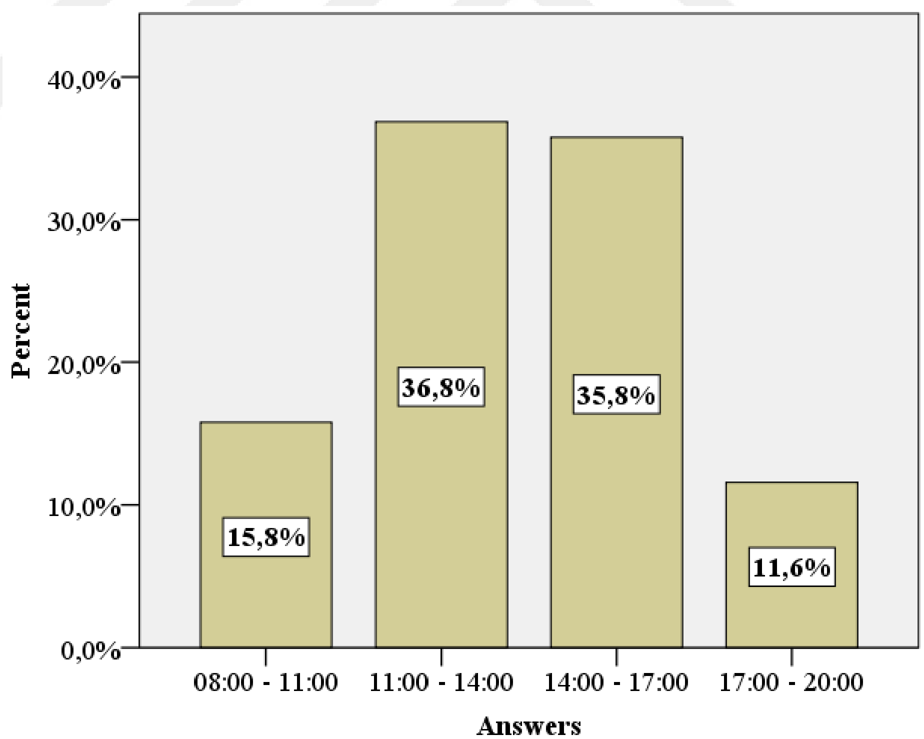

Figure 4.6. Time periods of the usage by the users of the wellness centre.

4.3.2. IEQ Evaluation

In this section the participants were requested to evaluate the indoor environmental quality according to their physical perception in the main areas of the case space; exercise and treatment rooms. The evaluation was performed on an even 6-point scale using associated adjective pairs as the semantic descriptors for the five main parameters in each area as the following:

1. Indoor air quality (IAQ) – Fresh / Stale
2. Acoustic quality – Quiet / Noisy
3. Thermal quality – Hot / Cold
4. Lighting quality – Bright / Dull
5. Humidity condition – Humid / Dry

In evaluation of the physical perception of the IEQ parameters in the exercise rooms, see Table 4.5, the results indicate a score of 1.5 for indoor air quality, which lays this parameter between (1) very fresh and (2) fresh rating range. Secondly, the users' answers indicate that the acoustic quality in the exercise room is (2) quiet to (3) slightly quiet, with a mean score of 2.2. Furthermore, the thermal quality is perceived from (2) hot to (3) slightly hot with a mean score of 2.5. The lighting quality is evaluated as close to (2) bright with a means score of 1.9. Finally, the humidity condition is evaluated as moderate that is rated close to (3) slightly humid with a mean score of 3.2.

Table 4.5. Physical perception evaluation for IEQ parameters in exercise rooms.

Indoor Environmental Quality Parameter	Mean Score	Range of Answer Scale
Humidity Condition	3.2	1-Very humid, 2-Humid, 3-Slightly humid, 4-Slightly dry, 5-Dry, 6-Very dry
Thermal Quality	2.5	1-Very Hot, 2-Hot, 3-Slightly hot, 4-Slightly cold, 5-Cold, 6-Very cold
Acoustic Quality	2.2	1-Very Quiet, 2-Quiet, 3-Slightly quiet, 4-Slightly noisy, 5-Noisy, 6-Very noisy
Lighting Quality	1.9	1-Very bright, 2-Bright, 3-Slightly bright, 4-Slightly dull, 5-Dull, 6-Very dull
Indoor Air Quality	1.5	1-Very fresh, 2-Fresh, 3-Slightly fresh, 4-Slightly stale, 5-Stale, 6-Very stale

In evaluation of the physical perception of the IEQ parameters in the treatment rooms, see Table 4.6, the results assign a score of 1.7 for indoor air quality, which lays this parameter between the very fresh (1) and fresh (2) rating range. Secondly, the users' answers indicate that the acoustic quality in the exercise room is quiet (2), with a mean score of 1.9. Furthermore, the thermal quality is perceived from hot (2) to slightly hot (3) with a mean score of 2.4. The lighting quality is evaluated as bright (2), and inclined to slightly bright (2), with a means score of 2.2. Finally, the humidity condition is evaluated as moderate or slightly humid (3) with a mean score of 3.2.

Table 4.6. Physical perception evaluation for IEQ parameters in treatment rooms.

Indoor Environmental Quality Parameter	**Mean Score**	**Range of Answer Scale**
Humidity Condition	3.2	1-Very humid, 2-Humid, 3-Slightly humid, 4-Slightly dry, 5-Dry, 6-Very dry
Thermal Quality	2.4	1-Very Hot, 2-Hot, 3-Slightly hot, 4-Slightly cold, 5-Cold, 6-Very cold
Lighting Quality	2.2	1-Very bright, 2-Bright, 3-Slightly bright, 4-Slightly dull, 5-Dull, 6-Very dull
Acoustic Quality	1.9	1-Very Quiet, 2-Quiet, 3-Slightly quiet, 4-Slightly noisy, 5-Noisy, 6-Very noisy
Indoor Air Quality	1.7	1-Very fresh, 2-Fresh, 3-Slightly fresh, 4-Slightly stale, 5-Stale, 6-Very stale

Furthermore, the participants were asked to rate the importance of the indoor environment quality parameters in the exercise and treatment rooms on a 6-point Likert scale. On indicating the importance of IEQ parameters in the exercise rooms, the indoor air quality was rated as the most important parameter with a mean of 5.7, while the humidity condition was rated as the least important with a mean of 4.8. Table 4.7 shows the mean calculations for the importance of IEQ parameters in the exercise rooms.

Table 4.7. Importance rating of IEQ parameters in exercise rooms.

Indoor Environmental Quality Parameter	Mean Score	Std. Deviation
Indoor Air Quality	5.7	0.615
Lighting Quality	5.4	0.730
Thermal Quality	5.3	0.753
Acoustic Quality	5	0.771
Humidity Condition	4.8	0.999

Moreover, on indicating the importance of IEQ parameters in the treatment rooms, the indoor air quality was rated as the most important parameter with a mean of 5.75, while the humidity condition was rated as the least important with a mean of 4.99. Table 4.8 shows the means calculations for the importance of IEQ parameters in the treatment rooms.

Table 4.8. Importance rating of IEQ parameters in treatment rooms.

Indoor Environmental Quality Parameter	Mean Score	Std. Deviation
Indoor Air Quality	5.8	0.461
Acoustic Quality	5.5	0.807
Thermal Quality	5.4	0.695
Lighting Quality	5.2	0.875
Humidity Condition	5	1.037

5. STATISTICAL ANALYSIS AND DISCUSSION

5.1. Relationship between Objective Measurements and Subjective Evaluations

This section evaluates the correlation between the objective and subjective data collected in the research. Therefore, one-way ANOVA correlations are established between the physical perceptions of the IEQ parameters in the exercise and treatment rooms and the average measurements of the IEQ parameters in both areas. All the tests indicate no correlation between the objective and subjective data, except for the lighting quality in the exercise rooms, see Table 4.13, where the significance is calculated as 0.013 ($p < 0.05$), as shown in Table 5.1. The lack of correlations between the other objective measurements and subjective assessment could be emerging from the lack of the relationship between the two data sets, or the insufficient information provided by the data to establish the correlation. Finding the correlation between the two parameters in Table 5.1 could be attributed that the physical perception of lighting is one of the most dominating sense and thereby when compared to other indoor environmental parameters, lighting parameter has been significantly correlated with the objective measurement.

Table 5.1. ANOVA testing between lighting measurement and its physical perception in exercise rooms.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	564995.637	3	188331.879	3.772	**0.013***
Within Groups	4543637.831	91	49930.086		
Total	5108633.469	94			

* Level of significance: $p<0.05$

5.2. Relationship between IEQ Parameters Subjective Measurement and Demographics and Space Use

In correlating the demographic and usage data of the participants with the subjective evaluation of IEQ parameters in terms of physical perception and importance, key correlations were found through one-way ANOVA testing for the following and explained through the subsequent tables:

1. Age category with humidity physical perception in the treatment rooms (Significance = 0.017 at $p < 0.05$) – Table 5.2. Moreover, another relation was found between Age category and importance of thermal quality in the treatment rooms (Significance = 0.023 at $p < 0.05$) – Table 5.6.
2. Frequency of visit with acoustic physical perception in the exercise rooms (Significance = 0.032 at $p < 0.05$) – Table 5.3. Also, the same kind of relation was found between Frequency of visit and importance of indoor air quality in the treatment rooms (Significance = 0.001 at $p < 0.05$) – Table 5.7.
3. Purpose of visit with thermal physical perception in the treatment rooms (Significance = 0.037 at $p < 0.05$) – Table 5.4. While a relationship was found between Purpose of visit and thermal physical perception in the exercise rooms (Significance = 0.016 at $p < 0.05$) – Table 5.5.

