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The effects of physical environment in Ottoman healthcare facilities: 2nd Beyazid Complex in Edirne

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Abstract

Healthcare facilities have an important place in Ottoman Architecture. Started to be built during the Anatolian Seljuk period and continued into the Ottoman in many cities, they manage to survive. However, it is not possible to use them with their original functions today. Most of them are used by serving as exhibition and museum buildings like Edirne Sultan 2nd Beyazid Health Complex. In the use of such historical buildings, the examination of their response to changing living conditions and needs is important. This study investigates how the physical environment affected the design of the complex, and the impacts of its planning and building envelope on today's IEQ. The physical environmental data were discussed about thermal, daylight, ventilation, and acoustics performances by calculating and evaluating the existing energy consumption of the building. Methods like literature review, direct observation, on-site examination, simulation, and documenting with photographs were used. It was determined that five hundred years ago, the building was compatible with its physical environmental data in terms of its function, planning, and building envelope, and, as being a museum today, it provides all the necessary comfort conditions for its users, and that the energy consumption is at an acceptable level.

Highlights

- It is necessary to examine the suitability of adaptive reused historical buildings with today's comfort conditions.
- The results of the analysis of the compatibility of historical buildings with physical environmental conditions can provide information about the sustainability of buildings to be constructed in the future.
- Sustainable building production depends on the design integrated with the physical environment.

Keywords

2nd Beyazid Health Complex; Healthcare facility; Historical buildings; Indoor environmental quality; Physical environment

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Osmanlı sağlık yapılarında fiziksel çevre koşullarının etkileri: Edirne 2. Beyazit Külliyesi

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Öz

Anadolu Türk Mimarisinde Darüşşifa/Şifahane gibi isimlerle karşımıza çıkan sağlık yapıları; hem halk sağlığına hizmet eden hem de tıp eğitiminin sürdürüldüğü medreselerle birlikte tasarlanan alanlardır. Anadolu Selçuklular döneminden başlayıp Osmanlı'da da Bursa, İstanbul, Edirne, Manisa gibi birçok şehirde inşa edilmiş bu yapıların çoğu günümüze kadar gelebilmiştir. Edirne Sultan II. Beyazıt Külliyesi Şifahanesi bu yapılardan biridir. Bu çalışmada II. Beyazıt Külliyesi Şifahanesi'nin yerleşim alanı özellikleri ile plan ve yapı kabuğu özellikleri birlikte ele alınarak fiziksel çevre verilerinin Şifahane tasarımına etkisi ve kullanıcılarına sağladığı iç ortam kalitesi analiz edilmiştir. Çalışmada fiziksel çevre verileri; ısıl performans, doğal aydınlatma, havalandırma ve akustik açıdan değerlendirilmiştir. Ayrıca mevcut durumun yapının enerji tüketimine etkisi de hesaplanmıştır. Bunun için çalışmada literatür araştırması, doğrudan gözlem, yerinde inceleme, simülasyon, ölçme ve fotoğraflarla belgeleme gibi yöntemler kullanılmıştır. Sonuç olarak Şifahane'nin 530 yıl öncesinde fonksiyon, planlama ve yapı kabuğu özellikleri açısından çevre koşullarıyla uyumlu olduğu, kullanıcılar açısından gerekli konfor şartını sağlarken enerji tüketiminin de kabul edilebilir olduğu tespit edilmiştir.

Öne Çıkanlar

- Yeniden işlevlendirilen tarihi yapıların günümüz konfor koşullarına uygunluğunun incelenmesi gerekmektedir.
- Tarihi yapıların fiziksel çevre koşullarına uygunluğuna yönelik yapılan analiz sonuçları gelecekte inşa edilecek yapıların sürdürülebilir üretimlerine ışık tutabilir.
- Sürdürülebilir yapı üretimi fiziksel çevreyle entegre tasarıma bağlıdır.

Anahtar Sözcükler

II. Beyazıt Külliyesi Şifahanesi; Sağlık yapıları; Tarihi binalar; İç ortam kalitesi; Fiziksel çevre koşulları

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INTRODUCTION

The comfort and health of the users in a built environment depend on the indoor environmental quality (IEQ) of the building (Horr et al., 2016). During the design and planning for a comfortable and healthy indoor environment in a building, all the parameters and functions of the building such as the location of the building, and physical outdoor environmental conditions which determines the quality of the indoor environment, user profile, and preferences, materials used in the interior, thermal comfort, indoor air quality (IAQ), acoustics, and lighting comfort should be considered. Thus, this provides a sustainable approach in the architecture. In fact, it is seen that historical buildings, foremost the traditional structures, are designed by paying attention to these parameters. From this perspective, the expected and widely used concept of sustainability for today's buildings is not too far for these buildings. Even more, despite being built hundreds of years ago, they can be exemplary for today's sustainable building design within the context of user comfort and health, and vernacular architecture (Roura, 1998; Philokyprou & Michael, 2021). Although these buildings are not constructed with an awareness of sustainability, with some improvements, they have a high potential for it (Magrini & Franco, 2016).

Although the historical buildings were constructed to meet the needs of the period they were built, the use of such buildings continues today. However, studies show that these buildings have some comfort condition problems and are even responsible for large amounts of energy consumption and CO_2 emissions (Colla et al., 2016). Therefore, it is important to evaluate the existing conditions of these buildings before and after used (Akande et al., 2016; Benchekroun et al., 2020). As such, creating an indoor environment suitable for the comfort conditions of the users means the creation of a suitable type of microclimate for the specific structure (Silva & Henriques, 2014; Timothy et al., 2016). In addition to regulating the IEQ of a building, the creation of a microclimate is essential for the life and survival of a historical building (Kramer et al., 2016). It is possible to regulate the quality of the indoor environment of historical buildings by creating a suitable microclimate for both the users and the building itself (Corgnati et al., 2009; Andretta et al., 2016). However, it should be noted that the created microclimate affects the health of the building as well as determines its energy consumption.

In recent years, following the growing importance of energy efficiency, the number of studies on the thermal behavior and energy efficiency of traditional buildings has been increasing in the literature (Mueller, 2013; Rota et al., 2015; Flores, 2016; Khledj and Bencheikh, 2021). Because many of historical buildings cannot be survived by remaining their original functions today. This makes re-functionalization or adaptive reuse of some historical buildings a current issue due to original function is not proper in today's living conditions (Bullen & Love, 2011; Çakır et al., 2020). Although it is possible to use historical buildings with many different functions, this re-functioning is commonly in the form of an example of presentation of the original function of the building itself as a museum or an artefact from the past to the present by hosting historical or contemporary artefacts. In any event, it is needed to assess the existing conditions under the current demands and today's comfort conditions by analyzing their IEQ. Thus, improvements for the buildings and the gains from these improvements could be determined and evaluated (Kim, 2018).

This study aims to examine the IEQ and energy consumption of a historical building depending on their physical environmental data. For this purpose, health complexes, which are one of the important building types in Ottoman Architecture, have been chosen as a case study. Because it is more important to provide the thermal, visual and acoustic comfort conditions in health buildings than in other buildings. It must be noted today many of these buildings are used as a museum where the buildings present themselves with their architectural features of their time and an experience on living their original function. In this scope, 2nd Beyazid Health Complex has been investigated to set a good example in examining all IEQ parameters and their effects on energy consumption after using as a museum. The building is a unique example due to (i) the existence of summer and winter spaces in the same building and their effects on thermal comfort of the building, (ii) the effect of the landscape elements, both in courtyards and the outside of the building itself, used for the treatment of the patients with the scent and the natural ventilation conditions on the IAQ, (iii) the effects of the building's gradual structure and various windows openings on the façade on the lighting comfort, and (iv) the effects of the one of the important mission of the building for treatment with music to the acoustic comfort. As a result of the examination of the building, it will be determined how these four features of the 2nd Beyazid Health Complex affect the IEQ of its museum usage. Besides, the energy consumption of the building will be calculated and it will be decided whether there is a need for improvement in accordance with today's energy efficiency policies.

HEALTH COMPLEXES IN OTTOMAN ARCHITECTURE

Healthcare facilities have an important place in Ottoman Architecture. Ottoman Empire, which was one of the important great states of its period, hosted health facilities belonging to civilizations with many different cultures. There was no need to build new health facilities in the places where Seljuk and Mameluke health facilities were located, and they continued their operations through foundations (Terzioğlu, 1998). Ottomans built new healthcare buildings or complexes in cities conquered during their periods such as Bursa, Edirne, Istanbul, Thessaloniki, Belgrade, and Budapest (Terzioğlu, 1998).

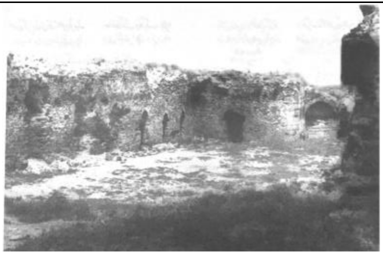
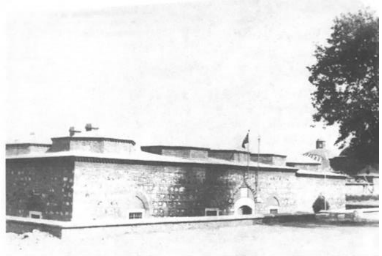
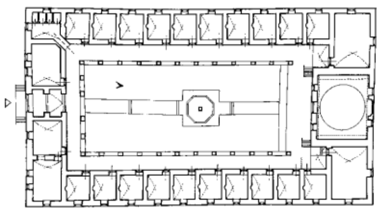
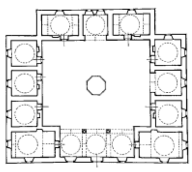
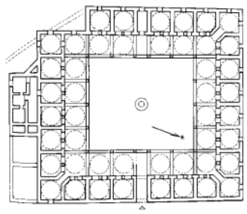
These buildings which are named either as a 'Darussifa' or 'Sifahane' in Ottoman Architecture were planned together with madrasas that aim to serve the public health and, were also place where medical education is carried out, as such, these buildings became exemplary healthcare facilities for many societies in their period. The most distinctive architectural feature of the Ottoman health buildings is that they are planned as a part of the complexes consisting of mosques, madrasahs, imaret, tabhane, caravanserais, hammam (Turkish bath), bazaar, fountain, etc. (Terzioğlu, 1998; Cantay, 2014). These complexes create small cities within the city and meet all socio-cultural and health-related needs of the people like a social center. Besides, it is seen that psychological disorders are treated in these centers as well as physiological diseases. It is seen that elements such as water, fragrance, light, and music are used to heal patients, especially in the planning of the buildings for psychological treatment.

