SÜRDÜRÜLEBİLİRLİK VE MİMARLIK EĞİTİMİ

Sustainability and Architectural Education

ISL@H 2023

Bildiriler Kitabı
Proceedings Book

4. Uluslararası İslam Mimarlığı Mirası Konferansı
4th International Conference on Islamic Architectural Heritage

FATİH SULTAN MEHMET VAKIF ÜNİVERSİTESİ YAYINLARI

ISL@H
2023

4. Uluslararası İslam Mimarlığı Mirası Konferansı

SÜRDÜRÜLEBİLİRLİK VE MİMARLIK EĞİTİMİ

Bildiriler Kitabı

4th International Conference on Islamic Architectural Heritage

SUSTAINABILITY AND ARCHITECTURAL EDUCATION

Proceedings Book

Editörler / Editors

Dr. Öğr. Üyesi / Assist. Prof. Dr. Mesut Dural

Doç. Dr. / Assoc. Prof. Dr. Burcu Balaban Ökten

Dr. Öğr. Üyesi / Assist. Prof. Dr. Yaprak Arıcı Üstüner

Dr. Öğr. Üyesi / Assist. Prof. Dr. Hakkı Can Özkan

FATİH SULTAN MEHMET VAKIF ÜNİVERSİTESİ YAYINLARI
2024

FATİH SULTAN MEHMET VAKIF ÜNİVERSİTESİ YAYINLARI: 55

ISL@H 2023: 4. ULUSLARARASI İSLAM MİMARLIĞI MİRASI KONFERANSI, SÜRDÜRÜLEBİLİRLİK VE MİMARLIK EĞİTİMİ, BİLDİRİLER KİTABI

Editörler:
Dr. Öğr. Üyesi Mesut Dural
Doç. Dr. Burcu Balaban Ökten
Dr. Öğr. Üyesi Yaprak Arıcı Üstüner
Dr. Öğr. Üyesi Hakkı Can Özkan

Editör Yardımcıları:
Arş. Gör. Aslı Yücel
Arş. Gör. Elif Özkazanç
Arş. Gör. Hale Nur Çakar
Arş. Gör. Hilal Günay

e-ISBN 978-605-2386-63-7

Fatih Sultan Mehmet Vakıf Üniversitesi Yayınları

Zeyrek Mahallesi Büyükkaraman Cad. No: 53 Fatih / İstanbul

Tel: 0212 521 81 00 **Faks:** 0212 521 84 84
Web: www.fsm.edu.tr **E-Posta:** yayinevi@fsm.edu.tr

Yayınevi Sertifika No: 47914
İstanbul, Mayıs, 2024

Tasarım: Zeynep Küçüker
Kapak Tasarımı: Arş. Gör. Muhammet Emin Şişman

Fatih Sultan Mehmet Vakıf Üniversitesi Kütüphanesi CIP

ISL@H 2023: 4. Uluslararası İslam Mimarlığı Mirası Konferansı, Sürdürülebilirlik ve Mimarlık Eğitimi, Bildiriler Kitabı / editörler Mesut Dural, Burcu Balaban Ökten, Yaprak Arıcı Üstüner, Hakkı Can Özkan – İstanbul: Fatih Sultan Mehmet Vakıf Üniversitesi Yayınları, 2024.
534 s. ; 24 cm. – (Fatih Sultan Mehmet Vakıf Üniversitesi Yayınları; 55)

e-ISBN 978-605-2386-63-7

1. İslam mimarisi -- Kongreler
2. Sürdürülebilir mimarlık

I. Dural, Mesut II. Balaban Ökten, Burcu III. Arıcı Üstüner, Yaprak

NA9093.9/I75 2024 723.304 ISL 2024

FATİH SULTAN MEHMET VAKIF UNIVERSITY PUBLICATIONS: 55

ISL@H 2023: 4TH INTERNATIONAL CONFERENCE ON ISLAMIC ARCHITECTURAL HERITAGE, SUSTAINABILITY AND ARCHITECTURAL EDUCATION, PROCEEDINGS BOOK

Editors:
Assist. Prof. Dr. Mesut Dural
Assoc. Prof. Dr. Burcu Balaban Ökten
Assist. Prof. Dr. Yaprak Arıcı Üstüner
Assist. Prof. Dr. Hakkı Can Özkan

Assistant Editors:
Res. Assist. Aslı Yücel
Res. Assist. Elif Özkazanç
Res. Assist. Hale Nur Çakar
Res. Assist. Hilal Günay

e-ISBN 978-605-2386-63-7

Fatih Sultan Mehmet Vakif University Publications

Zeyrek Mahallesi Büyükkaraman Cad. No: 53 Fatih / İstanbul

Tel: 0212 521 81 00 **Fax:** 0212 521 84 84
Web: www.fsm.edu.tr **E-Mail:** yayinevi@fsm.edu.tr