As shown in Table 5.2, there is a correlation between the age category and the humidity physical perception at the treatment rooms. Testing through Spearman's rho gives a correlation factor of 0.318 (Significance is 0.002 and correlation is at the 0.01 level 2-tailed) (Appendix 5), which indicates that higher age categories might perceive the indoor environment at the treatment room as more humid.

Table 5.2. ANOVA testing between age category and humidity physical perception in the treatment rooms

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	14.387	3	4.796	3.553	**0.017***
Within Groups	122.813	91	1.350		
Total	137.200	94			

* Level of significance: p<0.05

Moreover, the ANOVA testing shows a correlation between the frequency of visit to the wellness center and the physical perception of the acoustical quality in the exercise room as shown in Table 5.3. However, testing the correlation through Spearman's rho gives a correlation factor of 0.110, which is considered to be a weak correlation.

Table 5.3. ANOVA testing between frequency of visit and acoustic physical perception in the exercise rooms.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.967	3	2.322	3.071	**0.032***
Within Groups	68.823	91	0.756		
Total	75.789	94			

* Level of significance: p<0.05

Furthermore, Table 5.4 shows the correlation on ANOVA testing between the purpose of the visit to the wellness center and the thermal physical perception in the treatment rooms. The Spearman's rho correlation is obtained as 0.232 indicating a weak to medium correlation between the two variables (Significance 0.023 and correlation is at the 0.05 level 2-tailed) (Appendix 5). Such a result is explained that there is a tendency from the space users to prefer the exercise rooms, explained by the positive Spearman's rho so they perceive its thermal environment much cooler.

Table 5.4. ANOVA testing between purpose of visit and thermal physical perception in the treatment rooms.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.168	3	3.168	4.464	**0.037***
Within Groups	65.990	91	0.710		
Total	69.158	94			

* Level of significance: p<0.05

The correlation between the purpose of visit and the thermal physical perception in the exercise rooms shows a significance of 0.016 through ANOVA testing, Table 5.5, which indicates a correlation between the two variables. Moreover, through Spearman's rho correlation, the correlation factor is calculated as 0.255 (Significance is 0.013 at the 0.05 level 2-tailed) (Appendix 5), which indicates that space users perceive the exercise rooms cooler and they prefer its thermal environment.

Table 5.5. ANOVA testing between purpose of visit and thermal physical perception in the exercise rooms.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5.086	3	5.086	6.014	**0.016***
Within Groups	78.641	91	0.846		
Total	83.726	94			

* Level of significance: p<0.05

Testing the importance scale given by the participants for all IEQ parameters, the significant correlations were only found in the treatment rooms. The first correlation through ANOVA testing is established between the age category and the importance of the thermal quality of the treatment rooms, as shown in Table 5.6. The results of Spearman's rho give a correlation factor of 0.213 (Significance is 0.038: $p<0.05$ 2-tailed) (Appendix 5), which indicates a weak to medium correlation. The results are interpreted that higher age categories assign more importance to the thermal comfort within the space of the treatment rooms.

Table 5.6. ANOVA testing between age category and importance of thermal quality in the treatment rooms.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.510	3	1.503	3.343	**0.023***
Within Groups	40.922	91	0.450		
Total	45.432	94			

* Level of significance: $p<0.05$

Moreover, the ANOVA testing shows a significant correlation between the frequency of visit to the wellness center and the importance of the indoor air quality, as illustrated in Table 5.7. The spearman's rho correlation is calculated as -0.230 for this relationship (Significance is 0.025 at the 0.05 level 2-tailed), which indicates a weak to medium relationship between the two variables. The negative correlation means that when the frequency of the users' visits decreases the importance of the indoor air quality increases according to the assessment of the space users.

Table 5.7. ANOVA testing between Frequency of visit and importance of indoor air quality in the treatment rooms.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.095	3	1.032	5.575	**0.001***
Within Groups	16.842	91	0.185		
Total	19.937	94			

* Level of significance: $p<0.01$

5.3. Relationship between IEQ Parameters in Different Spaces

In order to check the difference in the objective and subjective measurements between the treatment and exercise rooms of the wellness center, ANOVA and means comparisons are tested between the data from both areas. The first parameter tested is the acoustic quality objective data, where the ANOVA testing significance was calculated as 0.000 ($p < 0.001$) indicating variation in means between the two data sets, as shown in Table 5.8. The same procedure is carried out for the acoustic quality subjective data, which yielded similar results, as shown in Table 5.9. The mean of the acoustic objective measurement in the treatment rooms is 42.6 dBA, while the value in the exercise room is 50.6. Moreover, the subjective assessment shows a mean of 1.9 for the treatment rooms versus 2.2 (Scale description in Table 3.2). These results confirm that the acoustic levels in the exercise rooms are significantly higher than the treatment rooms at 0.001 levels.

Table 5.8. ANOVA test between exercise and treatment acoustic quality based on objective data.

	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	357.184	3	119.061	1.709×10^{30}	**0.000***
Within Groups	0.000	91	0.000		
Total	357.184	94			

* Level of significance: p<0.001

Table 5.9. ANOVA test between exercise and treatment acoustic quality based on subjective data.

	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	13.969	3	4.656	6.854	**0.000***
Within Groups	61.821	91	0.679		
Total	75.789	94			

* Level of significance: p<0.001

The second parameter tested is the lighting quality objective and subjective data, where the ANOVA testing significance was calculated as 0.000 indicating a significant difference in the means between the two data sets, as shown in Tables 5.10 and 5.11. The means of the objective measurements are 252.4 lux and 855 lux for the treatment and exercise rooms, respectively. For the subjective evaluation of the users, the means are 2.2 and 1.9 for the treatment and the exercise rooms, respectively (Scale description in Table 3.2). Both means and the ANOVA testing confirm that the exercise rooms are significantly brighter than the treatment rooms.

Table 5.10. ANOVA test between exercise and treatment lighting quality based on objective data.

	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	16537.240	3	5512.413	1.379×10^{30}	**0.000***
Within Groups	0.000	91	0.000		
Total	16537.240	94			

* Level of significance: p<0.001

Table 5.11. ANOVA test between exercise and treatment lighting quality based on subjective data.

	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	11.628	4	2.907	7.351	**0.000***
Within Groups	35.593	90	0.395		
Total	47.221	94			

* Level of significance: p<0.001

The third parameter tested is the thermal quality, where the ANOVA testing significance was calculated as 0.000 indicating a significant means difference between the two data sets, as shown in Tables 5.12 and 5.13 for the objective and subjective data, respectively. In order to understand the means difference indicated by the ANOVA testing, the thermal objective measurement means are calculated as 23.9 °C and 23.2 °C for the treatment and exercise rooms, respectively, which are also confirmed by the subjective assessment means of 2.4 and 2.5 for the treatment and exercise rooms, respectively (Scale description in Table 3.2). These results confirm that both objective measurements and subjective physical perception of the space users indicate that the treatment rooms have higher temperatures than the exercise rooms.

Table 5.12. ANOVA test between exercise and treatment thermal quality based on objective data.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	152.816	3	50.939	1.489×10^{30}	**0.000***
Within Groups	0.000	91	0.000		
Total	152.816	94			

* Level of significance: p<0.001

Table 5.13. ANOVA test between exercise and treatment thermal quality based on subjective data.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	41.021	3	13.674	29.137	**0.000***
Within Groups	42.705	91	0.469		
Total	83.726	94			

* Level of significance: p<0.001

The last parameter tested is the humidity condition, where the ANOVA testing significance was calculated as 0.000 indicating significant means difference between the two data sets, as shown in Tables 5.14 for the objective measurement and Table 5.15 for the subjective physical perception. The objective data means show 32% humidity for the treatment rooms, while the exercise rooms had a mean of 28.6%. Furthermore, the subjective assessment means are compared as 3.20 and 3.18 for the treatment and the exercise rooms, respectively (Scale description in Table 3.2). Both results confirm that the treatment rooms are significantly more humid than the exercise rooms. Moreover, it was proven earlier that the higher age categories perceive the treatment rooms as more humid, Table 5.2.

Table 5.14. ANOVA test between exercise and treatment humidity condition based on objective data.

	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	489.388	3	163.129	4.976×10^{30}	**0.000***
Within Groups	0.000	91	0.000		
Total	489.388	94			

* Level of significance: p<0.001

Table 5.15. ANOVA test between exercise and treatment humidity condition based on subjective data.

	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	91.097	5	18.219	33.186	**0.000***
Within Groups	48.861	89	0.549		
Total	139.958	94			

* Level of significance: p<0.001

5.4. Discussion

This section discusses the results of the case study in comparison with the international standards in healthcare facilities to the objective measurements collected from the case space. Moreover, the subjective measurements are reviewed along with the objective measurements, in order to understand the issues that can be highlighted from the performed analysis and work towards possible solutions.

The materials used in the case space are partially suitable for its functionality. The glass façade at the exercise rooms support providing natural light during the day time, which adds to the benefits of providing better lighting quality. Moreover, the PVC linoleum flooring is also suitable for fitness areas. However, there is no evidence from the architectural survey and analysis that the ceiling type support the acoustic requirements of a healthcare facility (CISCA, 2010), which is discussed further in this chapter. The wood flooring in the treatment rooms is suitable for cleaning and disinfection.