Darussifas have a certain architectural style. Most of them are built in the shape of four iwans around a courtyard (Şengül, 2014). However, Edirne Sultan 2nd Beyazid Health Building is architecturally different from this planning. It is seen that the Seljuk traditions were continued in the Ottoman health buildings, but new architectural ideas were also applied during and after the Renaissance period (Terzioğlu, 1998; Cantay, 2014). Although not all of these buildings are survived today, darüussifas in Manisa and Edirne are restored and used as museums now.

During the Ottoman period, the construction of the healthcare buildings continued from the 15th to the 17th century. There are 8 known health complexes in this period. 15th-century examples are the Darussifa of Yildirim Beyazid in Bursa, Mehmet the Conqueror in Istanbul, and Sultan Beyazid II in Edirne. While the Haseki Hurrem Sultan, Atik Valide and Nurbanu Valide Sultan darussifas in Istanbul and the Hafsa Sultan Darussifa in Manisa are examples of the 16th century, the only building in the 17th century is the Sultan Ahmet II Darussifa in Istanbul (Terzioğlu, 1998; Cantay 2014). In this study, a sample of darussifas representing from 15th to 17th century has been comparatively analyzed. For this, buildings in different locations were chosen (Table 1). Accordingly, only the Hafsa Sultan Darussifa, among the buildings in Table 1, has survived today. It is must be noted that there is no study to give the original plan of Sultan Ahmed Darussifa, the only health complex built in the 17th century (Cantay, 2014).

According to the Ottoman culture, it is seen that all darussifas are located in a health complex. They are generally independent buildings within the complex. It is seen that the most basic difference in terms of plan scheme is in Yıldırım Beyazid Darussifa, which is one of the 15th-century examples. While other schemes have a squarer central plan, this is rectangular in Yıldırım Beyazid. In fact, this darussifa is different from the usual madrasa plan. While the classroom in the madrasah can be chosen as a unit dominating the building in the plan of the Yıldırım Complex, the classroom is in the integrity of the monoblock structure in the darussifa (Cantay, 2014). Moreover, in the planning, the buildings were built with courtyards. This is a common practice seen in the health buildings of the period. This water element is used for cleaning and hygiene in treatment. Considering the importance of water in health, the location of these buildings is decided to be located either on or near a water source. Among the buildings shaped around a courtyard, in Hafsa Sultan Darussifa, unlike the other two hospitals, the spaces open directly to the courtyard. However, in Yıldırım Beyazid and Sultan Ahmed II darussifas, there is a row of porticoes in front of the spaces. Here, the spatial organization is arranged as open, half-open, and closed in a hierarchy. Accordingly, it can be said that the plan scheme and spatial organizations aim to provide patients with an appropriate IEQ.

Table 1 - Comparison of the health complexes in different periods (created by authors over Cantay, 2014).

15th Century	16th Century	17th Century
Darussifa of Yıldırım Beyazid *Bursa* - H. 802 / C.E. 1400	Darussifa of Hafsa Sultan *Manisa* - H. 946 / C.E. 1539	Darussifa of Sultan II. Ahmed *Istanbul* - H. 1018 / C.E. 1609
		
Other Units in the Complex Mosque, Madrasah, Tomb, Turkish Bath, Imaret	*Other Units in the Complex* Mosque, Madrasah, Infants' School, Imaret, Hankah	*Other Units in the Complex* Mosque, Madrasah, Infants' School, Tomb, Public Fountain, Turkish Bath, Imaret, Stores, Houses, Crypt
		
Plan Scheme It has a rectangular form (53x30 m) in the north-south direction. The entrance to the building is provided by the door on the north. The entrance area opens to the courtyard surrounded by a pillared and arched portico system in three directions. The rooms (10 + 10) with a barrel vault top cover are located in the east and west direction. The classroom is directly connected to the south and expands towards the courtyard.	*Plan Scheme* Located in the north of the complex, the building is accessed through a three-part entrance. It has an almost square (17x10 m) courtyard. There is an octagonal pool in the center of the courtyard. Rows of spaces surround the three sides of the courtyard. There are 9 closed rooms in this area. There are two iwans in the east and north direction.	*Plan Scheme* The square planned building is shaped around a courtyard with portico. There is a fountain pool in the middle of the courtyard. 18 closed independent units (rooms) to treatment of the patients. North, east and west corner of the building has semi-open spaces. It is covered with lead-covered domes. There is a hammam (Turkish bath) near to the south-east wall.
Architectural Features *Construction Material and System* Masonry Structure constructed with Brick, Stone and Rubble Stone *Wall Order* Exterior wall consists of one-line stone and two lines brick – a mixture of rubble stone wall bond	*Architectural Features* *Construction Material and System* Masonry Structure constructed with Brick and Rubble Stone *Wall Order* Exterior wall consists of one-line rubble stone and two lines brick	*Architectural Features* *Construction Material and System* Masonry Structure constructed with Cut Stone *Wall Order* Not available data (n/a)
Current Use and Condition Only some parts of wall exist Demolished	*Current Use and Condition* Re-functioned as Museum Restored	*Current Use and Condition* Entrance Gate & Turkish Bath exist Demolished

The buildings were built on masonry, the traditional construction system of the period. Apart from Yıldırım Beyazid, which was an early period example among the Ottoman period darussifas, domes were used as top cover. In the walls, cut or rubble stone was used together with brick, considering the materials available in the surrounding of the building. Domes or vaults were covered with lead. It is mentioned that Bursa tiles were used inside of the building in Yıldırım Beyazid (Cantay, 2014). Hafsa Sultan is an important building that shows the characteristics of the 16th century Classical Ottoman architecture. The building has a balanced decoration with building materials (Cantay, 2014).

Brief History of 2nd Beyazid Health Complex

After the Fatih Complex in Bursa and Istanbul, the Beyazid Complex was to be the third widely comprehensive complex in the Ottoman Empire (Tuna, 2015). The Sultan 2nd Beyazid ordered the preparation of the construction materials and the complex was decided to be built close to the Tunca River in Edirne (Figure 1). Deep moats were dug to realize the construction and prepare the foundations of the building (Kazancıgil & Gökçe, 2012).

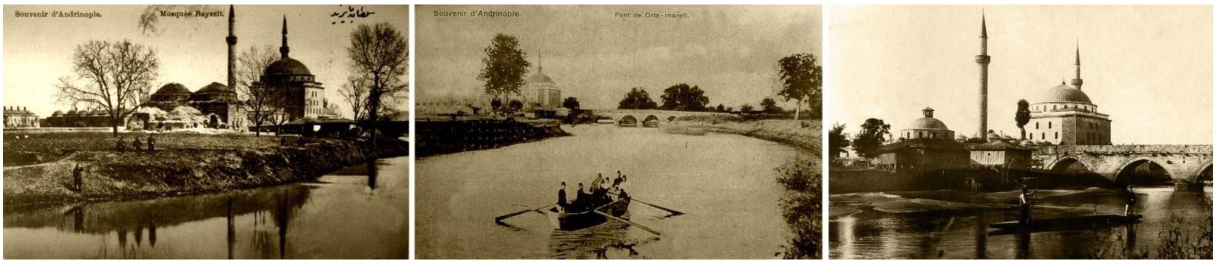


Figure 1 - Old photographs of 2nd Beyazid Health Complex from Tunca River (Trakya University, 2013).

2nd Beyazid Complex is a group of buildings, which consist of important health, education, worship, and social service structures of the 15th century (Figure 2). The darussifa, which is located in the complex, together with the sifahane, is the building that gives this complex its most distinctive feature. Although there are definitive records for the architect of the complex, two different names are mentioned. Some records mention the name Yakub-Şah Bin Sultan; however, it is well accepted that Mimar Hayrettin was the main architect of the complex, as he was the chief architect of II. Beyazid period. The complex was constructed between 1484 and 1488 (Tuna, 2015). The complex includes 8 independent structures; a mosque as a worship unit, a madrasah and a primary school as educational units, darussifa as a health unit, and two imaret structures, a hammam (Turkish bath), and a mill as social service units. However, the bath, mill and the primary school did not survive to the present day.