Publisher's Certificate No: 47914
Istanbul, May, 2024

Design: Zeynep Küçüker
Cover Design: Res. Assist. Muhammet Emin Şişman

Fatih Sultan Mehmet Vakif University Library CIP

ISL@H 2023: 4th International Conference on Islamic Architectural Heritage, Sustainability and Architectural Education, Proceedings Book / editors Mesut Dural, Burcu Balaban Ökten, Yaprak Arıcı Üstüner, Hakkı Can Özkan – Istanbul: Fatih Sultan Mehmet Vakif University Publications, 2024.
534 p. ; 24 cm. – (Fatih Sultan Mehmet Vakif University Publications; 55)

e-ISBN 978-605-2386-63-7

1. Islamic architecture -- Congresses
2. Sustainable architecture

I. Dural, Mesut II. Balaban Ökten, Burcu III. Arıcı Üstüner, Yaprak

NA9093.9/I75 2024 723.304 ISL 2024

ISL@H
2023

4. ULUSLARARASI İSLAM MİMARLIĞI MİRASI KONFERANSI
4TH INTERNATIONAL CONFERENCE ON ISLAMIC ARCHITECTURAL HERITAGE

Bilim Kurulu

ISL@H
2023

4. ULUSLARARASI İSLAM MİMARLIĞI MİRASI KONFERANSI
4TH INTERNATIONAL CONFERENCE ON ISLAMIC ARCHITECTURAL HERITAGE

Scientific Committee

ISL@H
2023

4. ULUSLARARASI İSLAM MİMARLIĞI MİRASI KONFERANSI
4TH INTERNATIONAL CONFERENCE ON ISLAMIC ARCHITECTURAL HERITAGE

Organizasyon Komitesi

Başkan, Prof. Dr. İbrahim Numan
Fatih Sultan Mehmet Vakıf Üniversitesi / Türkiye

Eş Başkan, Prof. Dr. Noor Cholis Idham
Endonezya İslam Üniversitesi / Endonezya

Eş Başkan, Doç. Dr. Nurul Hamiruddin B. Salleh
Malezya Uluslararası İslam Üniversitesi / Malezya

Eş Başkan, Doç. Dr. Florina Jerliu
Priştine Üniversitesi / Kosova

Eş Başkan, Doç. Dr. Çiğdem Canbay Türkyılmaz
Semerkant Devlet Mimarlık ve İnşaat Mühendisliği Üniversitesi / Özbekistan

Eş Başkan, Dr. Öğr. Üyesi Meriem Chaggar
Sousse Politeknik Okulu / Tunus

Dr. Öğr. Üyesi Mesut Dural
Fatih Sultan Mehmet Vakıf Üniversitesi / Türkiye

Dr. Öğr. Üyesi Yaprak Arıcı Üstüner
Fatih Sultan Mehmet Vakıf Üniversitesi / Türkiye

Doç. Dr. Burcu Balaban Ökten
Fatih Sultan Mehmet Vakıf Üniversitesi / Türkiye

Dr. Öğr. Üyesi Hakkı Can Özkan
Fatih Sultan Mehmet Vakıf Üniversitesi / Türkiye

Konferans Sekreteryası

Arş. Gör. Aslı Yücel
Fatih Sultan Mehmet Vakıf Üniversitesi / Türkiye

Arş. Gör. Elif Özkazanç
Fatih Sultan Mehmet Vakıf Üniversitesi / Türkiye

Arş. Gör. Hale Nur Çakar
Fatih Sultan Mehmet Vakıf Üniversitesi / Türkiye

Arş. Gör. Hilal Günay
Fatih Sultan Mehmet Vakıf Üniversitesi / Türkiye

Arş. Gör. Alim Battal
Fatih Sultan Mehmet Vakıf Üniversitesi / Türkiye

Arş. Gör. Rengin Gürel
Fatih Sultan Mehmet Vakıf Üniversitesi / Türkiye

ISL@H
2023

4. ULUSLARARASI İSLAM MİMARLIĞI MİRASI KONFERANSI
4TH INTERNATIONAL CONFERENCE ON ISLAMIC ARCHITECTURAL HERITAGE

Organizing Committee

Chair, Prof. Dr. İbrahim Numan
Fatih Sultan Mehmet Vakif University / Turkey

Co-chair, Prof. Dr. Noor Cholis Idham
Universitas Islam Indonesia / Indonesia

Co-chair,
Assoc. Prof. Ts. Dr. Nurul Hamiruddin B. Salleh
International Islamic University Malaysia / Malaysia

Co-chair, Assoc. Prof. Dr. Florina Jerliu
University of Prishtina / Kosovo

Co-chair,
Assoc. Prof. Dr. Çiğdem Canbay Türkyılmaz
Samarkand State Architectural and Construction University / Uzbekistan