Based on the objective measurements, the lighting quality fluctuates from 1973 lux in the exercise rooms near the glass façade during the day time hours to as low as 74 lux in the inner parts of the exercise rooms. According to standards on healthcare facilities, general lighting in healthcare facilities shall have a minimum of 100 foot-candles, which is equivalent to 1076 lux. Task lighting shall be between 150 and 200 foot-candles (1614 to 2153 lux) (Michigan Department of Community Health, 2007). Based on these results the lighting quality in the case study wellness centre does not meet international standards. Through the review of less stringent requirements in LARA (1998), the standards indicate illuminance levels of 215 lux, 225 lux and 540 lux for the corridor (general lighting), exercise rooms, and treatment rooms, respectively, which indicates the same results in terms of meeting international lighting comfort requirements.

The acoustic quality in the treatment centre is tested by recording readings from different parts of the facility. The data shows an average reading that range from 40.68 to 54.02 dBA. International standards for healthcare facilities and World Health

Organization, recommend as maximum of 35 dBA in the day time. Nevertheless, some model healthcare facilities have exceeded this limit up to 50 dBA, which is considered above the allowed limit (CISCA, 2010). Moreover, the ceiling type used in the facility plays a role in determining the acoustic quality of the space. Therefore, the architectural analysis did not include the use of acoustic ceiling, which could be a suitable solution for this issue.

For the thermal comfort in healthcare environments, the British Standards recommends that temperature should range between 15 and 30 °C, while humidity shall not exceed 60% (Lomas & Giridharan, 2012). According to the recorded readings for temperature in the treatment and exercise rooms, the minimum temperature was recorded as 18.9 °C and the maximum temperature was recorded as 26.6 °C, which falls within the standard range. Furthermore, the relative humidity had a maximum of 39.8%, not exceeding the 60% limit.

The results of the questionnaire show that 87.37% of the wellness centre visitors spend at least 1 hour and some even more in the facility, and 80% visit the facility at least 2 times a week. Therefore, the indoor environment of the facility could have an influential impact on the visitors' health and wellbeing. The physical perception results show the air quality as the best-perceived parameter of the IEQ parameters, followed by the lighting quality, acoustic quality and thermal quality, considering the exercise and treatment areas of the facility. Due to lack of equipment the measurement of the indoor air quality has not been accomplished. This can be discussed as one of the drawbacks of this study.

In correlating the objective measurements to the subjective questionnaire ratings, there are no correlations found between the two data sets, except for the lighting quality in the exercise room and its physical perception. This could be attributed to either the lack of such correlations in reality or the insufficient information provided by the data to establish the relationship. Nevertheless, significant means' differences were found between the objective measurements of the exercise rooms and its counterpart of the treatment rooms. The exercise rooms were found significantly noisier, brighter, cooler and less humid than the treatment rooms.

Further correlations are established between the demographics and space usage data and the subjective measurements of the IEQ parameters physical perception and importance. Several relations were found significant, such as the age category and the humidity physical perception in treatment rooms with ANOVA significance of 0.017 and Spearman's rho = 0.318 at the 0.01 level. The second correlation was found between the frequency of the visit and the acoustical perception in the exercise rooms, which had an ANOVA significance of 0.032 and Spearman's rho = 0.110.

Furthermore, significant correlation is found between the purpose of the visit and the thermal physical perception in the treatment rooms. The means comparison test (ANOVA) and the correlation factor showed significance of 0.037 and a Spearman's rho = 0.232 at the 0.05 level. The forth parameter that showed relationship between the usage data and the subjective user assessment was the purpose of the visit and the thermal physical perception in the exercise rooms. The ANOVA testing for this relationship had a significance of 0.016 and Spearman's rho = 0.255 at the 0.05 level.

The age category relationship variance with the thermal quality importance in the treatment rooms was found significant (ANOVA Significance = 0.023), while the Spearman's rho = 0.213 at the 0.05 level. Finally, the frequency of visit was tested with the importance of indoor air quality in the treatment rooms, which showed an ANOVA significance of 0.001 and Spearman's rho = -0.230 at the 0.05 level.

6. CONCLUSION

As a conclusion, the hypotheses presented in this research are tested according to the findings of the case study. Moreover, further information is incorporated from the international standards of the healthcare facilities through the discussion, which are used to test some of the hypotheses.

Since the international standards specify that the acoustic level in healthcare facilities shall not exceed 35 dBA (CISCA, 2010), and based on the data collected in the objective measurement section, where the vast majority of the readings exceed this limit up to 55%, the first hypothesis stating, "the wellness center acoustic measurements are within the acceptable limits as per the IEQ requirements (International Standards) and space functionality" is rejected as measurements in the treatment and exercises rooms exceed the 35 dBA limit. Better acoustic performance can be achieved through installation of acoustic ceiling and wall material.

As per the British standards the temperature in the healthcare facility shall be between 15 and 30 °C (Lomas & Giridharan, 2012). The readings measured in the wellness centre for temperature are ranging between 18.9 and 26.6 °C. Therefore, the second hypothesis stating, "the wellness center temperature measurements are within the acceptable limits as per the IEQ requirements (International Standards) and space functionality" is accepted.

As per the British standards the relative humidity in the healthcare facility shall not exceed 60% (Lomas & Giridharan, 2012). The readings measured in the wellness centre for relative humidity have a maximum of 39.8%. Thus, the third hypothesis stating, "the wellness center humidity measurements are within the acceptable limits as per the IEQ requirements (International Standards) and space functionality" is accepted.

According to building codes, (LARA, 1998) and WHO recommendations, the general lighting in healthcare facilities shall be with a minimum of 215 lux, physical therapy should have a minimum of 225 lux, and treatment rooms shall have a minimum of 540 lux. However, none of the illuminance measurements in the treatment rooms comply with the required minimum, while the general lighting in the wellness center and the exercises rooms is sufficient but with many exceptions. Therefore, the fourth hypothesis stating, "the wellness center lighting measurements are within the acceptable limits as per the IEQ requirements (International Standards) and space functionality" is rejected. A further detailed study shall be performed on the incompliant spaces in order to understand the lighting patterns and areas of low luminance. Following that, additional lighting can be provided in order to achieve the minimum lighting values that are required in the standards.

According to performed ANOVA tests to assess the correlation between the objective measurements and the subjective assessment by the users (physical perception), the significance between all IEQ parameters from both data sets are ranging between 0.466 and 0.800 p values showing no correlation, except for lighting comfort and its physical perception in the exercise rooms with significance level of 0.013. Such a result indicates no correlation between tested parameters. Thus, the fifth hypothesis stating, "there is a relation between the IEQ measurements and the user's assessment of the IEQ in the case study wellness center" is rejected. As explained earlier, lack of correlation between the two measurements could be due to insufficient sample size of the subjective assessments. In addition, measurements and questionnaire assessments are synchronized as much as possible, but it can be more controlled with exact time defined objective measurements and subjective assessment. This approach can be adapted if the case study is done by a research group. In future research, bigger sample size and more detailed analysis in each different area regarding measurements and questionnaire sampling could also be possible.

The ANOVA and Spearman's rho correlation testing between the different demographic and usage data of the participants and the subjective assessments by the users shows few weak to medium correlations (ANOVA significance ranging between 0.001 and 0.037 at the 0.05 level). Thus, the sixth hypothesis stating, “there is a relation between the IEQ subjective assessments and the demographic and usage data of the participants” is accepted.

According to performed ANOVA tests to assess the correlation between the objective measurements of the exercise and the treatment rooms in the wellness Centre, the significance between all IEQ parameters from both data sets is 0.000, without exception, which indicates a very strong correlation between them. Thus, the seventh hypothesis stating that “There is a relation between the measurements of the exercise and treatment areas of the wellness center” is accepted.

Finally, questionnaire results indicating the subjective physical perception ratings of the exercise and the treatment rooms in the wellness Centre, shows great variations with the significance level of 0.000, which indicates a very strong correlation between them. Thus, the eight hypothesis stating, “there are variations between the subjective ratings of the exercise and treatment areas of the wellness center” is accepted.

As a note for future research on the subject, this research has covered some of the indoor environment quality parameters. Nevertheless, due to the unavailability of the required measurement devices, IAQ parameters such as VOC, CO and CO_2 levels were not measured, which could be part of a future research.

Future work could include comparison of different wellness centers with varying architectural characteristics such as, material finishing, façade orientations, and window openings. In addition, seasonal changes could be studied to understand its effects on the indoor environmental parameters and their perception by the users.

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APPENDIX 1

Questionnaire Form

ÇANKAYA UNIVERSITY - FACULTY OF ARCHITECTURE - DEPARTMENT OF INTERIOR ARCHITECTURE

INFORMATION SHEET

INDOOR ENVIRONMENTAL QUALITY ASSESSMENT PARAMETERS: A CASE STUDY IN WELLNESS CENTER, ANKARA

Dear participant,

You are invited to participate in the captioned research study conducted by a Master's degree student which is an on-going study at the Graduate Program in the Interior Architecture Department at Çankaya University.

Definition**:** The indoor environmental quality assessment will be on the factors related with: humidity, temperature, lighting, and sound levels. This research is on indoor environmental quality assessment of Medifit Wellness Center, located in Ankara.