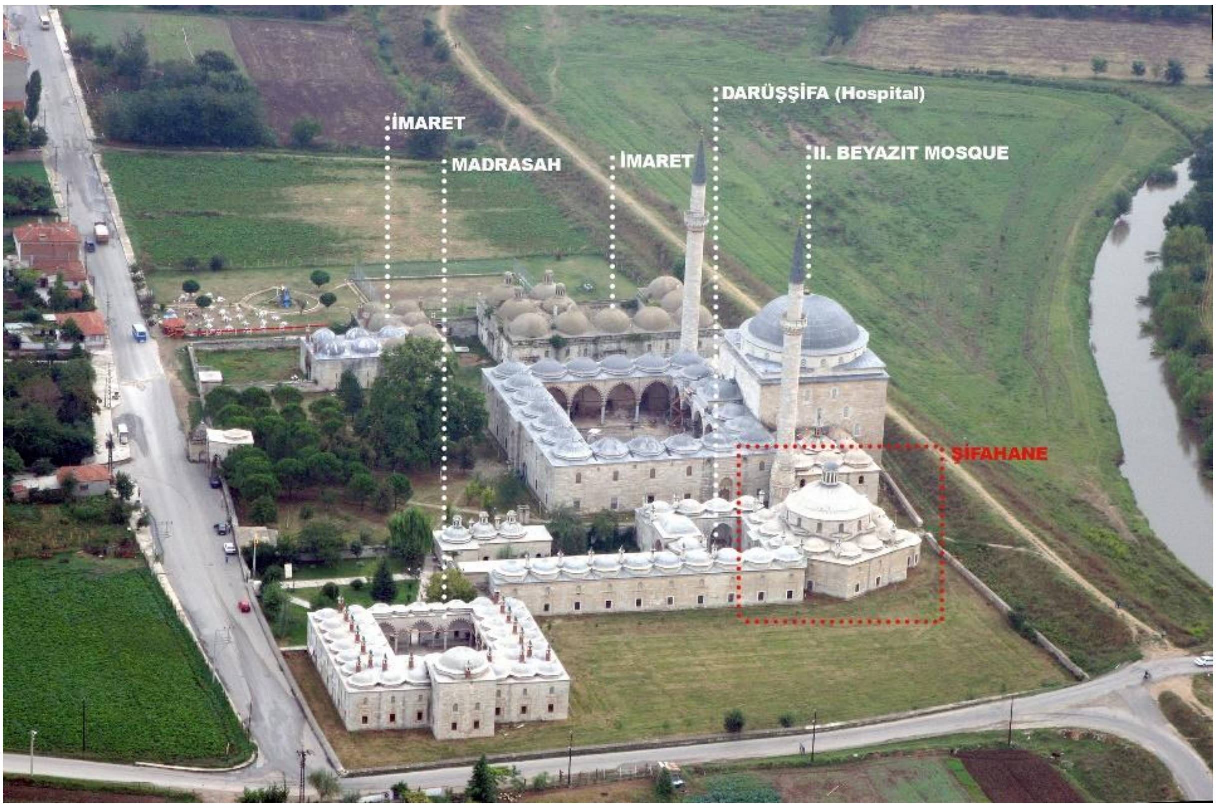


Figure 2 - Sifahane and other units in the 2nd Beyazid Health Complex (created by authors over Edirne Regional Directorate of Foundations, 2005).

The darussifa that gives its characteristics to the complex is located at the right side of the mosque in the center, along the northwest-southeast axis (Figure 2). The building is formed with courtyards, which are connected to the unique hexagon-centered domed space. As one of the earlier examples of today's hospital structures, the darussifa is composed of 3 main sections (Cantay, 2014). These sections include, (i) the service section with polyclinics opening to the first courtyard in the front section, and units such as a pantry, kitchen, and laundry, (ii) the section with 4 rooms and 2 sofas used as pharmacy and senior staff room located around the second courtyard (inner courtyard) and (iii) the sifahane section with beds where the summer and winter treatment areas are located. There are 6 rooms and 5 open sofas in the sifahane section. One of the sofas, which was built towards the river, is used as a musical stage while others are used during the summer. The features of the darussifa settlement and the properties of its spatial usage are shown in Figure 3.

The building was built with a stone masonry system, one of the traditional construction techniques of the period. Cut limestone was used as the main building material (Cantay, 2014) (Figure 4). The carbonated limestone (called as kufeki), which is composed of calcium carbonate ($CaCO_3$) composition, has a soft, workable, and hollow structure. This material contains dolomite, calcite, and quartz (Yıldız, 2012). In addition, brick was used in the hearth of the rooms; wood in the window and door frames and in the eaves; and, also metal materials as window railing and covering material. Elements, such as interior walls, ceiling (dome), etc. were finished with plaster (Figure 4).

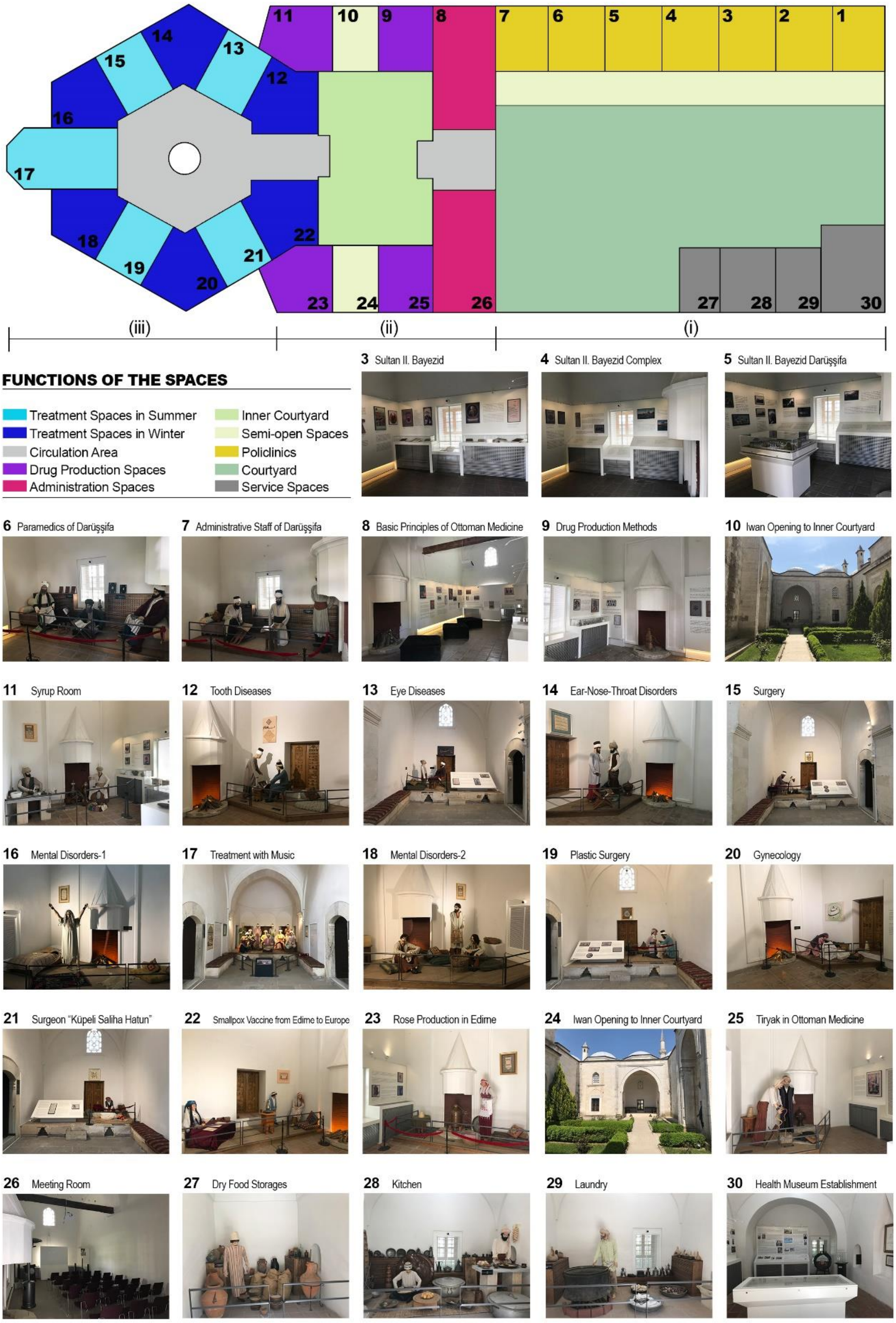


Figure 3 - Functions of the spaces in the Darussifa of 2nd Beyazid.

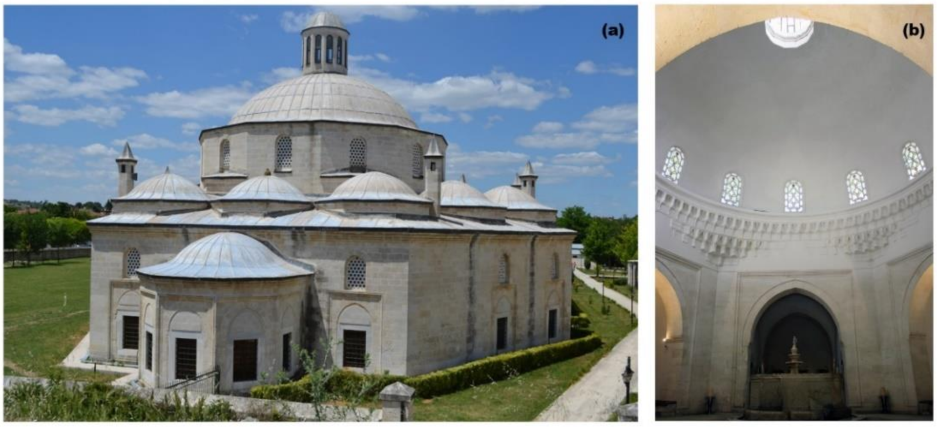


Figure 4 - Building masonry wall (a), plastered interior walls and dome (b).

Darüşşifa, which was used until the end of the 19th century, was abandoned after the 1876-1877 Ottoman-Russian war. As a 530-year-old building, Darüşşifa has gone through different restoration and maintenance processes at various times. It was reopened after the restoration in 1894-1896, the oldest known, and was used for a while in the isolation and treatment of mental patients. In 1910, another restoration was carried out by the German architect Cornalius (Trakya University, 2013). The building, which was closed again during the Balkan War (1912-1913), was in a hulk, although it was restored during this period (Kahya Erdemir and Demirhan, 2000). The General Directorate of Foundations restored the hulk sections in 1964 and prevented the building from being demolished (Şengül, 2014). According to the sources of the Edirne Cultural Heritage Preservation Regional Board, there are no detailed documents regarding the restoration works of this period. Figure 5 shows the condition of the building before the restoration works. It is stated that during this restoration process, the stone works, imitation screed works, and the oven and soup kitchen parts of the building were preserved against external effects. Again, the collapsed domes and arches of the madrasah were repaired in this period (Edirne Cultural Heritage Preservation Regional Board Archive, 2022). The building, which was later transformed into a Health Museum in 1977, was transferred to Trakya University in 1984 by the General Directorate of Foundations. The building was renovated by Trakya University with a comprehensive restoration in the same year (Trakya University, 2013).