Co-chair, Assist. Prof. Dr. Meriem Chaggar
Ecole Polytechnique Sousse / Tunisia

Assist. Prof. Dr. Mesut Dural
Fatih Sultan Mehmet Vakif University / Turkey

Assist. Prof. Dr. Yaprak Arıcı Üstüner
Fatih Sultan Mehmet Vakif University / Turkey

Assoc. Prof. Dr. Burcu Balaban Ökten
Fatih Sultan Mehmet Vakif University / Turkey

Assist. Prof. Dr. Hakkı Can Özkan
Fatih Sultan Mehmet Vakif University / Turkey

Conference Secretaria

Res. Assist. Aslı Yücel
Fatih Sultan Mehmet Vakif University / Turkey

Res. Assist. Elif Özkazanç
Fatih Sultan Mehmet Vakif University / Turkey

Res. Assist. Hale Nur Çakar
Fatih Sultan Mehmet Vakif University / Turkey

Res. Assist. Hilal Günay
Fatih Sultan Mehmet Vakif University / Turkey

Res. Assist. Alim Battal
Fatih Sultan Mehmet Vakif University / Turkey

Res. Assist. Rengin Gürel
Fatih Sultan Mehmet Vakif University / Turkey

ORGANİZATÖR KURUMLAR
ORGANIZING INSTITUTIONS

FATİH SULTAN MEHMET VAKIF ÜNİVERSİTESİ

الجامعة الإسلامية العالمية ماليزيا
INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA
يونيرسيتي إسلام انتارابغسا ملايسيا

SAMARKAND STATE UNIVERSITY OF ARCHITECTURE AND CONSTRUCTION

Poly technique SOUSSE
ECOLE D'INGÉNIEURS & D'ARCHITECTURE

UNIVERSITETI I PRISHTINËS
UNIVERSITAS STUDIORUM PRISHTINIENSIS
1970 MCMLXX

UNIVERSITAS ISLAM INDONESIA

SUNUŞ / PRESENTATION

Zaman birçok kere tekerrürlerle ibret vesilesi olarak karşımıza çıkar. Maddi ve manevi tahribat ile insanlık ayıbının yaşanmakla olup, İslam alemini, hatta şuur ve insaf sahibi tüm insanlığı üzüntüye boğan bu günlerde, devralınan maddi ve manevi İslam mirasının ele alınmasındaki ehemmiyet bir kez daha ortaya çıkmış bulunmaktadır. Maalesef şer güçlerinin Kudüs gibi İslam alemi için üçüncü önemli yeri olan miras şehirdeki saldırıları, insan ile mukaddes mekan arasına mahrumiyet sınırları koyma arzularının, hatta Mescid-i Aksa'yı, Kubbetü's Sahra'yı ortadan kaldırma niyetlerinin aşikare çıktığı bu günlerde ISL@H (İslam, Mimarlığı Mirası) 2023 Konferansı taşıdığı önemle acımıza bir nebze olsun su serper ümidindeyiz.

ISL@H Konferansları yapılması fikri ilk defa 2016'da FSMVÜ- IIUM müşterek yaz okulu esnasında atılmış bulunmaktadır. Dr. Numan, Dr. Hamiruddin ve Dr. Siyal'in şekillendirmeleriyle, IIUM (Malezya Uluslararası İslam Üniversitesi) ve FSMVÜ (Fatih Sultan Mehmet Vakıf Üniversitesi) ortaklığı ile ilki 2017 de Malezya, Kuala Lumpur'da başlatılmıştır. İkincisi ISL@H 2019 olarak FSMVÜ, Mimarlık ve Tasarım Fakültesince gerçekleştirilip bildiriler kitabı yayınlanmıştır. Her iki yılda bir yapılması kararlaştırılan konferansların üçüncüsü ilan edildiği halde gerek pandemi süreçlerinden gerekse bazı aksaklıklardan dolayı gerçekleştirilememiştir.

Başlarda uluslararası katılım için bazı tereddütler olsa bile, dördüncüsü idrak edilen ISL@H 2023'ün FSMVÜ- IIUM yanında, UII (Endonezya İslam Üniversitesi), UP (Priştine Üniversitesi), US (Semerkant Mimarlık ve İnşaat Üniversitesi) ve Ecol Polytech (Tunus Sousse Politeknik) Üniversitelerinin iştiraki ile yaygınlaşması ve konusunda tanınan bir platform olma yoluna girmiş bulunması sevindiricidir.

İslam mimari mirasının sadece yapılı eserlerin kapsamı içerisinde kalmayıp bunların incelenmesinin çok ötesinde, miras eserlere alt yapı oluşturarak bu unsurların da ele alınacağı bir saha oluşturduğu muhakkaktır.

Nitekim ISL@H2023'ün teması Sürdürülebilirlik ve Mimarlık Eğitimi olarak belirlenmiştir. Temennimiz odur ki, mimarlık eğitimi başka başlıklar yanında bundan sonra yapılacak her konferansta tema olarak yer alsın.