The aim of this study is to;

1. Evaluate the objective indoor environmental quality parameters (IEQP) and the subjective quality assessment of the users in the wellness center.

2. Understand the relationship between measured indoor environmental conditions and assessment of the users.

This indoor environmental quality questionnaire, which you are about to complete, should take approximately 10 minutes. Any information provided from participators will be confidential and used only for academic purposes. If you have any question about this project, please contact the researcher through the email address: abubaker.hassn.86@gmail.com.Thank you for taking part in the questionnaires and your time and contribution to this study.

DEMOGRAPHIC INFORMATION				
1- YOUR GENDER	□ Male	□ Female		
2-AGE	□ Under 30	□ 30-44	□ 45-59	□ 60 and over
3- DATE	………../………/………....			
4- TIME	…………………………….			
5- How much time do you usually spend in this wellness centre in one day?				
□ 1 to 2 hours	□ 2 to 3 hours	□ More than 3 hours	□ Less than 1 hour	
6- How frequently do you come to this wellness centre in one week?				
□ 1 day per week	□ 2-3 days per week	□ 4-5 days per week	□ More than 5 days per week	
7- For which purpose do you come to this wellness center?				
□ Exercise in Medifit	□ Treatment in physio room			
8- Which time interval do you use this wellness center mostly?				
□ 08:00-11:00	□11:00-14:00	□14:00-17:00	□ 17:00-20:00	

9- How do you rate your physical perception of the following indoor environmental parameters for the exercise rooms?

1	Indoor Air Quality	**Very fresh** □	**Fresh** □	**Slightly fresh** □	**Slightly stale** □	**Stale** □	**Very stale** □
2	Acoustic Quality	**Very quiet** □	**Quiet** □	**Slightly quiet** □	**Slightly noisy** □	**Noisy** □	**Very noisy** □
3	Thermal Quality	**Very hot** □	**Hot** □	**Slightly hot** □	**Slightly cold** □	**Cold** □	**Very cold** □
4	Llighting Quality	**Very bright** □	**Bright** □	**Slightly bright** □	**Slightly dull** □	**Dull** □	**Very dull** □
5	Humidity Condition	**Very humid** □	**Humid** □	**Slightly humid** □	**Slightly dry** □	**Dry** □	**Very dry** □

10- How do you rate your physical perception of the following indoor environmental parameters for the treatment rooms?

a	Indoor Air Quality	**Very fresh** ◻	**Fresh** ◻	**Slightly fresh** ◻	**Slightly stale** ◻	**Stale** ◻	**Very stale** ◻
b	Acoustic Quality	**Very quiet** ◻	**Quiet** ◻	**Slightly quiet** ◻	**Slightly noisy** ◻	**Noisy** ◻	**Very noisy** ◻
c	Thermal Quality	**Very hot** ◻	**Hot** ◻	**Slightly hot** ◻	**Slightly cold** ◻	**Cold** ◻	**Very cold** ◻
d	Llighting Quality	**Very bright** ◻	**Bright** ◻	**Slightly bright** ◻	**Slightly dull** ◻	**Dull** ◻	**Very dull** ◻
e	Humidity Condition	**Very humid** ◻	**Humid** ◻	**Slightly humid** ◻	**Slightly dry** ◻	**Dry** ◻	**Very dry** ◻

11- Please rate the importance of following indoor environmental parameters for the exercise rooms.

		Very unimportant	Unimportant	Slightly unimportant	Slightly important	Important	Very important
		1	2	3	4	5	6
1	Indoor Air Comfort	◻	◻	◻	◻	◻	◻
2	Acoustic Comfort	◻	◻	◻	◻	◻	◻
3	Thermal Comfort	◻	◻	◻	◻	◻	◻
4	Lighting Comfort	◻	◻	◻	◻	◻	◻
5	Humidity Comfort	◻	◻	◻	◻	◻	◻

12- Please rate the importance of following indoor environmental parameters for the treatment rooms.

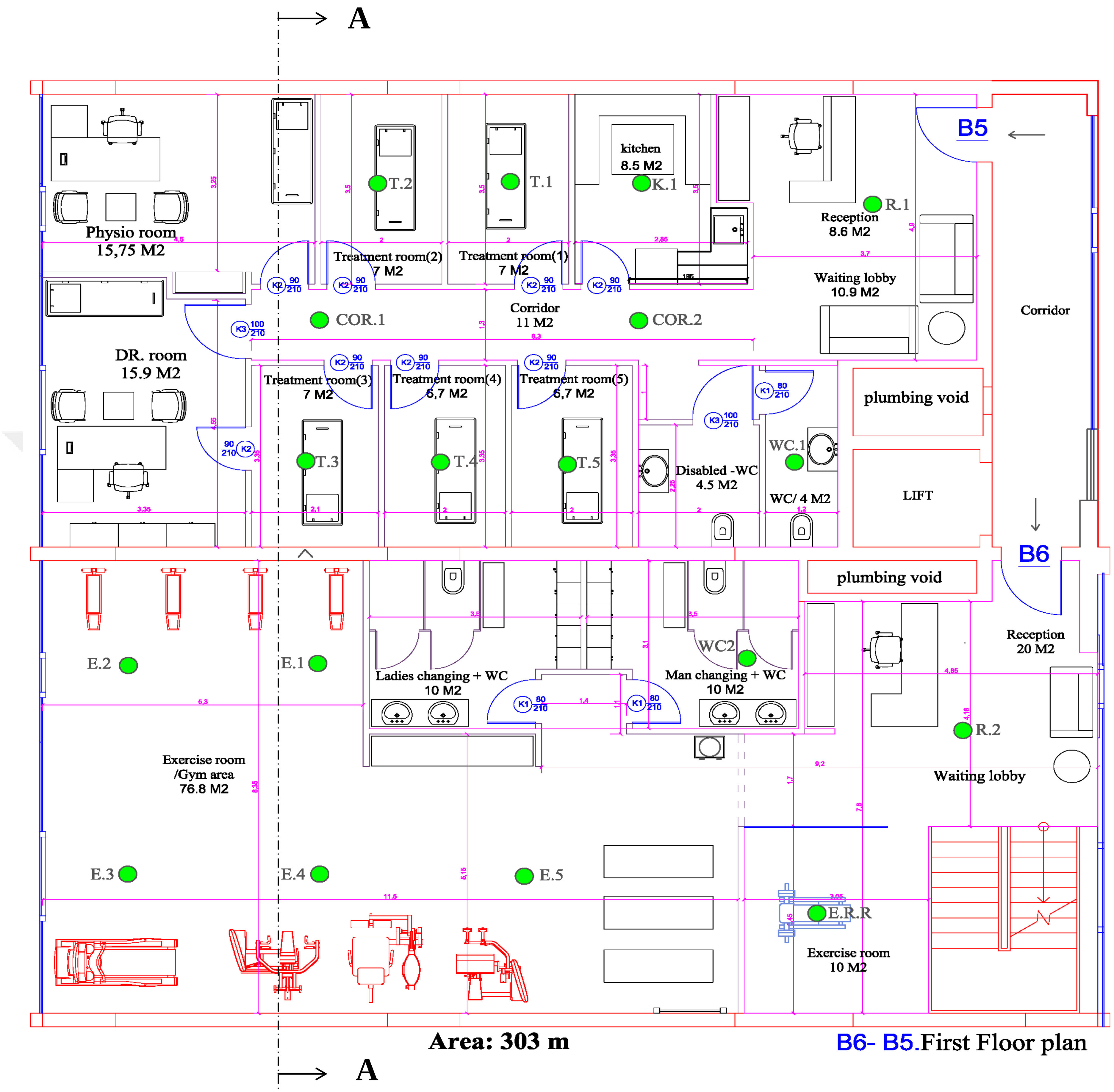
		Very unimportant	Unimportant	Slightly unimportant	Slightly important	Important	Very important
		1	2	3	4	5	6
1	Indoor Air Comfort	◻	◻	◻	◻	◻	◻
2	Acoustic Comfort	◻	◻	◻	◻	◻	◻
3	Thermal Comfort	◻	◻	◻	◻	◻	◻
4	Lighting Comfort	◻	◻	◻	◻	◻	◻
5	Humidity Comfort	◻	◻	◻	◻	◻	◻