Figure 5 - Before restoration in 1964; Darüşşifa (a), courtyard (b) and interior of Şifahane (c) (Edirne Cultural Heritage Preservation Regional Board Archive, 2022).

In 1993, some conservation works were carried out on the building within the scope of transforming the Darüşşifa into a Health Museum within the body of Trakya University. After the restorations were completed by the university, some parts of the Darüşşifa and its madrasah were used as educational spaces for a while. After the approval of the Ministry of Culture, General Directorate of Monuments and Museums, the "T.Ü. Sultan II. Beyazid Complex Health Museum" was put into service. In this process, the heating system was included in the building. During its use as a museum, simple repairs were carried out at various times in line with the needs of the building. While the lead coatings of the domes were renewed in 2002, the muqarnas of the kitchen area and the furnaces and ovens were restored in 2006. In 2008, the facade of the complex was cleaned (Figure 6), and then a restoration project was prepared for the facades in 2009. In the same year, garden and landscaping arrangements were made (Edirne Cultural Heritage Preservation Regional Board Archive, 2022).

Figure 6 - Before (2008) and after (2018) facade cleaning.

In 2011 and 2015, the restoration of the building was carried out in the museum for the compositions of medical education and practices (Radikal, 2015). The most recent restoration of the building was made for the garden and landscaping of the complex (Karakaya Aytin et al., 2021).

Significance of the 2nd Beyazid Health Complex

The significance of the building can be classified under two topics. One of them is the central plan of the building and the other is the treatment methods used in the complex. The central plan was often used in many buildings like baths, religious buildings (basilica, churches, and mosques), etc. from Roman to Ottoman. It is seen that the planning of health buildings or facilities emerges in different ways in the history (Miller, 1997). With its central plan, 2nd Beyazid Health Complex differs from previously constructed health facilities. The building was centrally planned to emphasize the provided services and social benefits to the patients (İnci, 2004; Cantay, 2014). In this way, the building was affected by the previous health buildings while it became an example for the buildings after it. Thirty years after the Ospedale Maggiore in Milan, which was considered as a turning point of hospital architecture in the Renaissance period and planned by Antonio Filarete in the form of a cross to provide a central system in 1457, the 2nd Beyazid Complex has a superior position because it provides acoustics for music therapy and it is the first hospital known to be built in the central system (Terzioğlu, 1985). Furthermore, in his work published by L. Ch. Sturm in Augsburg in 1720, the fact that the centrally planned hospital project with the ventilation lantern placed on the central dome is similar to that of the Beyazid Darussifa, is an indication that the building is a guide to the next period (Figure 7). In fact, 400 years after it, there are many hospitals designed with a similar approach in Europe and America. It can be said that in 19th-century hospital buildings such as Stuivenberg Hospital in Antwerpen (1855), Presbyterian Hospital in Philadelphia (1885), Bradford Children's Hospital (1890), and Seaford Military Hospital in Liverpool (1884) were used similar central plan (Kuhn, 1897; Şengül, 2014; Tunca, 2014; Duymaz and Topaloğlu, 2015).

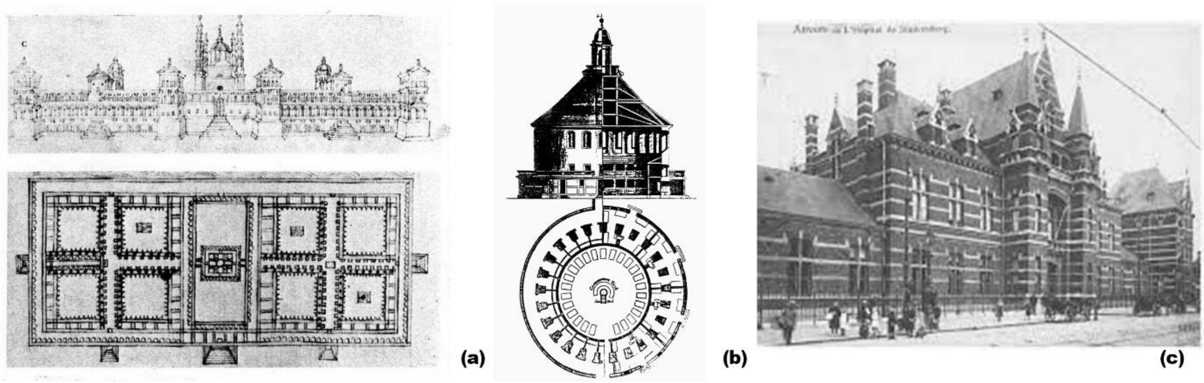


Figure 7 - Ospedale Maggiore in Milan (a), L. Ch. Sturm Hospital Drawing in Augsburg (b) and Stuivenberg Hospital in Antwerpen (Terzioğlu, 1998).

The second significance of building depends on the treatment approaches and methods used in the complex. Previously all patients were cured in the health complex, however, in the following years mostly mental patients were treated. Fragrances, water sounds and music were used together in the treatment of patients. It is stated that fragrant plants grown in the garden of the darussifa are good for the mental health of the patients. Located on the banks of the Tunca River, water was taken from the river with water cabinets and cycled to the fountain in the Health Complex. The sound made by the water and the coolness it provided were also used in the treatment of patients. In addition, patients were employed in hand craftsmanship and small jobs within the hospital to be kept engaged. The treatment with music, which is the most important feature of the hospital, was scientifically introduced for the first time in BC. 580-500 by Pythagoras. Moreover, Farabi and İbn-i Sina also studied music treatment methods for mental patients (İnci, 2004). Figure 8 which is a miniature, shows the treatment with music in the complex (Erke, 2002). This makes the building unique and creates its character.

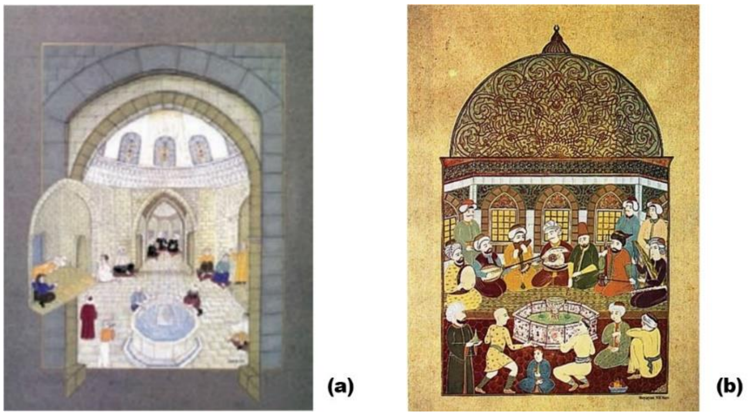


Figure 8 - Mental patients in the darussifa (a), an insane patient during a musical therapy session at the complex (b) (Erke, 2002).

In his 'Book of Travels' or Seyahatname, Evliya Çelebi calls the complex "Beyazid Khan Hospital" and describes it briefly in terms of its location and its spatial features. He describes the complex as a "Healing Dormitory" inside an Eden, which is located at the right of the large outer courtyard of the Beyazid Mosque. He mentions the Stone Dome is a bright space and has a hammam-like dome with glass clerestory windows. It was mentioned that there was a flag on top of this dome and it blew according to the wind direction. It is stated that there are fragrant flowers in its garden and has a musical delegation who comes three times a week for a performance and that the patients were healed in this way. The importance given to the nourishment of the patients was also stated by providing examples as to meals were given three times a day, and in which various game animals were cooked according to the wishes of the physicians (Kazancıgil & Gökçe, 2013).

Built five centuries ago with a human-oriented approach, the structure with its grand physicians and staff render service for a long time. It is seen that during the said period patients are left to die without treatment in other countries (Kazancıgil & Gökçe, 2013). In this context, the Darussifa of 2nd Beyazid has many aspects worthy of study.

As being a museum the building, which won the Council of Europe Museum Prize in 2004, was also accepted to the "Excellence Club" by the European Heritage Association (Trakya University, 2013). Today, the building is among the most visited places by local and foreign tourists in Edirne. Moreover, the complex, approved candidate for UNESCO World Heritage List, is in the tentative list (UNESCO, 2016).

RESEARCH PROCESS AND METHODS

The healthcare facilities are one of the important structures of Ottoman Architecture. Edirne, which was the capital city of the Ottoman Empire for 92 years, houses one such complex called 2nd Beyazid Complex. It is seen that 2nd Beyazid Complex settlement and/or its structures are evaluated in various ways in many national studies (Kazancıgil & Gökçe, 2012; Şengül, 2014; Tuna, 2015; Ergüven & Yılmaz, 2020). However, unlike previous studies, this study analyses how physical environmental data guides the planning and design of a traditional building and their effect on IEQ and energy consumption of the building.