Bu konferansta "sosyal, kültürel ve ekonomik sürdürülebilirlik"; "malzeme kullanımında sürdürülebilirlik"; "yerleşmelerde sürdürülebilirlik"; "eğitimde sürdürülebilirlik"; "yeniden işlevlendirme" ve "kapsayıcı mimarlık" konularındaki çalışmalar yer almaktadır.

Dört davetli konuşmacının yanında 40 Türk ve 33 yabancı katılımcı yer almış bulunmaktadır. 30'u yüz yüze ve 21'i çevrimiçi olmak üzere toplam 51 bildirinin 32'si İngilizce ve 19'u Türkçe olarak sunulmuştur.

Konferansımıza davetli konuşmacı olarak Prof. Dr. Saddettin ÖKTEN, Prof. Dr. Nour Cholis IDHAM ve Prof. Dr. Asiah Abdul RAHİM onur vermişlerdir.

Konferans hazırlıkları için özveri ile katkıda bulunan fakültemiz öğretim üyeleri, araştırma görevlileri ve idari personeli başta olmak üzere, Bilgi İşlem Daire Başkanlığı'na, Sağlık Kültür ve Spor Daire Başkanlığı'na, Halkla ilişkiler Müdürlükleri ve Kütüphane Dokümantasyon Daire Başkanlığı'na teşekkürü borç biliriz.

Son söz olarak, ISL@H Konferans serisinin İslam akademiyası arasında artarak ve benimsenerek İslam mimari mirasının her yönü ile ele alınacağı bir platform olmasını tekrar temenni ederiz.

Fatih Sultan Mehmet Vakıf Üniversitesi
Mimarlık ve Tasarım Fakültesi adına,

Prof. Dr. İbrahim Numan

ISL@H
2023

4. ULUSLARARASI İSLAM MİMARLIĞI MİRASI KONFERANSI
4TH INTERNATIONAL CONFERENCE ON ISLAMIC ARCHITECTURAL HERITAGE

İÇİNDEKİLER / CONTENTS

ENERJİ VERİMLİLİĞİ VE SÜRDÜRÜLEBİLİRLİK
ENERGY EFFICIENCY AND SUSTAINABILITY

ENERJİ VERİMLİLİĞİ VE SÜRDÜRÜLEBİLİRLİK
ENERGY EFFICIENCY AND SUSTAINABILITY

EVALUATION OF MONUMENTAL MOSQUE BUILDINGS BELONGING TO THE ANATOLIAN SELJUK PERIOD IN KONYA IN TERMS OF ENERGY EFFICIENCY

Neriman Gül Çelebi[1], Serhat Aniktar[2], Ümit Arpacioğlu[3]

[1] Ph.D. Student, Mimar Sinan Fine Arts University, Institute of Science and Technology, Department of Architecture, Istanbul, Türkiye, ngcelebi@gmail.com, ORCID No: 0000-0003-0478-0449

[2] Assist. Prof. Dr., Istanbul Sabahattin Zaim University, Faculty of Engineering and Natural Sciences, Department of Architecture, Istanbul, Türkiye, serhat.aniktar@izu.edu.tr, ORCID No: 0000-0002-7727-5331

[3] Assoc. Prof. Dr., Mimar Sinan Fine Arts University, Faculty of Architecture, Department of Architecture, Istanbul, Türkiye, umit.arpacioglu@msgsu.edu.tr, ORCID No: 0000-0001-8858-7499

Abstract

Monumental mosques are valuable elements of religious and cultural heritage and Islamic architecture. In this respect, creating an inventory of monumental mosque buildings, and documenting and preserving them have great importance. Konya has hosted many civilizations throughout its history and the city has preserved its importance for many years as the capital of the Anatolian Seljuk Civilization. It has many valuable monumental buildings built during the Seljuk and Ottoman periods and has been an architectural center throughout its history. In this study, mosques belonging to the Anatolian Seljuk Period in Konya, one of the most important main centers of Turkish-Islamic culture and art in Anatolia, were handled. Mosque buildings are characterized by intermittent working hours and represent a central area where people gather for daily and weekly prayers. Mosques are also considered a place for educational, cultural, and social activities. The comfort of the user in a religious building is important for a sense of sacred worship. In this direction, providing the comfort conditions in the interior space in an energy-efficient method is important and should be handled. In this context, this study, it is aimed to create and document the inventory of monumental mosques and to research the mosques in terms of energy efficiency. Architectural design properties and construction techniques of mosques were explained and energy analyses were made by using the DesignBuilder simulation program. The relationship between architectural design

properties, built periods, and the energy demands of mosques were handled. Considering the limitations of studies in this field, this study in which monumental Islamic architecture was evaluated in the context of energy efficiency is important. It is aimed to show the importance of monumental religious buildings in terms of energy efficiency, and this study is pioneering and will light on future studies.