THANK YOU VERY MUCH FOR TAKING PART IN THIS SURVEY

☺

APPENDIX 2

Wellness Centre Floor Plans and Photographs

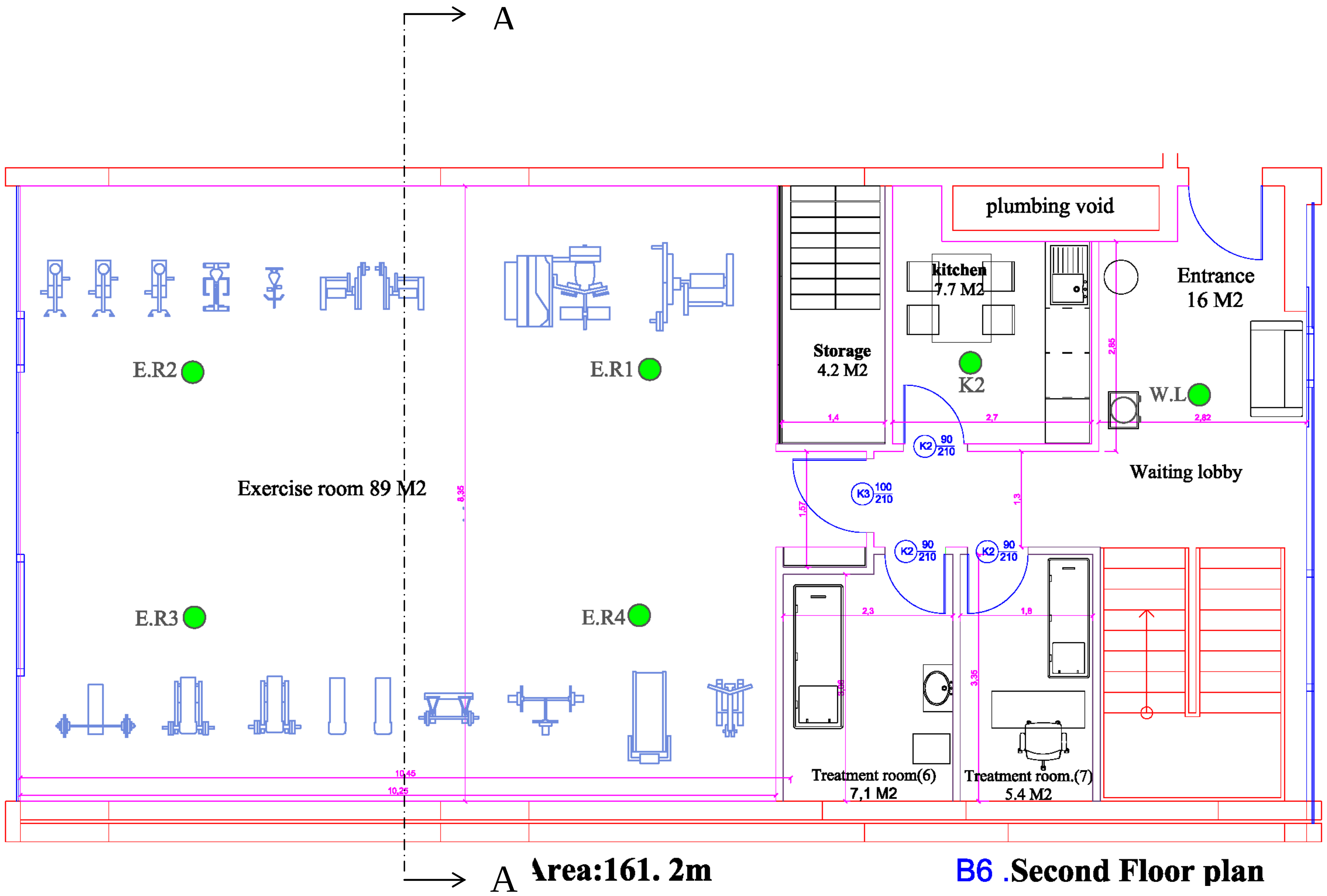


Area: 303 m

B6- B5.First Floor plan

IEQ Parameter Measurement Point

B5.First Floor plan					
Treatment rooms	T.1	T.2	T.3	T.4	T.5
kitchen	K.1				
Corridor	COR.1	COR.2			
Reception	R.1				
WC	WC.1				
B6.First Floor plan					
Reception	R.2				
Exercise room /Gym area	E.1	E.2	E.3	E.4	E.5
Exercise room	E.R.R				
Man changing + WC	WC.2				
B6 .Second Floor plan					
Waiting lobby	W.L				
kitchen	K.2				
Exercise room	E.R.1	E.R.2	E.R.3	E.R.4	E.R.5

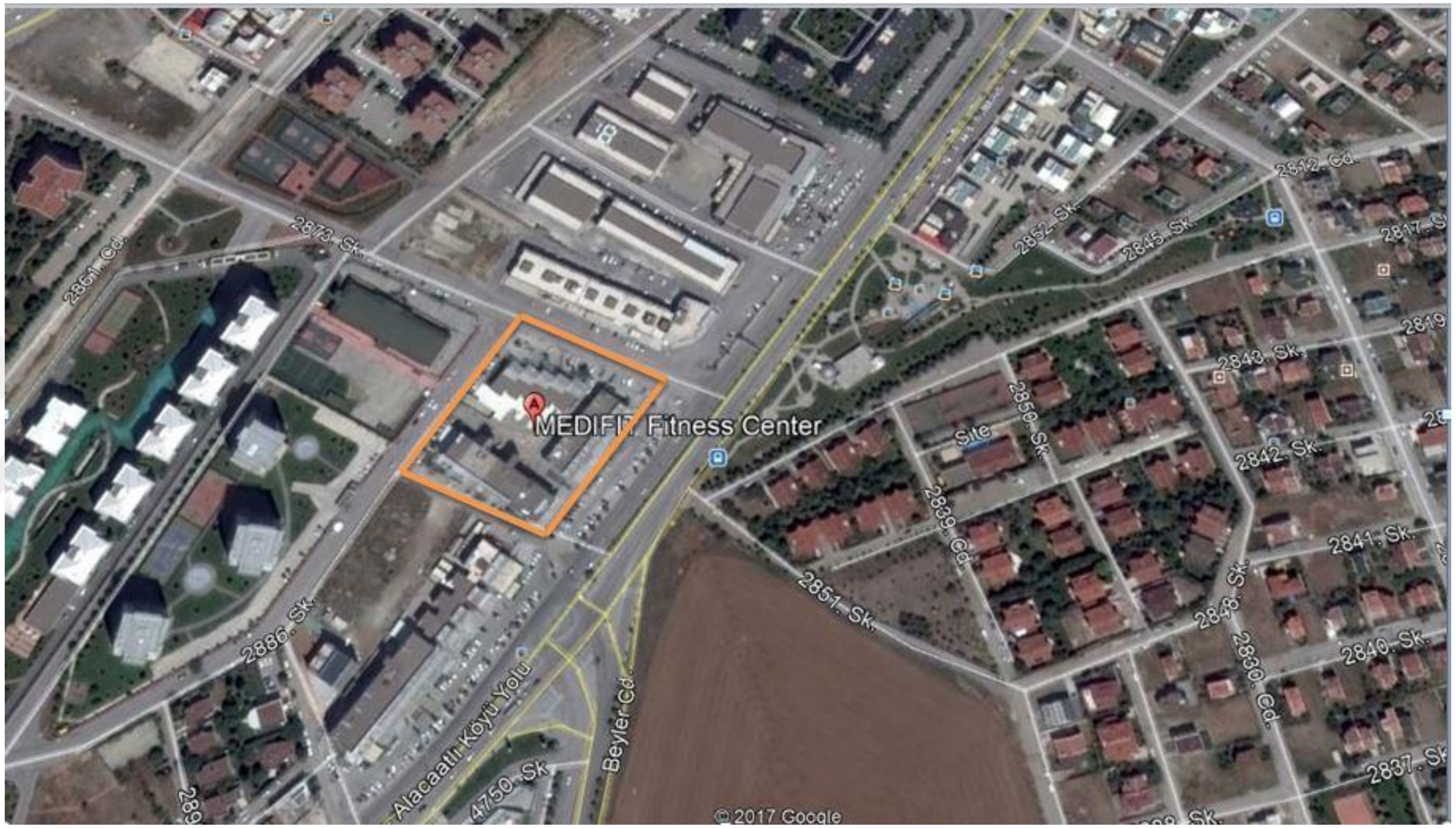


Area:161. 2m

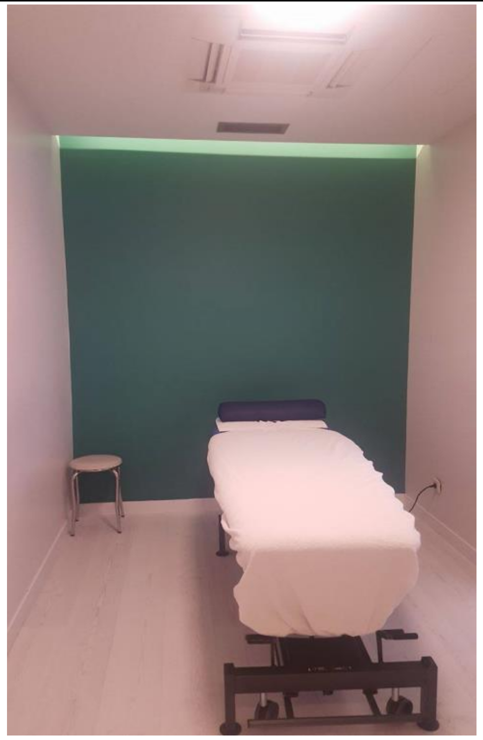
B6 .Second Floor plan

IEQ Parameter Measurement Point

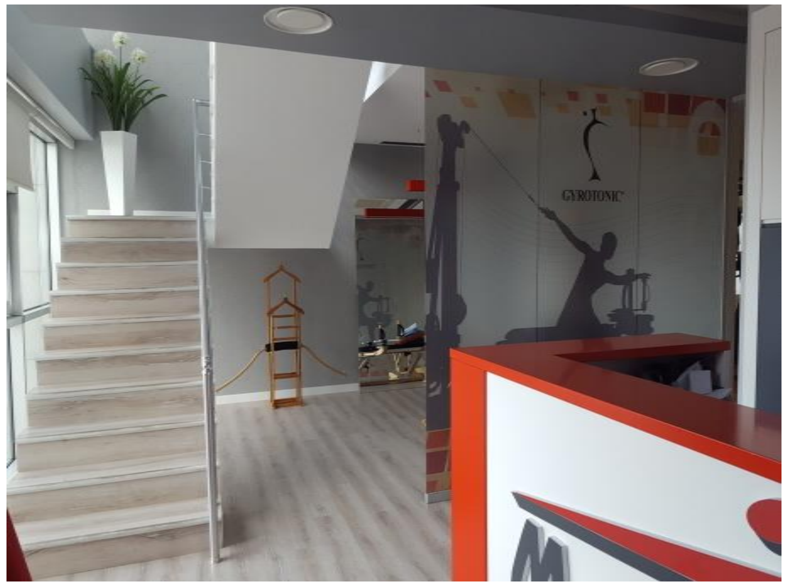
B5.First Floor plan					
Treatment rooms	T.1	T.2	T.3	T.4	T.5
kitchen	K.1				
Corridor	COR.1	COR.2			
Reception	R.1				
WC	WC.1				
B6.First Floor plan					
Reception	R.2				
Exercise room /Gym area	E.1	E.2	E.3	E.4	E.5
Exercise room	E.R.R				
Man changing + WC	WC.2				
B6 .Second Floor plan					
Waiting lobby	W.L				
kitchen	K.2				
Exercise room	E.R.1	E.R.2	E.R.3	E.R.4	E.R.5