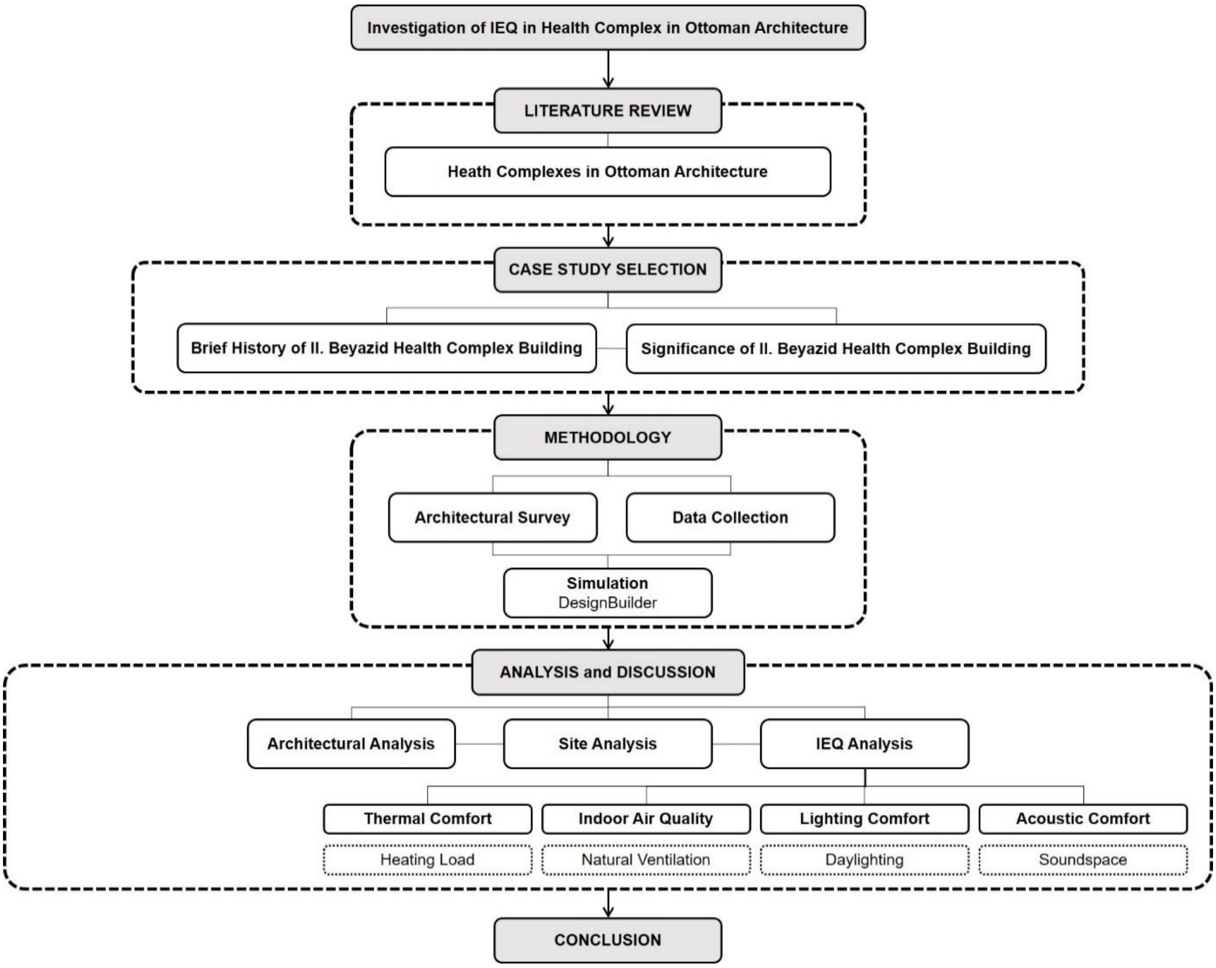


Figure 9 - Research process diagram.

To evaluate historical buildings concerning the physical environmental data, many different analysis techniques and methods, such as simulation, monitoring, CFD analysis, are used separately or in combination with each other in the literature (Matinez-Molina et al., 2016; Ide et al., 2022). This study was carried out in four main steps. Figure 9 summarizes the all steps within including their scopes and conducting methods to obtain data. The process, which begins with a literature review, provides the research background within a historical way and shows the importance of healthcare complexes in the Ottoman Architecture. Thus, the similarities and the differences in the health complexes were presented in a comparative way. This also helps to show the uniqueness of the 2nd Beyazid Health Complex. After the historical examination, the data were collected to analyze the building for IEQ and energy consumption. For this, architectural documents were used to determine the architectural features of the building and meteorological documents were used to determine the outdoor conditions. In the analysis step, while the physical outdoor environmental conditions are evaluated according to the effects of the building on the site plan, the indoor conditions are addressed in terms of thermal comfort, IAQ, lighting, and acoustics. Analyses were made on the heating load of the building for thermal comfort conditions, natural ventilation conditions of the building for IAQ, natural lighting conditions for lighting, and soundspace for acoustic comfort. In this context, while the analysis of IAQ and acoustic comfort were carried out by using qualitative methods such as direct observation, on-site examination, and documented with photographs, thermal and lighting comfort were examined by using quantitative methods such as simulation and measurement with DesignBuilder. Consequently, the results of the analysis were evaluated and interpreted based on the results obtained in the literature.

ANALYSIS OF THE 2ND BEYAZID HEALTH COMPLEX

The analysis of the 2nd Beyazid Health Complex is discussed under 3 headings as indicated in Figure 9. These are the architectural analysis (survey), site (environmental) analysis and IEQ analysis of the darussifa, respectively. The analysis of the building is primarily examined in terms of architectural history in comparison with other buildings of its period. Thus, it is aimed to reveal the similarities and differences of the building with other buildings in terms of architectural planning, construction technique, materials and technologies, which affect and determine the comfort condition of the building. Under the site analysis, the effects of outdoor environment on the planning of the building and its indoor environment conditions are evaluated. Finally, how both architectural and outdoor impacts of the building affect the building's IEQ and energy consumption is discussed.

Architectural Analysis

As it is stated in the previous sections of the study, 2nd Beyazid Health Complex especially the Darussifa was influenced by some buildings in its period or before while it was a pioneer for the next generations. In this section architectural features of the building are discussed with others in its time and later examples to present the similarities and differences of the darussifas comparatively. In Figure 10, plan schemes of the 2nd Beyazid Darussifa and some other buildings are shown. 2nd Beyazid Darussifa is different in terms of its plan scheme, both according to its own period and the buildings after it. Although the general form of the building is similar to Sultan Beyazid, it is different in terms of spatial organization. It is seen that the building was planned in connection with the madrasa and has a structure with more than one courtyard. This planning follows a hierarchical order from general use and access to more specific treatment areas according to the functions of the spaces (Figure 4). Another important difference is that the sifahane section has central hexagonal planning and this area is covered with a single dome in the center. Thus, the building can offer an IEQ according to summer and winter conditions. Again, as in other buildings, water is located at the center of this area as an important treatment element.

Another difference in the building is the materials used. Although it was built with the masonry system, it is seen that kufeki stone with high thermal performance was used as a basic construction material. Considering that the selection of material used in the building has a crucial impact on the IEQ of the building, especially thermal comfort (Chandel et al., 2016), this leads to differing from other buildings.

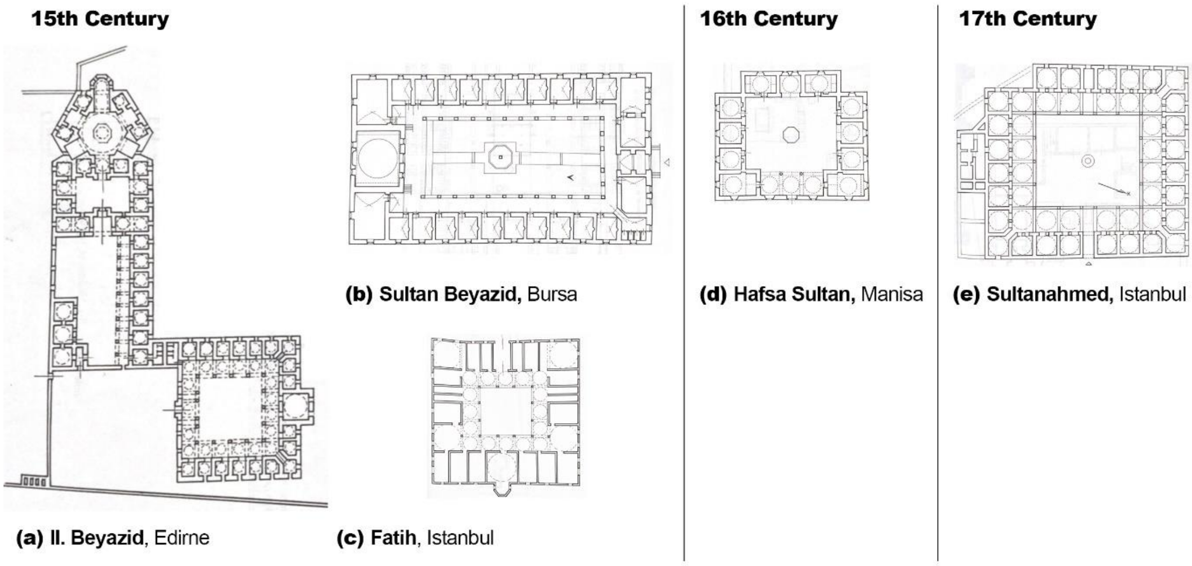


Figure 10 - Comparison of the plan schemes of darussifas (Cantay, 2014).

In summary, in many respects like building planning, space organization, material, location selection, etc. 2nd Beyazid Darussifa is in a unique position as a different structure of both its period and its aftermath. Therefore, it is very important to investigate the suitability of the existing conditions of use to today's needs.

Site Analysis

One of the most important design inputs concerning buildings from all eras is the climatic properties. The data about the site also play a critical role in terms of settlement decisions. Because the physical environmental data of the settlement determines the architectural design and the building envelope. In Table 2, the physical environmental data of the building is summarized. The building is located at the edge of the Tunca River which is a river sourced in Bulgaria and that enters Turkey from Edirne. In terms of climatic conditions of Edirne, the building is located in a temperate humid climate zone; however, it is also exposed to a humid environment due to its closeness to the river. It can be argued that for a city where there is a relative humidity of 70% on average, the building faces a higher rate of relative humidity.

The direction of the sun path and the prevailing wind is shown on the building's site plan and presented in Figure 11. Although the darussifa is located around its own courtyards, it is also connected to the courtyard in front of the mosque in the center of the settlement (Figure 3-4). However, the fact that the courtyard in front of the mosque is intensely planted provides control of the negative effects of the prevailing cold wind.

Table 2 - Physical environmental data of the settlement.