Keywords: Islamic architecture, Seljuk architecture, mosques, energy efficiency

1. Introduction

Konya, which has traces dating back to the Neolithic period and has hosted many civilizations, has been an architectural center throughout its history. The city has preserved its importance for many years as the capital of the Anatolian Seljuk Civilization and as it is one of the important state centers of the Ottoman Empire. The city has many historical and cultural architectural heritages (Baykara, 2002). Mosques built during the Seljuk and Ottoman Periods provide the formation of the city morphology and create an important typology with their architectural design properties. Monumental mosques are valuable elements of religious and cultural architectural heritage. Mosques represent a central area where people gather for daily and weekly prayers and are considered a place for the educational, cultural, and social activities of Muslims. Creating an inventory, documenting, and preserving these buildings have great importance. In this respect, in this study, the monumental mosques built in Konya during the Anatolian Seljuk Period are handled.

Compared to other types of buildings, mosques are characterized by their unique working hours. Mosques are used simultaneously in a certain region and time zone. They are used intermittently, five times a day and weekly. This situation has an impact on the energy demand of the building depending on the climate regions during the heating and cooling periods required (Al-Homoud et al., 2005). It is of great importance that the comfort of the user in a religious mosque building in terms of the sense of sacred worship. It should be possible to worship in a comfortable area for worshipers. In this respect, providing the comfort conditions in the interior space in an energy-efficient method is an important object and should be handled. Climate-related design properties of buildings affect the comfort conditions and thermal performance of the building (Abdou et al., 2005). Mosque buildings' energy efficiency largely depends on the overall thermal performance of building components such as walls, roofs, and windows working together as a system (Al-Homoud et al., 2009). In a mosque that has low thermal performance, more energy is consumed to provide comfort conditions.

In the study of Al-Homoud et al., indoor comfort conditions were analyzed for three mosques located in the hot humid climate zone of Damman, Saudi Arabia. The relationship between these conditions and the consumed energy loads was evaluated. It was determined that only one of the mosques had a thermal insulation layer in the envelope. It was reported that two uninsulated mosques had higher levels of energy consumption and dissatisfaction in terms of thermal comfort. In conclusion, the importance of integrating a thermal insulation layer was emphasized (Al-Homoud vd., 2009). In the study of Ahriz et al., mosque building components that can control and determine thermal comfort conditions are indicated that the orientation of the building, the area surrounding the building, the size and geometric form of the building, architectural form, closed galleries, roof form, prayer halls, the height of the prayer hall, openings, building materials, and surface colors (Ahriz et al., 2021). In this study, it is aimed to create and document the inventory of monumental mosques that are important elements of Turkish-Islamic culture, and to research the mosques in terms of energy efficiency. Studies in this area are limited. In this respect, this study is pioneering and will light on future studies. It is aimed to contribute to the studies within the scope of energy efficiency and mosques, to investigate the current energy needs of buildings, which are important elements of the monumental architectural heritage built centuries ago, and to show the importance of mosques in terms of energy efficiency.

2. Methodology

This study is prepared within the scope of the Scientific Research Project (BAP) and among the analyzed mosques and masjids, monumental mosques built in Konya during the Anatolian Seljuk Period are handled. These are the Şems Tebrizi Mosque and İplikçi Mosque. Firstly, information about the mosques belonging to the Anatolian Seljuk Period period and Konya City were collected using the analyzing technique in the literature. The mosques were visualized with the drone and their features are documented with photographs. Drawings in the electronic environment were taken from the Konya Regional Directorate of Foundations and colored, and their current situation was based on on-site determinations, and their relations with their immediate surroundings were processed on the drawings. The plan, section, facade, roof cover, and interior space elements were explained and design typologies were determined in the light of the information in the literature, drawings, and visuals. At the same time, the construction technique and material properties were explained. Mosques' architectural design properties were

documented are modeled in the Design Builder simulation program. According to the simulation results, the heating-cooling and total energy loads of the mosques were analyzed. An evaluation was explained according to the findings.

3. Findings

In this section, the architectural design properties of the Şems Tebrizi Mosque and İplikçi Mosque built in the Anatolian Seljuk Period and their energy loads according to simulation results are explained. Şems Tebrizi Mosque is located in the central Karatay district of Konya. The building, which dates back to the 13th century, was built using masonry technique. The mosque and the tomb were built adjacent to each other. The tomb has the typology of classical Seljuk cupolas. İplikçi Mosque is located in Kürkçü District, east of Alaaddin Hill. While the new street was being created, it remained below the road level. The construction technique of the mosque, which was built in the 13th century, is masonry. The covering system rising on the arches is the cross-ribbed vault.

Figure 1. Şems Tebrizi Mosque and İplikçi Mosque (Photographs by the authors, 2019)

3.1. Anatolian Sejuk Mosques' Architectural Design Properties

The architectural design properties of Şems Tebrizi Mosque are shown in Table 1, and the architectural design properties of İplikçi Mosque are shown in Table 2.