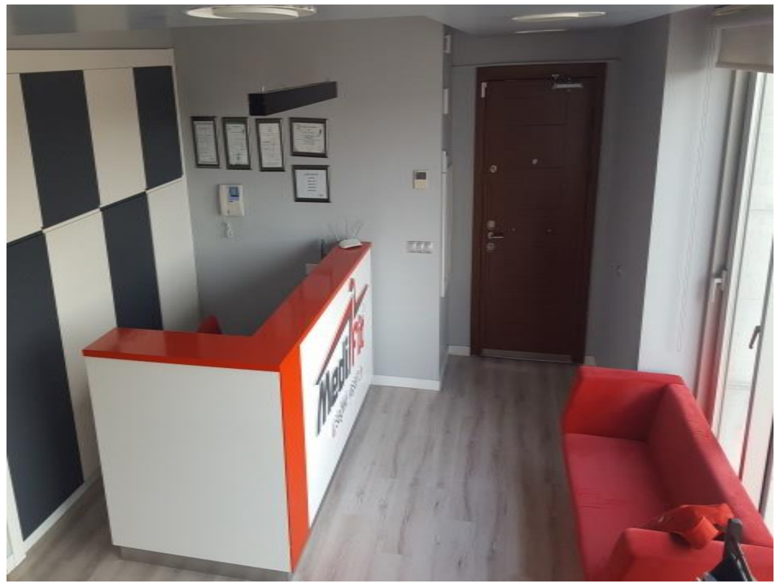


Location of Case Space in Çayyolu Yenimahalle Ankara



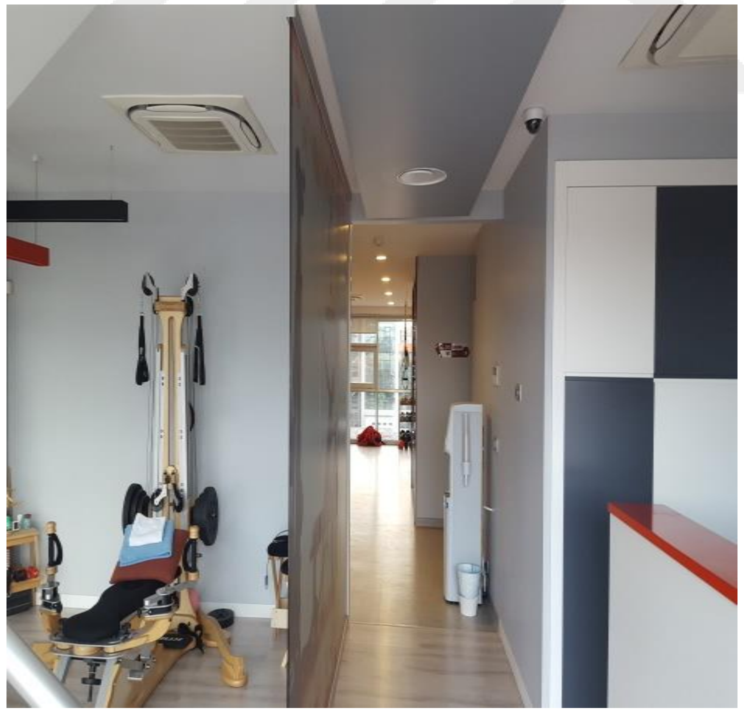
Treatment rooms in the case space

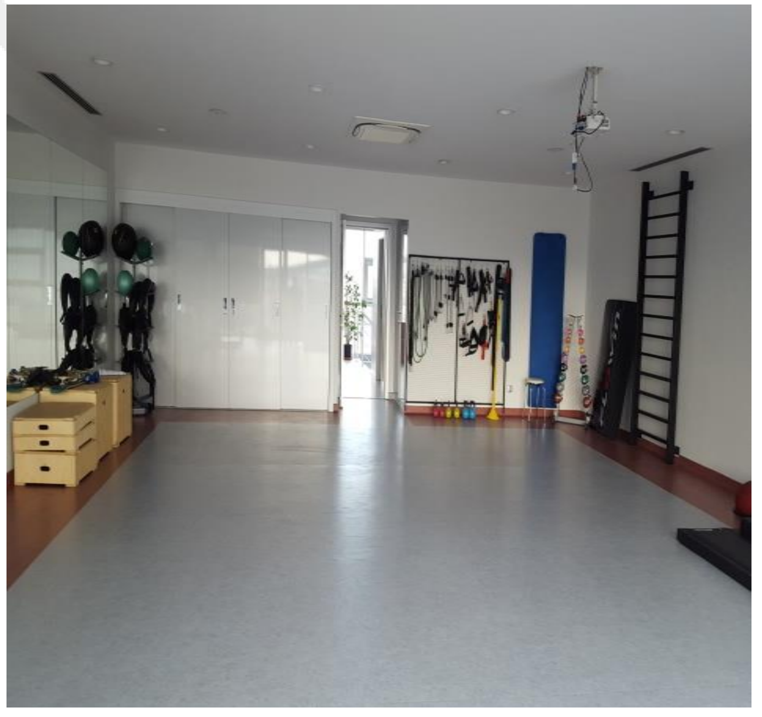


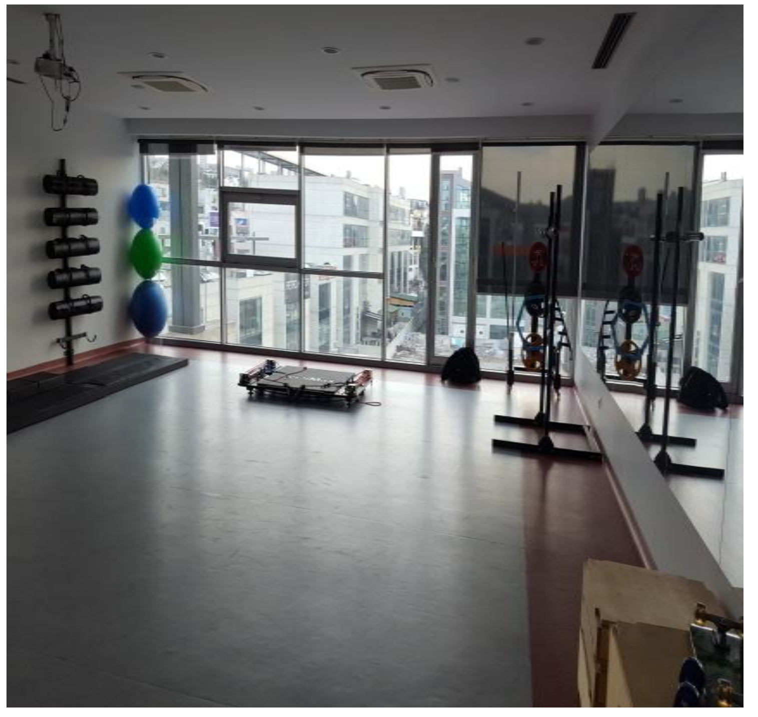


Reception area in the case space

Waiting lobby in the case space







Exercise room in the case space

APPENDIX 3

Measurement Table Template

Medifit Wellness Center In Ankara					Weather Condition							Date……... /……../………..		
MORNING					Sunny ◻			rainy ◻		cloudy ◻		External Temperature. ……………°C		
N	Floors	Space Type	Area (m2)	Time interval most often	Measurements							Space Condition		
					Name	Air Co2	Light (lux)	Sound (db.)	Relative Humidity (%)	Temperature (°C)	Time Am/Pm	Walls	Ceiling	Floors
												Window-pane. ◻ Wallpaper. ◻ Paint on gypsum Board. ◻ Mirror. ◻ Other ………….. ◻	Suspended ceiling Panel. ◻ Plaster on concrete. ◻ Suspended gypsum Ceiling. ◻ Other………….. ◻	Marble. ◻ Wood laminate. ◻ PVC linoleum. ◻ Ceramic. ◻ Other………… ◻
												Window-pane. ◻ Wallpaper. ◻ Paint on gypsum Board. ◻ Mirror. ◻ Other ………….. ◻	Suspended ceiling Panel. ◻ Plaster on concrete. ◻ Suspended gypsum Ceiling. ◻ Other………….. ◻	Marble. ◻ Wood laminate. ◻ PVC linoleum. ◻ Ceramic. ◻ Other………… ◻