Settlement	*Location*	Yeni İmaret District
	Topography	Lowland topography near the river
	Access	With historical bridges from the city center to the settlement
Climate	*Climate Zone*	Temperate humid climate
	Temperature	18 °C with 70% relative humidity
	Prevailing Wind	North and Northeast directed with 7,4 km/h mean speed
Vegetation & Landscape		Dense trees in the inside of the settlement, Landscape of various odorous plants
Water Element		Outside the settlement: River (Tunca River); Inside the settlement: Pool, well

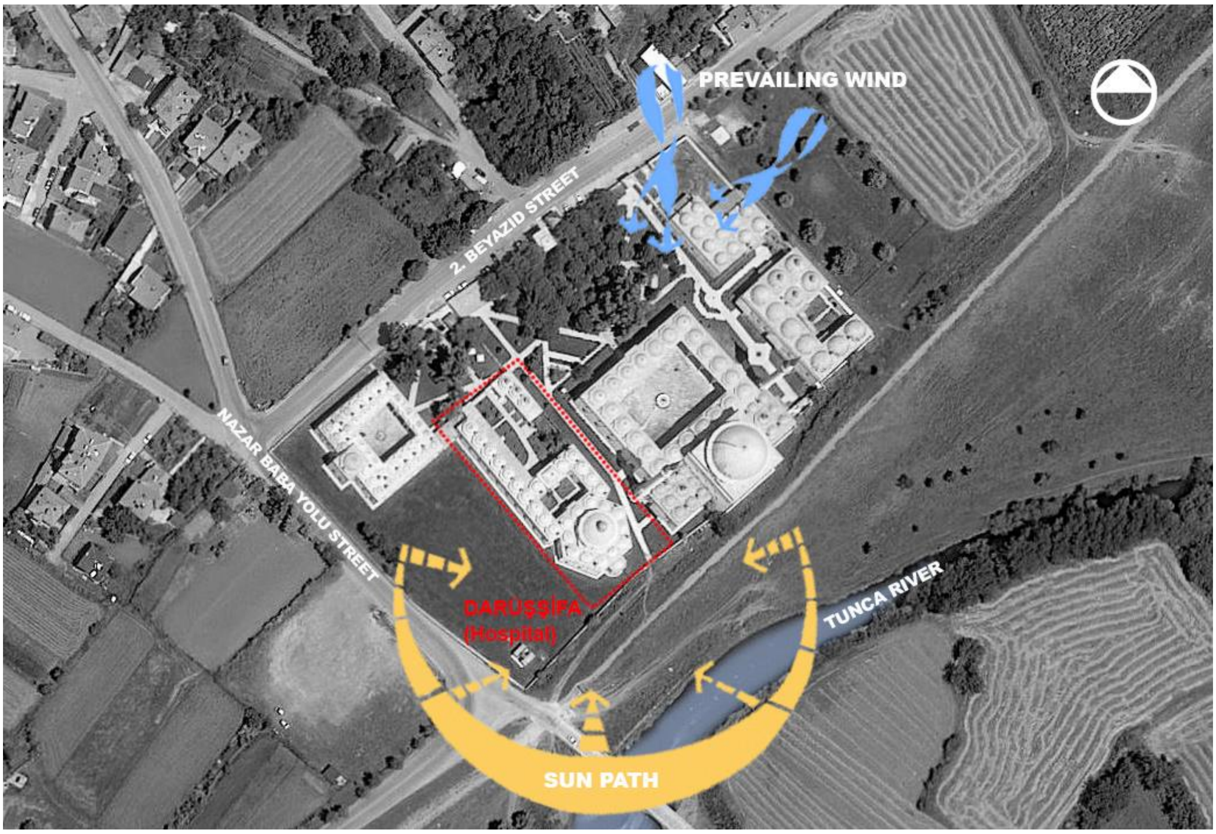


Figure 11 - Site analysis of the settlement.

When it is evaluated in terms of vegetation and landscape design, it can be observed that the courtyard in front of the mosque is intensely afforested, at the same time; there are plenty of pleasant and aromatic plants, which is one of the treatment methods of the sifahane. Due to the location of these plants and along with the prevailing wind, the fragrances are able to reach to the darussifa.

By considering the sun path and the daylight, the darussifa was placed in the south and south-west part of the site. In fact, the polyclinics being located to the south specifically contributes positively both to the comfort conditions of the building and the health of the patients (Figure 11).

IEQ Analysis

IEQ includes air quality inside the building, thermal, lighting, and acoustic comfort conditions, other ergonomic conditions such as odor and ambient vibrations and the effects of these on the user. However, thermal comfort, IAQ, lighting, and acoustic comfort parameters constitute the most basic components for IEQ for all types of buildings. Therefore, the IEQ of the sifahane of 2nd Beyazid Complex is examined according to these four parameters. As indicated in Figure 9 in the study, while DesignBuilder, a simulation program, was used for thermal and lighting comfort analyses, architectural plans and sections and photographs of the building were examined for IAQ and acoustic comfort. For the analysis, the modeling has been carried out in DesignBuilder by using the plan and material properties of the building (Figure 12). Since the study only examines the sifahane section of the complex, the areas outside of this building were created as a solid model (purple and green areas) and included as such in the simulation.

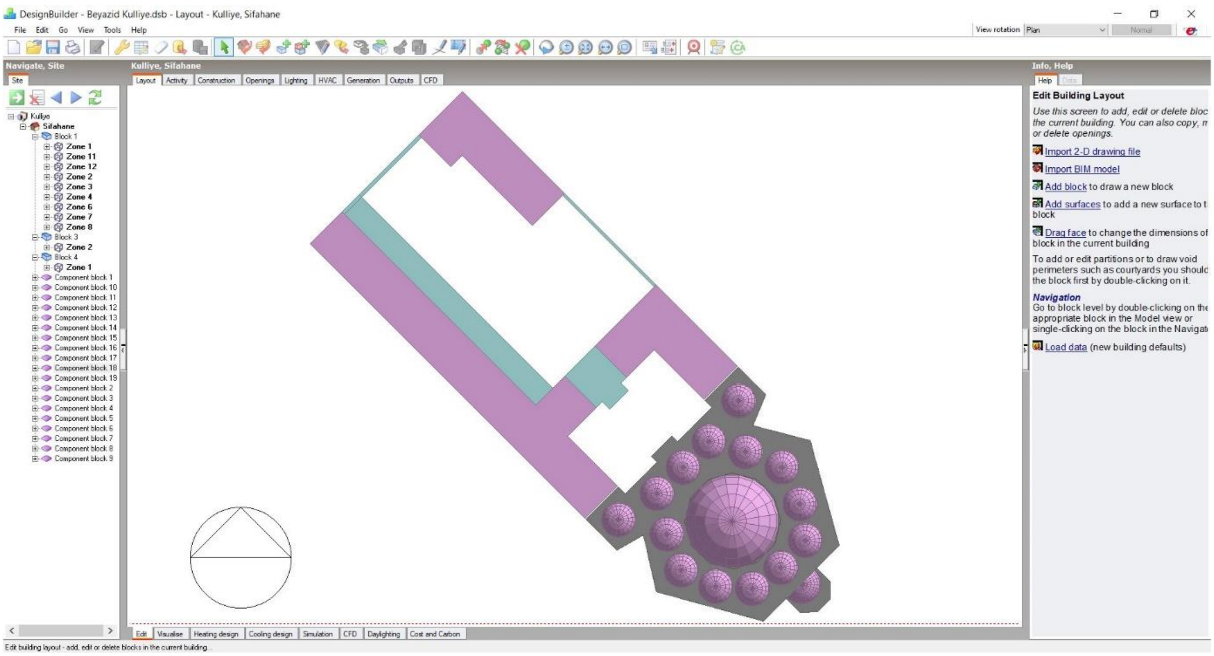


Figure 12 - DesignBuilder model of the sifahane.

Thermal Comfort

Considering the restoration processes of the Şifahane in the historical process, the entire building envelope, especially the body walls of the building, has survived to the present day with minor interventions. In this process, the interventions made on the walls were simple maintenance and repair operations, and the wall surface cleaning and joint finishing operations were carried out (Edirne Cultural Heritage Preservation Regional Board Archive, 2022). Built with a masonry system, the thickness of the stone walls reaches from 120 cm to 160 cm in the sifahane. Regarding the thermal performance, walls with high thermal resistance and thermal mass properties contribute positively to the building's winter and summer comfort. The thermal performance of the building was analyzed with the help of the DesignBuilder simulation program. In the simulation program, properties of the building envelope materials were assigned considering the originality of the building and its interventions during its mentioned restorations. In Figure 13, the thermal transmittance value (U-value) calculated for the sifahane and the condensation verification results on the wall section of the building are shown. Accordingly, the U-value of the building envelope was calculated as 0.857 W/m^{2}K. This value can rise to 3.00 W/m^{2}K in reinforced concrete structures of today. The maximum U-value expected from a building envelope also varies according to the user comfort limit values determined specific to the geography of the buildings. Due to the location of the case building, this limit was determined to be 0.50 W/m^{2}K in the TS825 Thermal Insulation Requirements for Buildings which is a national standard to regulate building envelope in Turkey (TS825, 2013). It must be noted that although the U-value of the building envelope is over the limit, the low U-value that could be obtained without the use of insulation was achieved with the construction techniques of that period. However, it has been determined that there is no condensation on the walls in terms of water vapor transmission. This is an important point to obtain a healthy indoor with thermal comfort. In addition, the thermal mass feature of the masonry stone material also contributes to the comfort of the indoor.

Inner surface	
Convective heat transfer coefficient (W/m2-K)	2,152
Radiative heat transfer coefficient (W/m2-K)	5,540
Surface resistance (m2-K/W)	0,130
Outer surface	
Convective heat transfer coefficient (W/m2-K)	19,870
Radiative heat transfer coefficient (W/m2-K)	5,130
Surface resistance (m2-K/W)	0,040
No Bridging	
U-Value surface to surface (W/m2-K)	1,003
R-Value (m2-K/W)	1,167
U-Value (W/m2-K)	**0,857**
With Bridging (BS EN ISO 6946)	
Thickness (m)	1,2500
Km - Internal heat capacity (KJ/m2-K)	170,5600
Upper resistance limit (m2-K/W)	1,167
Lower resistance limit (m2-K/W)	1,167
U-Value surface to surface (W/m2-K)	1,003
R-Value (m2-K/W)	1,167
U-Value (W/m2-K)	**0,857**

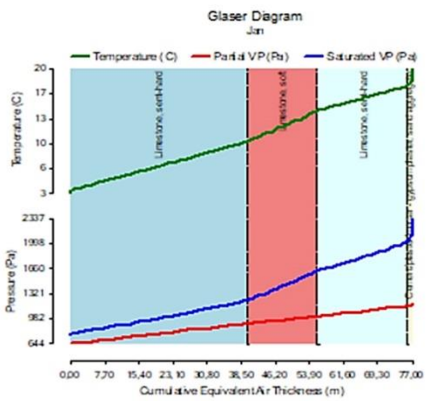


Figure 13 - Thermophysical properties of the building envelope and the condensation analysis.