Table 1. Şems Tebrizi Mosque's Architectural Design Properties

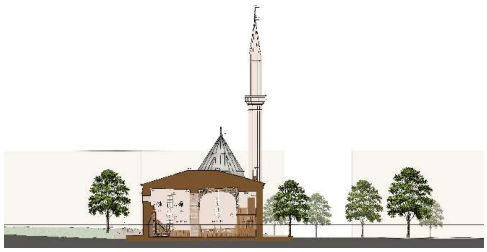
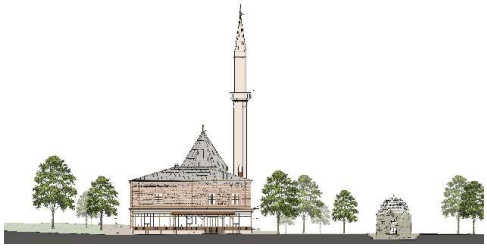
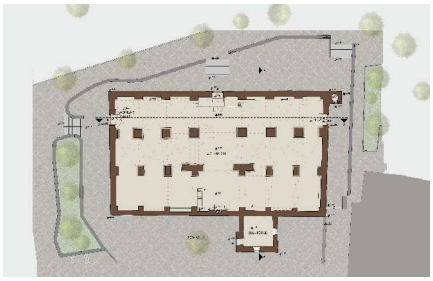
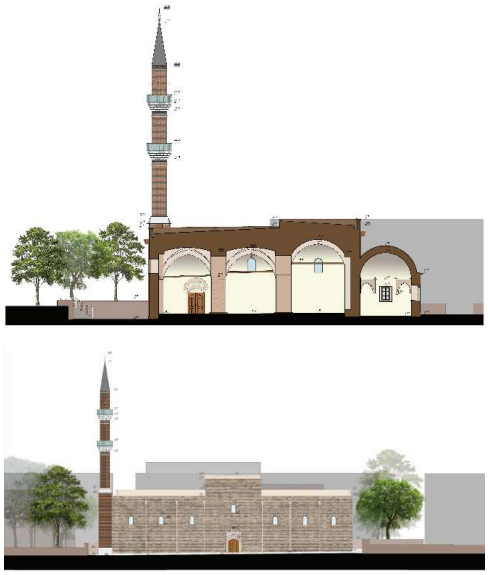
Design Typology			
	**Period**	13th Century, Anatolian Seljuk Period	
	Building Form	Rectangle	
	Plan Organization	Three Spaces	
	Top Cover	Dome	
	Building Order	Detached Order	
	Total Area of Mosque m²	271 m^2	
Construction Techniques and Material Properties			
 	**WALL**	Bond Technique	Masonry Wall
		Material	Stone
		Openings	Windows ratios are 1/2
	FLOORING	Material	Wood flooring
	TOP COVER	Bond Technique	Wooden construction pitched roof
		Material	Plumbing
		Openings	There are no openings
	MINARET	Bond Technique	Masonry
		Material	Cut-stone

Table 2. İplikçi Mosque's Architectural Design Properties

Design Typology		
	**Period**	13th Century, Anatolian Seljuk Period
	Building Form	Rectangle
	Plan Organization	Two Spaces
	Top Cover	Flat roof outside; domed inside

<table>
<tr><td colspan="2" rowspan="2"></td><td>Building Order</td><td colspan="2">Detached Order</td></tr>
<tr><td>Total Area of Mosque m2</td><td colspan="2">794.5 m^2</td></tr>
<tr><td colspan="5">Construction Techniques and Material Properties</td></tr>
<tr><td colspan="2" rowspan="8">  </td><td rowspan="3">WALL</td><td>Bond Technique</td><td>Masonry Wall</td></tr>
<tr><td>Material</td><td>Brick</td></tr>
<tr><td>Openings</td><td>Windows ratios are square and 1/2.</td></tr>
<tr><td>FLOORING</td><td>Material</td><td>Wood flooring</td></tr>
<tr><td rowspan="3">TOP COVER</td><td>Bond Technique</td><td>Masonry</td></tr>
<tr><td>Material</td><td>Brick</td></tr>
<tr><td>Openings</td><td>There are no openings.</td></tr>
<tr><td rowspan="2">MINARET</td><td>Bond Technique</td><td>Masonry</td></tr>
<tr><td>Material</td><td>Brick</td></tr>
</table>

3.2. Energy Analysis of Anatolian Seljuk Mosques

Şems Tebrizi Mosque and İplikçi Mosque belonging to the Anatolian Seljuk Civilization, are analyzed in terms of energy efficiency in light of the literature review and simulation results. Mosques are modeled using the DesignBuilder simulation program. Design Builder is an EnergyPlus-based software tool developed to measure and analyze the performance of building design in terms of energy, carbon, lighting, and comfort (Zhang, 2014). Models specific to mosque buildings that have characteristic properties are developed in the DesignBuilder simulation program, taking into account the users, occupancy rate, and usage times.