APPENDIX 4

Detailed Objective Measurements

<table>
<tr><th colspan="5">Medifit Wellness Center In Ankara</th><th colspan="9">Weather Condition</th></tr>
<tr><th colspan="5">MORNING</th><th colspan="9">Sunny √ □ rainy □ cloudy □</th></tr>
<tr><th rowspan="2">N</th><th rowspan="2">Floors</th><th rowspan="2">Space Type</th><th rowspan="2">Area (m2)</th><th rowspan="2">Time interval most often</th><th colspan="9">Measurements</th></tr>
<tr><th>Name</th><th>Air Co2</th><th colspan="3">Light (lux)</th><th>Sound (db.)</th><th>Relative Humidity (%)</th><th>Temperature (°C)</th><th>Time Am/Pm</th></tr>
<tr><td rowspan="5">1</td><td rowspan="5">B5- First Floor plan</td><td rowspan="5">Corridor/ Kitchen / Reception / WC1</td><td rowspan="2">11</td><td rowspan="5">8:00
11:00</td><td>COR.1</td><td></td><td colspan="3">429</td><td>44.4</td><td>36.5</td><td>21.4</td><td>9:40 Am</td></tr>
<tr><td>COR.2</td><td></td><td colspan="3">306</td><td>51.7</td><td>35.5</td><td>20.6</td><td>9:42 Am</td></tr>
<tr><td>8.5</td><td>K1</td><td></td><td colspan="3">151</td><td>46.3</td><td>34.6</td><td>21.7</td><td>9:49 Am</td></tr>
<tr><td>19.5</td><td>R1</td><td></td><td colspan="3">305</td><td>62.9</td><td>34.2</td><td>21.3</td><td>9:47 Am</td></tr>
<tr><td>4</td><td>WC1</td><td></td><td colspan="3">133</td><td>54.5</td><td>35.2</td><td>20.7</td><td>9:45 Am</td></tr>
<tr><td rowspan="5">2</td><td rowspan="5">B5 -First Floor plan</td><td rowspan="5">Treatment room (T).</td><td rowspan="5">7</td><td rowspan="5">8:00
11:00</td><td>T.1</td><td></td><td>10</td><td>21</td><td>288</td><td>46.1</td><td>34.0</td><td>21.6</td><td>10:56 Am</td></tr>
<tr><td>T.2</td><td></td><td>14</td><td>35</td><td>313</td><td>40.2</td><td>38.1</td><td>20.9</td><td>9:37 Am</td></tr>
<tr><td>T.3</td><td></td><td>62</td><td>70</td><td>304</td><td>45.6</td><td>39.8</td><td>20.8</td><td>9:30 Am</td></tr>
<tr><td>T.4</td><td></td><td>5</td><td>14</td><td>206</td><td>48.0</td><td>33.0</td><td>21.9</td><td>10:59 Am</td></tr>
<tr><td>T.5</td><td></td><td>11</td><td>17</td><td>258</td><td>51.4</td><td>38.3</td><td>21.0</td><td>9.34 Am</td></tr>
</table>

<table>
<tr><th colspan="5">Medifit Wellness Center In Ankara</th><th colspan="9">Weather Condition</th></tr>
<tr><th colspan="5">NOON</th><th colspan="9">Sunny √□ rainy □ cloudy □</th></tr>
<tr><th rowspan="2">N</th><th rowspan="2">Floors</th><th rowspan="2">Space Type</th><th rowspan="2">Area (m2)</th><th rowspan="2">Time interval most often</th><th colspan="9">Measurements</th></tr>
<tr><th>Name</th><th>Air Co2</th><th colspan="3">Light (lux)</th><th>Sound (db.)</th><th>Relative Humidity (%)</th><th>Temperature (°C)</th><th>Time Am/Pm</th></tr>
<tr><td rowspan="5">1</td><td rowspan="5">B5- First Floor plan</td><td rowspan="5">Corridor/ Kitchen / Reception / WC1</td><td rowspan="2">11</td><td rowspan="5">11:00
14:00</td><td>COR.1</td><td></td><td colspan="3">467</td><td>43.4</td><td>31.6</td><td>22.5</td><td>11:45 Am</td></tr>
<tr><td>COR.2</td><td></td><td colspan="3">238</td><td>44.5</td><td>31.3</td><td>22.0</td><td>11:50 Am</td></tr>
<tr><td>8.5</td><td>K1</td><td></td><td colspan="3">136</td><td>38.1</td><td>32.5</td><td>23.3</td><td>11:52 Am</td></tr>
<tr><td>19.5</td><td>R1</td><td></td><td colspan="3">306</td><td>44.1</td><td>29.8</td><td>23.9</td><td>11:55 Am</td></tr>
<tr><td>4</td><td>WC1</td><td></td><td colspan="3">138</td><td>55.3</td><td>30.6</td><td>22.8</td><td>11:57 Am</td></tr>
<tr><td rowspan="5">2</td><td rowspan="5">B5 -First Floor plan</td><td rowspan="5">Treatment room (T).</td><td rowspan="5">7</td><td rowspan="5">11:00
14:00</td><td>T.1</td><td></td><td>7</td><td>18</td><td>242</td><td>38.00</td><td>32.6</td><td>23.00</td><td>11:34 Am</td></tr>
<tr><td>T.2</td><td></td><td>14</td><td>43</td><td>291</td><td>39.1</td><td>33.2</td><td>22.9</td><td>11.27 Am</td></tr>
<tr><td>T.3</td><td></td><td>18</td><td>34</td><td>217</td><td>33.7</td><td>32.00</td><td>23.4</td><td>11:40 Am</td></tr>
<tr><td>T.4</td><td></td><td>8</td><td>12</td><td>208</td><td>42.4</td><td>33.7</td><td>23.4</td><td>11:12 Am</td></tr>
<tr><td>T.5</td><td></td><td>10</td><td>15</td><td>254</td><td>50.2</td><td>29.8</td><td>26.6</td><td>12.09 Pm</td></tr>
</table>

Medifit Wellness Center In Ankara					Weather Condition									
AFTERNOON					Sunny □		rainy □				cloudy √□			
N	Floors	Space Type	Area (m2)	Time interval most often	Measurements									
					Name	Air Co2	Light (lux)			Sound (db.)	Relative Humidity (%)	Temperature (°C)	Time Am/Pm
1	B5- First Floor plan	Corridor/ Kitchen / Reception / WC1	11	14:00 17:00	COR.1		468			47	29.2	25.2	3:38 Pm
					COR.2		230			45	29.1	25.1	3:41 Pm
			8.5		K1		165			48.8	28.3	25..2	3:45 Pm
			19.5		R1		295			54.2	29.6	25.2	3:28 Pm
			4		WC1		139			57.4	30.0	23.9	4:02 Pm
2	B5 -First Floor plan	Treatment room (T).	7	14:00 17:00	T.1		8	20	260	40.9	30.1	24.5	3:55 Pm
					T.2		11	39	287	44.8	29.4	24.6	3:32 Pm
					T.3		28	37	242	33.00	30.2	25.3	3:36 Pm
					T.4		9	12	220	41.9	30.0	24.9	3:50 Pm
					T.5		6	13	223	51.2	29.6	24.8	3.59 Pm

Medifit Wellness Center In Ankara					Weather Condition									
EVENING					Sunny □		rainy □				cloudy √□			
N	Floors	Space Type	Area (m2)	Time interval most often	Measurements									
					Name	Air Co2	Light (lux)			Sound (db.)	Relative Humidity (%)	Temperature (°C)	Time Am/Pm	
1	B5- First Floor plan	Corridor/ Kitchen / Reception / WC1	11	17:00 20:00	COR.1		279			51.9	30.4	24.4	5:15 Pm	
					COR.2		375			48.7	30.8	24.7	5:18 Pm	
			8.5		K1		161			45.8	31.9	25.5	5:04 Pm	
			19.5		R1		288			53.9	30.4	24.9	5:20 Pm	
			4		WC1		157			56	31.7	24.5	5.13 Pm	
2	B5 -First Floor plan	Treatment room (T).	7	17:00 20:00	T.1		8	15	273	41.9	30.6	24.8	6:05 Pm	
					T.2		10	42	305	45.5	32.3	24.8	7:03 Pm	
					T.3		30	36	305	40.0	30.6	25.3	5:08 Pm	
					T.4		5	12	237	42.9	30.6	25.4	5:11 Pm	
					T.5		9	14	248	50.3	31.5	25.6	6:26 Pm	

Medifit Wellness Center In Ankara					Weather Condition						
MORNING					Sunny √□		Rainy □		Cloudy □		
N	Floors	Space Type	Area (m2)	Time interval most often	Measurements						
					Name	Air Co2	Light (lux)	Sound (db.)	Relative Humidity (%)	Temperature (°C)	Time Am/Pm
1	B6- First Floor plan	Exercise room (E).	16	8:00 11:00	E.1		247	61.4	31.4	19.3	10:30 Am
					E.2		692	92.5	31.4	19.1	10:28 Am
					E.3		489	55.6	31.5	18.9	10:26 Am
					E.4		197	59.8	31.5	19.0	10:24 Am
					E.5		74	58.4	31.6	19.3	10:21 Am
2	B6 -First Floor plan	Reception / Exercise room / WC2	7	8:00 11:00	R2		1090	54.9	31.6	20.0	10:19 Am
			10		E.R.R		715	50.2	31.3	20.0	10:51 Am
			10		WC2		460	57.7	31.5	19.8	10:33 Am