Figure 14 shows the calculated amount of annual energy consumption, temperature and relative humidity values for the building. In the figure, while the limit values of different standards and regulations was used to compared with obtained data of indoor temperature and relative humidity, for the comparison of energy consumption, this was made with the help of previous studies' results in the literature.

According to the simulation prepared by the current conditions of the building, the annual heating energy consumption is 213.08 kWh/m^2. Considering that this consumption is between 118-294 kWh/m^2 in similar historical buildings in different geographies, these values are at an acceptable level for this building (Lo Faro et al., 2013; Murgul, 2014; Salata et al., 2014; Mancini et al., 2016). Moreover, with this consumption, the building consumes as much energy as the existing buildings in the 20th century building stock (EUMEPS, 2011).

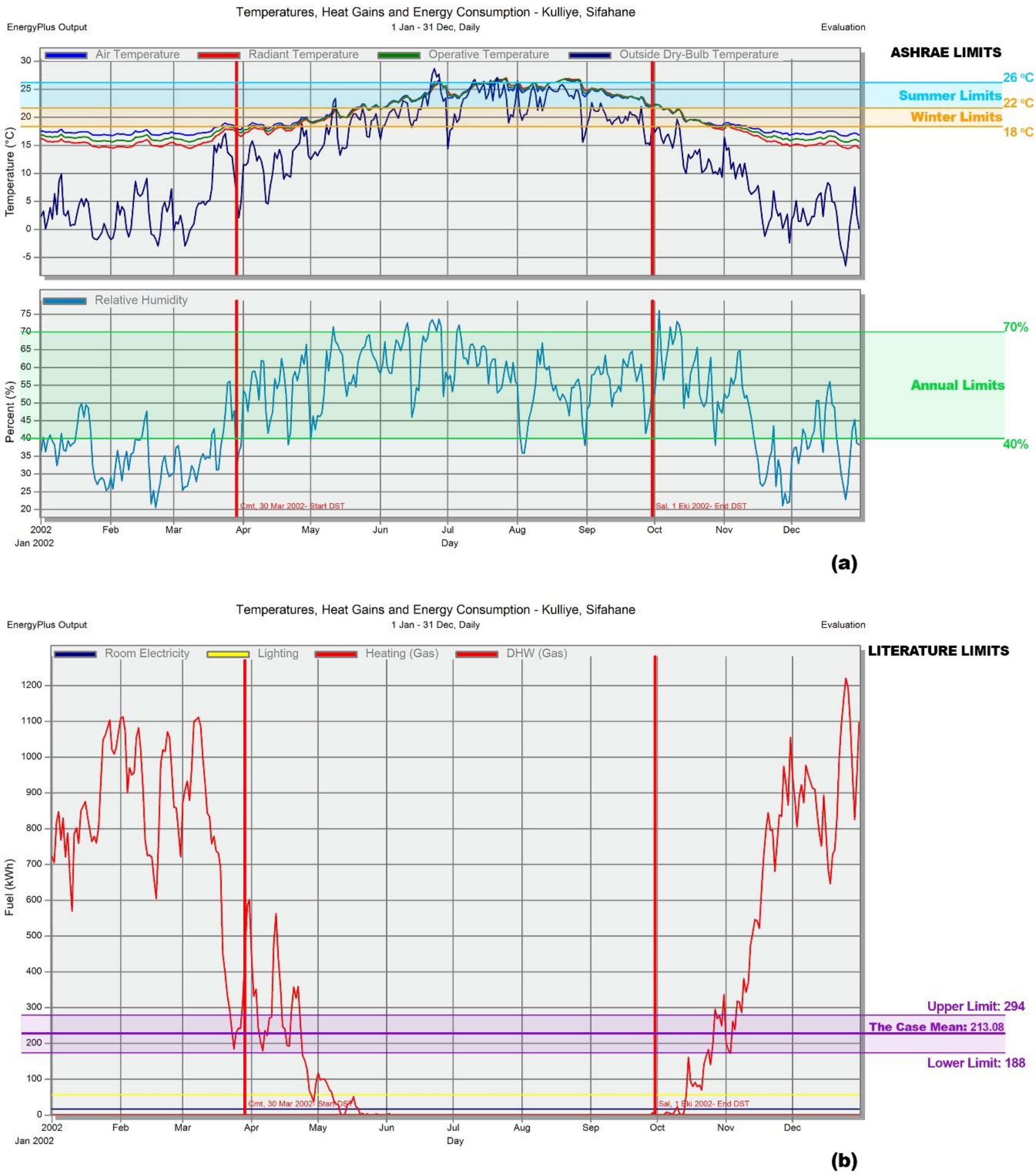


Figure 14 - (a) Comfort condition of the Şifahane, (b) annual energy consumption results.

Indoor Air Quality (IAQ)

In traditional buildings, ventilation is provided naturally. The element that will affect the IAQ of the space is the openable windows that will bring fresh air from outside to the indoor. In the sifahane, there are 15 windows on the hexagonal central dome. The lighthouse at the top of the dome, together with other windows, contributes to the ventilation and lighting of the large central space. The sofa (treatment space), which is located right opposite the entrance and used as a musical stage, has 5 windows in a single file, while, in other 4 summer sofas which are located around the center, each one has double row single windows (Figure 4). Again, in 4 winter rooms located next to their summer sofas, there are double row single windows, and on two of the rooms that open up to the musical stage there are double windows (Figure 15). In addition to these windows, which are used for ventilation of the rooms, the furnaces in the rooms also contribute in terms of heating and air circulation. After cleaning the indoor air of the spaces, furnaces help to remove polluted air from indoor as being a smokestack. Window organizations, together with the air circulation of the building, are shown respectively in the plan and section (Figure 15). Accordingly, it has been determined that the plan scheme and the central dome of the building has a positive effect on the IAQ. Besides, the absence of windows opening directly to the prevailing wind direction has an effect on increasing the thermal comfort of the building.

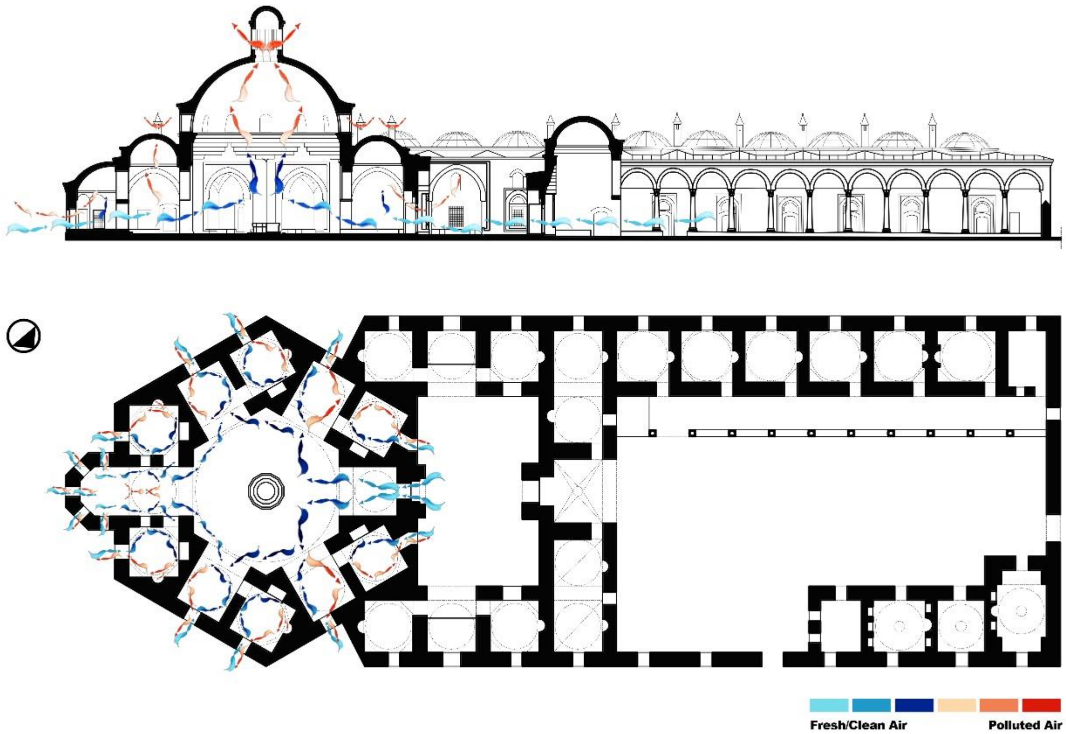


Figure 15 - Ventilation analysis of the Şifahane from the façade openings.

After refunctioning process, natural ventilation features of the buildings help to improve IAQ. If the ventilation of the building had not been provided naturally, air conditioning units would be needed. However, this is not an issue that can be solved very easily due to conservation rules. Also, natural ventilation of the building has the advantage on the humidity control which helps to prevent the weathering of the materials displayed in the spaces. It is very important to provide natural ventilation in the use of such buildings as museums (Yang & Celements-Croome, 2012; Dzulkifli et al., 2016). It also contributes to improving the thermal comfort of the sifahane without consuming energy (Zhang & Guan, 2006).