In the DesignBuilder simulation program, information about the location of the building is first entered. The DesignBuilder program, which uses the same simulation engine as the EnergyPlus program, does not have climatic data for all cities. In this respect, in the study, the data provided from the meteorological stations in the region through the Meteonorm software were defined into the Design Builder software, and the typical year method was used for climate data.

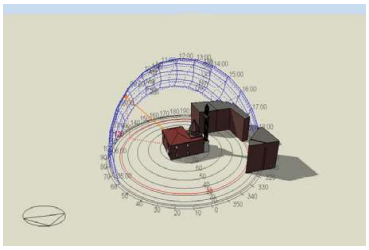
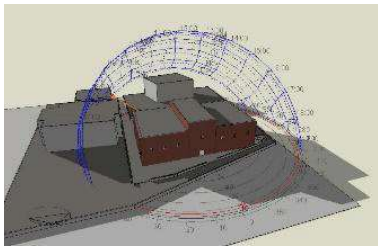
The functional properties of the building must be defined in the DesignBuilder program. There is no mosque function ready in the program. The mosque building's properties, such as daily and weekly working hours and user density, are defined by us in the program. Daily prayer times and user densities during Friday prayer times are defined in the system and heat gains due to people were calculated. The comfort range has been defined by taking ASHRAE standards into consideration for the comfort conditions in the interior.

Konya is located in the temperate-dry climate region of Türkiye. In terms of energy efficiency, the period when heating is required in temperate-dry climate regions is important. Design parameters affecting the energy performance of a building are handled as the location and orientation of the building, the building form, the distance between buildings, the optical and thermophysical properties of the building envelope, and the solar control and natural ventilation layout. It can be said that energy-efficient design parameters are also valid for mosque buildings. However, mosques have characteristic design properties that affect the basic design such as qibla, qibla wall, mihrab, and minbar. In this respect, the orientation of mosque buildings is the direction of the qibla. The orientation of the Konya mosques (their qibla), which are handled within the scope of the study, is in the south direction.

Şems Tebrizi Mosque and İplikçi Mosque have a detached order property. This should be considered as a factor that is important in terms of solar radiation gain and natural ventilation and therefore affects the energy load of buildings. In this respect, building order should be handled as a factor affecting the energy load of mosque buildings. In terms of building form, the form of mosque buildings is square or rectangular, which should be in the temperate-dry climate zone. Other architectural design properties affecting the energy loads of Şems Tebrizi Mosque and İplikçi Mosque and the heating-cooling and total energy loads of the mosques per m^2 are shown in Table 3. In the calculations using the DesignBuilder simulation program, the total energy load per square meter represents the sum of heating, cooling, and lighting loads.

Table 3. Architectural Properties and Energy Loads of Şems Tebrizi and İplikçi Mosques

Mosque Name	**Şems Tebrizi Mosque** 13th Century	**İplikçi Mosque** 13th Century
Total Area of Mosque m^2	271 m2	794,5 m^2
Mosque height (h)	12.30 m	13.14 m
Wall Material	Stone	Brick

Wall Thickness		100 cm	95 cm
Top Cover Material		Plumbing	Brick
Top Cover Thickness		Pitched roof	55 cm
Window-Wall Ratio (%)	South	6.07	1.62
	North	4.05	1.80
	East	5.43	0.76
	West	4.06	0.77
Cooling Load per m² kWh		9.24	11.02
Heating Load per m² kWh		62.17	185.07
Energy Consumed per m² (heating-cooling-lighting) kWh		78.23	202.90
Masjids' Energy Models			

In terms of the top cover, Şems Tebrizi Mosque has a pitched roof and the İplikçi Mosque Mosque has a flat roof outside and domed inside. In this respect, it can be said that the top cover is one of the factors affecting the differences between the energy loads of the mosques. In terms of building materials, Şems Tebrizi Mosque's building materials are stone and the wall thickness is 100 cm. İplikçi Mosque's building material is brick and the wall thickness is 95 cm. Stone and brick building materials have the qualification to contribute to the heating and cooling loads of buildings in terms of thermal performance. It should be noted that the thermal conductivity properties of the opaque and transparent components of the building envelope are important parameters that can affect the energy loads of the buildings. The thermal conductivity of the wall varies depending on the building material properties and wall thickness. Built years and temporal differences between the Şems Tebrizi and İplikçi Mosque, the type of stone and brick materials used, differences in wall thickness of mosques, and the type of glass used in the openings should be handled as factors affecting the thermal conductivity of the wall. It can be stated that the building materials used in the analyzed mosques have the qualification of reducing the energy load of the buildings. In this respect, mosques' envelope properties should be handled as the parameter that affects the energy needs of mosques.