Medifit Wellness Center In Ankara					Weather Condition						
NOON					Sunny √□		Rainy □		Cloudy □		
N	Floors	Space Type	Area (m2)	Time interval most often	Measurements						
					Name	Air Co2	Light (lux)	Sound (db.)	Relative Humidity (%)	Temperature (°C)	Time Am/Pm
1	B6- First Floor plan	Exercise room (E).	16	11:00 14:00	E.1		528	59.8	30.2	23.1	12:25 Pm
					E.2		1160	57.7	30.1	23.00	12.28 Pm
					E.3		945	56.2	30.00	22.8	12:31 Pm
					E.4		457	58.7	30.00	23.00	12:35 Pm
					E.5		200	56.8	30.00	23.00	12:37 Pm
2	B6 -First Floor plan	Reception / Exercise room / WC2	7	11:00 14:00	R2		771	52.5	30.2	23.3	12.17 Pm
			10		E.R.R		564	44.0	30.2	23.0	12:20 Pm
			10		WC2		355	54.2	31.0	23.6	12:51 Pm

Medifit Wellness Center In Ankara					Weather Condition							
AFTERNOON					Sunny □		Rainy □			Cloudy √□		
N	Floors	Space Type	Area (m2)	Time interval most often	Measurements							
					Name	Air Co2	Light (lux)	Sound (db.)	Relative Humidity (%)	Temperature (°C)	Time Am/Pm	
1	B6- First Floor plan	Exercise room (E).	16	14:00 17:00	E.1		484	60.8	26.5	24.4	2:51 Pm	
					E.2		1492	67.7	26.4	24.5	2:53 Pm	
					E.3		1578	59.6	26.5	24.5	2:56 Pm	
					E.4		522	59.4	26.2	24.3	3:00 Pm	
					E.5		193	62.3	26.00	23.9	3:03 Pm	
2	B6 -First Floor plan	Reception / Exercise room / WC2	7	14:00 17:00	R2		966	58.7	26.7	24.8	2:43 Pm	
			10		E.R.R		550	54.4	26.7	24.0	2:47 Pm	
			10		WC2		246	55.1	37.8	24.6	3:25 Pm	

Medifit Wellness Center In Ankara					Weather Condition							
EVNING					Sunny □		Rainy □			Cloudy √□		
N	Floors	Space Type	Area (m2)	Time interval most often	Measurements							
					Name	Air Co2	Light (lux)	Sound (db.)	Relative Humidity (%)	Temperature (°C)	Time Am/Pm	
1	B6- First Floor plan	Exercise room (E).	16	17:00 20:00	E.1		385	41.2	28.1	23.7	5:40 Pm	
					E.2		509	39.4	28.0	23.5	5:38 Pm	
					E.3		315	36.3	28.1	23.2	5:35 Pm	
					E.4		254	51.9	28.2	23.2	5:30 Pm	
					E.5		207	47.8	28.4	23.2	5:25 Pm	
2	B6 -First Floor plan	Reception / Exercise room / WC2	7	17:00 20:00	R2		156	61	27.8	23.4	5:24 Pm	
			10		E.R.R		125	53.4	27.9	23.4	5:26 Pm	
			10		WC2		364	56.5	27.9	23.2	5:43 Pm	

Medifit Wellness Center In Ankara					Weather Condition						
MORNING					Sunny √□		rainy □		cloudy □		
N	Floors	Space Type	Area (m2)	Time interval most often	Measurements						
					N	Air Co2	Light (lux)	Sound (db.)	Relative Humidity (%)	Temperature (°C)	Time Am/Pm
1	B6 Second Floor plan	Exercises/ Kitchen / waiting lobby /	7.7	8:00 11:00	K2		254	55.4	34.5	20.7	10:48 Am
			16		W.L		1997	44.9	31.1	20.1	10.37 Am
			89		E.R1		382	43	30.7	19.3	10:39 Am
					E.R2		1596	40	30.7	19.0	10:41 Am
					E.R3		1476	42.8	30.7	19.1	10:43 Am
					E.R4		418	36.5	30.7	18.9	10:46 Am

Medifit Wellness Center In Ankara					Weather Condition						
NOON					Sunny √□		rainy □		cloudy □		
N	Floors	Space Type	Area (m2)	Time interval most often	Measurements						
					N	Air Co2	Light (lux)	Sound (db.)	Relative Humidity (%)	Temperature (°C)	Time Am/Pm
1	B6 Second Floor plan	exercises/ Kitchen / waiting lobby /	7.7	11:00 14:00	K2		233	67.8	32.5	26.0	1:08 Pm
			16		W.L		1955	39.5	30.1	24.6	12:58 Pm
			89		E.R1		762	37.7	29.9	23.9	1:49 Pm
					E.R2		1950	36.7	29.2	24.2	1:51 Pm
					E.R3		1973	34.6	29.0	24.8	1:54 Pm
					E.R4		775	44.2	27.7	24.7	1:57 Pm

Medifit Wellness Center In Ankara					Weather Condition						
AFTERNOON					Sunny □		rainy □		cloudy √□		
N	Floors	Space Type	Area (m2)	Time interval most often	Measurements						
					N	Air Co2	Light (lux)	Sound (db.)	Relative Humidity (%)	Temperature (°C)	Time Am/Pm
1	B6 Second Floor plan	exercises/ Kitchen / waiting lobby /	7.7	14:00 17:00	K2		254	52.2	27.1	25.5	2:38 Pm
			16		W.L		1949	38.0	28.7	25.7	2:13 Pm
			89		E.R1		868	36.2	28.0	24.7	2:23 Pm
					E.R2		1958	41.8	27.6	24.8	2:27 Pm
					E.R3		1966	42.4	26.7	25.4	2:30 Pm
					E.R4		822	47.4	26.3	25.5	2:34 Pm

Medifit Wellness Center In Ankara					Weather Condition						
EVINING					Sunny □		rainy □		cloudy √ □		
N	Floors	Space Type	Area (m2)	Time interval most often	Measurements						
					N	Air Co2	Light (lux)	Sound (db.)	Relative Humidity (%)	Temperature (°C)	Time Am/Pm
1	B6 Second Floor plan	Exercises/ Kitchen / waiting lobby /	7.7	17:00 20:00	K2		251	52.9	29.4	23.5	5:49 Pm
			16		W.L		550	43.2	27.7	23.2	5:46 Pm
			89		E.R1		172	41.1	27.5	22.1	5:51 Pm
					E.R2		654	44.0	27.6	22.1	5:53 Pm
					E.R3		579	46.1	27.8	21.9	5:57 Pm
					E.R4		189	41.4	28.1	22.3	6:00 Pm

APPENDIX 5

Spearman's rho Correlation Tables

Correlations

			Age Category	Physical perception rating of Humidity Condition in the treatment rooms
Spearman's rho	Age Category	Correlation Coefficient	1,000	,318**
		Sig. (2-tailed)	.	,002
		N	95	95
	Physical perception rating of Humidity Condition in the treatment rooms	Correlation Coefficient	,318**	1,000
		Sig. (2-tailed)	,002	.
		N	95	95

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

			Purpose for visiting the wellness centre	Physical perception rating of Thermal Quality in the treatment rooms
Spearman's rho	Purpose for visiting the wellness centre	Correlation Coefficient	1,000	,232*
		Sig. (2-tailed)	.	,023
		N	95	95
	Physical perception rating of Thermal Quality in the treatment rooms	Correlation Coefficient	,232*	1,000
		Sig. (2-tailed)	,023	.
		N	95	95

*. Correlation is significant at the 0.05 level (2-tailed).

Correlations

			Purpose for visiting the wellness centre	Physical perception rating of Thermal Quality in the exercise room
Spearman 's rho	Purpose for visiting the wellness centre	Correlation Coefficient	1,000	,255*
		Sig. (2-tailed)	.	,013
		N	95	95
	Physical perception rating of Thermal Quality in the exercise room	Correlation Coefficient	,255*	1,000
		Sig. (2-tailed)	,013	.
		N	95	95

*. Correlation is significant at the 0.05 level (2-tailed).

Correlations

			Age Category	Rating of importance of Thermal Comfort in the treatment rooms
Spearman 's rho	Age Category	Correlation Coefficient	1,000	,213*
		Sig. (2-tailed)	.	,038
		N	95	95
	Rating of importance of Thermal Comfort in the treatment rooms	Correlation Coefficient	,213*	1,000
		Sig. (2-tailed)	,038	.
		N	95	95

*. Correlation is significant at the 0.05 level (2-tailed).

Correlations

			Frequency of visiting the wellness centre per week	Rating of importance of Indoor Air Comfort in the treatment rooms
Spearman's rho	Frequency of visiting the wellness centre per week	Correlation Coefficient	1,000	-,230*
		Sig. (2-tailed)	.	,025
		N	95	95
	Rating of importance of Indoor Air Comfort in the treatment rooms	Correlation Coefficient	-,230*	1,000
		Sig. (2-tailed)	,025	.
		N	95	95

*. Correlation is significant at the 0.05 level (2-tailed).