Lighting Comfort

Sunlight, which is an important component of the physical environment and climatic factors, has a great role in architectural design. Effective use of daylight is possible when considered with other physical environmental values. Daylight is a critical parameter that ensures people's integration with nature and provides comfort. The relationship between architecture and daylight was of great importance for architects in the past when there was no electrical lighting inside the spaces. Therefore, the sifahane has been analyzed according to natural lighting conditions in terms of lighting comfort. Wide window openings are realized in the rooms to allow daylight to enter the patient rooms. The bottom window dimensions are 100/160 cm and the top windows are 85/150 cm. The daylight effect of the transparent window sections in summer and winter conditions is shown in Figure 16 together with the location-related sun path diagram. The natural lighting analysis of the sifahane has been simulated in DesignBuilder for two different seasons, 21 December for winter and 21 June for summer. It is seen that in winter the daylight, which has a lower light intensity and reaches the earth at a narrower angle, is utilized in the building (Figure 16). While during the summer, as shown in Figure 17, the moldings on the windows provide solar control for the building and prevent overheating.

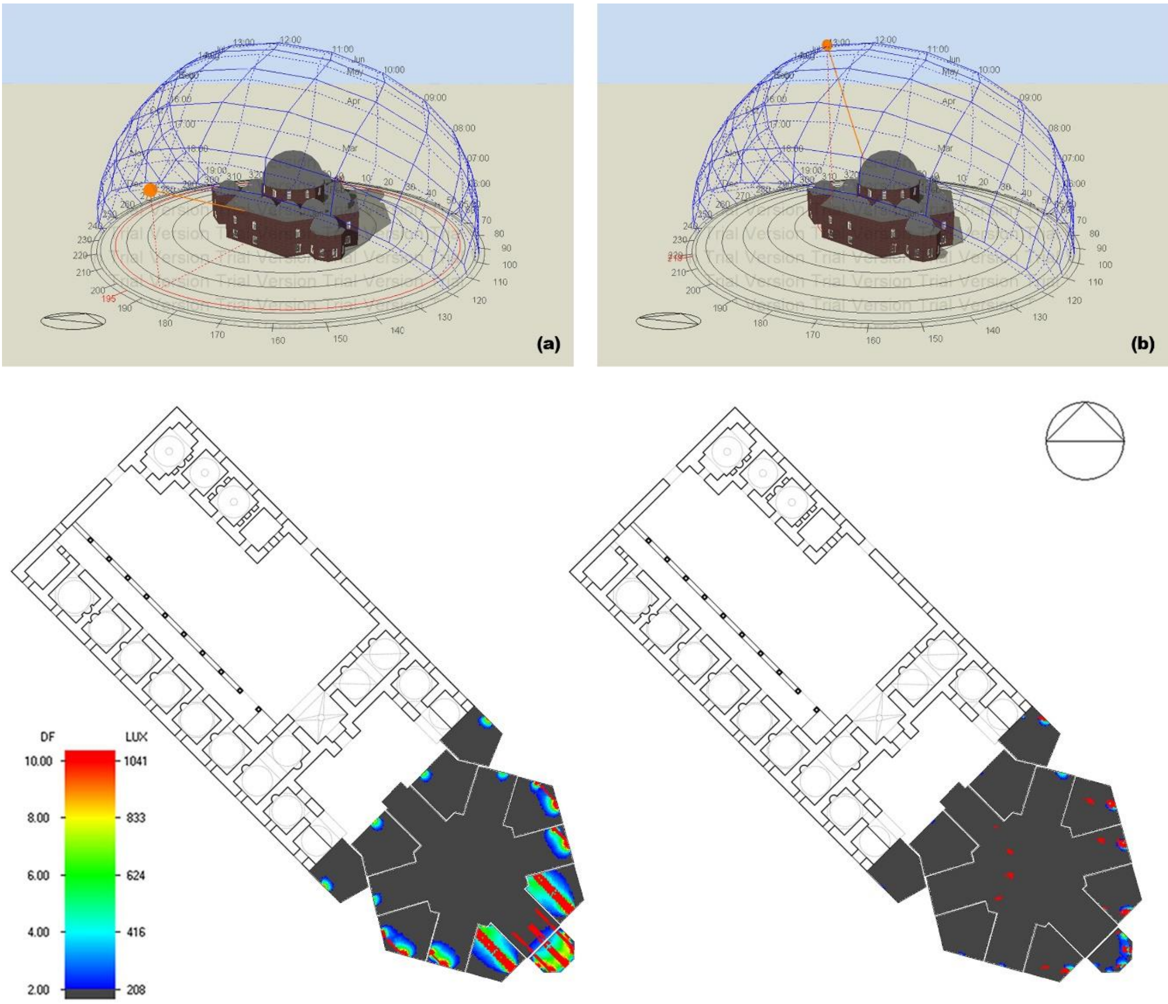


Figure 16 - Daylighting analysis of the sifahane (a) Dec. 21, 9 am and (b) Jun. 21, 9 am.

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Figure 17 - Daylighting in winter and summer seasons.

There are many studies on the effects of daylight on energy gain and thermal load reduction, comfort, productivity and health (Codinhoto et al., 2009; Huisman et al., 2012). It has been stated in the related studies that the recovery rate of patients close to the window in hospitals is much higher than those who are far from it (Ulrich, 1984; Park et al., 2018). However, it is seen that the transparency ratio of the building envelope is not very high considering the fact that with some diseases light may cause sensitivity and discomfort for the patient. It should be noted that the construction system of the building also affects this. Masonry allows for limited openings on the façade. In this context, it has been determined that the lighting comfort of the building is at an acceptable level, although not very high.

Today, the building is used as a museum and instead of the treatment of the patients, some models or documents are presented to demonstrate that time in each space as shown in Figure 3. Therefore, to protect the materials on display, direct access to sunlight should be controlled. While the existing building envelope provides this, there is no glare indoors. Thus, the lighting comfort of the building in its museum usage is maintained.

Acoustics Comfort

Since the Sifahane was used especially for music therapy, attention has been paid to its acoustic properties. Limestone, which is used as a wall material, contributes to preventing the reverberation of sound waves with its porous structure. In terms of soundspace, muqarnas were used in the transition parts of the walls in order to prevent sound reverberation inside the dome (Figure 18). Muqarnas are important engineering inventions formed by employing knowledge and art together. Muqarnas are used in buildings as acoustic balancing elements in addition to their structural properties (Doğanay, 2007). The acoustic comfort offered by the building stems from its architectural shape and structure.

Located directly below the dome in a centrally planned building, the 12-sided fountain pool with its sprinkler is intended for the use of water sounds in treatments (Figure 19). It is considered that this water sound is to be distributed equally to all partitions and sections in the building. In addition, with the sloping floor of the pool, the flow of the water was regulated and the ground was kept clean.

Figure 18 - Muqarnas used in spaces with their acoustic properties.

Figure 19 - Placement of the water element used in treatment.

Today, in the use of the building as a museum, visitors are offered the opportunity to experience the effects of music therapy. A comfortable concert is provided to visitors without the need for today's technological sound systems. Even today in some special events, the building is used with this feature (Figure 20).

Figure 20 - (a) Musical therapy display and projected miniatures, (b) concerts in 2000s.

CONCLUSION

Physical environmental parameters are an important to affect the quality of life in spaces. That's why it should be considered primarily at the design stage, such that this is a common attitude in traditional architecture so for. However, managing all the physical environmental data is a difficult issue in architecture. Tackling with the physical environmental data in a well-rounded manner is critical to offer a comfortable indoor environment for the users. While even new buildings today fail to deliver the ideal IEQ, it is even more difficult to provide this by a historical building. Therefore, the historical buildings, which are included in today's building stock and are actively used, should be used with arrangements that can meet the needs of the age, and if improvement is necessary, these should be determined and the buildings should be innovated.

Belonging to the 15th century, the 2nd Beyazid Health Complex has become an exemplary building in planning healthcare facilities not only in its own period, but also in later periods. It is widely acknowledged that the building is a very successful example with its health services which it provided half a century ago with musical tunes, sounds of water in the fountain, sounds of birds in its natural environment, the smell of plants in its vicinity and its connection with the river (İnci, 2004). Today, the use of the building as a museum offers its visitors the opportunity to experience this environment. This means that while showing the historical atmosphere of the building, IEQ of the building is provided to respond to today's comfort conditions. Examined in regard to its site properties, daylight (lighting), ventilation, and acoustic aspects, it was observed that the sifahane is compatible with its physical environmental data in terms of function, planning, and building envelope features, all necessary comfort conditions are provided for users and its energy consumption is at an acceptable level. However, this is a temporary situation and the building will need energy efficient improvements in time. Because, after each energy-efficient renovations in the existing building stock, the current consumption of these historical buildings will not be acceptable in the future. Even so the building draws attention to and bears traces of the fundamentals of the passive design concept in today's architecture in terms of its natural ventilation, solar control and natural lighting. The complex has important features in terms of environmental and urban aesthetics with its general setting and it reflects these to the present day. It is important to emphasize that with its acquired sustainability features; by its integration with water (river), efficiently making use of natural resources, creating a healthy built environment, which provides all the comfort conditions for its function and users, the building has the role of providing a livable world to the next generations.

In summary, modern architecture, which aims to present the ideal IEQ in a sustainable way, today provides this with location-specific solutions by accurately analyzing physical environmental data. However, this study shows that as an approach adopted in historical buildings for centuries, these buildings can adapt to the sustainable understanding of the modern world. In future studies, the comfort perceived by the users can be determined by visitor survey. This will help to develop the renovation solutions for the building by evaluating the situation between perceived and calculated comfort conditions.

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There is no conflict of interest for conducting the research and/or for the preparation of the article.

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Copyright Statement for Intellectual and Artistic Works

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Author Contribution Statement

A. Fikir / Idea, Concept	B. Çalışma Tasarısı, Yöntemi / Study Design, Methodology	C. Literatür Taraması / Literature Review
D. Danışmanlık / Supervision	E. Malzeme, Kaynak Sağlama / Material, Resource Supply	F. Veri Toplama, İşleme / Data Collection, Processing
G. Analiz, Yorum / Analyses, Interpretation	H. Metin Yazma / Writing Text	I. Eleştirel İnceleme / Critical Review

AUTHOR 1: A/B/C/D/E/F/G/H/I
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