Directional openings are important factors in terms of solar radiation gain and natural ventilation layout. It should be noted that openings in the south direction provide direct solar radiation gain, but multi-directional openings cause heat losses. The opening ratios of Şems Tebrizi Mosque and İplikçi Mosque vary depending on the directions. According to the opening ratios depending on the directions given in Table 3, it is seen that Şems Tebrizi Mosque has higher opening ratios. In this respect, it can be said that the openings depending on the directions have an impact on the differences between the energy demand of the mosques. In addition, monumental mosque buildings' volume should be handled and evaluated as an important factor. As a result, the parameters affecting the energy load of a mosque building make differences in mosques' energy loads, especially the envelope design, building material used, wall thickness, top cover properties, facade openings depending on directions, and size of the building. As a result, it can be said that more positive results are obtained in terms of energy efficiency for both mosques although the differences between the energy loads.

4. Conclusion and Recommendations

In this study, monumental mosques built during the Anatolian Seljuk Period in the city of Konya, one of the most important main centers of Turkish-Islamic culture and art, are researched in terms of energy efficiency. Monumental mosques, which are important elements of religious and cultural heritage, built during the Seljuk period are important buildings that provide the formation of city morphology. In this respect, it is important to document an inventory of these monumental buildings, determine their current situation, and analyze these buildings in terms of energy efficiency.

In the study, Şems Tebrizi Mosque and İplikçi Mosque belonging to the Anatolian Seljuk Period in the 13th century, are handled. The energy demands of mosques vary depending on their architectural design properties. It should be noted that with these differences, positive results are obtained in terms of energy efficiency. It can be said that mosque buildings, which are important elements of the monumental architectural heritage built in the Anatolian Seljuk Period, are energy-efficient buildings in line with today's energy needs and traditional design features and construction techniques. In addition to energy analysis, building volume is an important factor in monumental mosque buildings in terms of energy efficiency. In this respect, it has been determined that the DesignBuilder simulation program, which calculates the energy load per m^2, is inadequate for mosques where volume is an important factor, and volume-related analysis results are required.

As a result, positive results are obtained for the Şems Tebrizi and İplikçi Mosques in terms of energy efficiency in line with the energy loads consumed per m^2. These monumental mosques are valuable and important in terms of energy efficiency. Considering the limitations of studies on the energy demands and energy efficiency of monumental mosques, it is expected that this study will create potential research scopes for future research. In addition, documenting and protecting religious and cultural heritage and analyzing it in terms of energy efficiency has great importance in guiding mosques that will be designed as religious and cultural architectural elements with minimum energy requirements.

Information Note

This study is reproduced from the Mimar Sinan Fine Arts University Scientific Research Project (BAP) titled "Research of the Monumental Architectural Heritage in Terms of Comfort Parameters and Energy Efficiency, Seljuk-Ottoman Period" coordinated by Assoc. Prof. Dr. Ümit ARPACIOĞLU.

REFERENCES

Abdou, A., Al-Homoud, M., & Budaiwi, I. (2005). Mosque Energy Performance, Part I: Energy Audit and Use Trends Based on the Analysis of Utility Billing Data. Journal of King Abdulaziz University-Engineering Sciences, 16(1), 155–173. https://doi.org/10.4197/ENG.16-1.10

Ahriz, A., Mesloub, A., Elkhayat, K., Alghaseb, M. A., Abdelhafez, M. H., & Ghosh, A. (2021). Development of a Mosque Design for a Hot, Dry Climate Based on a Holistic Bioclimatic Vision. Sustainability 2021, Vol. 13, Page 6254, 13(11), 6254. DOI: https://doi.org/10.3390/SU13116254

Al-Homoud, M., Abdou, A., & Budaiwi, I. (2005). Mosque Energy Performance, Part II: Monitoring of Energy End Use in a Hot-Humid Climate. *Journal of King Abdulaziz University-Engineering Sciences*, *16*(1), 175–191. https://doi.org/10.4197/ENG.16-1.11

Al-Homoud, M. S., Abdou, A. A., & Budaiwi, I. M. (2009). Assessment of monitored energy use and thermal comfort conditions in mosques in hot-humid climates. *Energy and Buildings*, *41*(6), 607–614. https://doi.org/10.1016/J.ENBUILD.2008.12.005

Baykara, T. (2002). "Konya", Türkiye Diyanet Vakfı İslâm Ansiklopedisi, 26, s. 182-187.

Zhang, L. (2014). Simulation Analysis of Built Environment Based on Design Builder Software. Applied Mechanics and Materials, 580–583, 3134–3137. https://doi.org/10.4028/WWW.SCIENTIFIC.NET/AMM.580-583.3134

SÜRDÜRÜLEBİLİRLİK VE MİMARLIK EĞİTİMİ

Sustainability and Architectural Education