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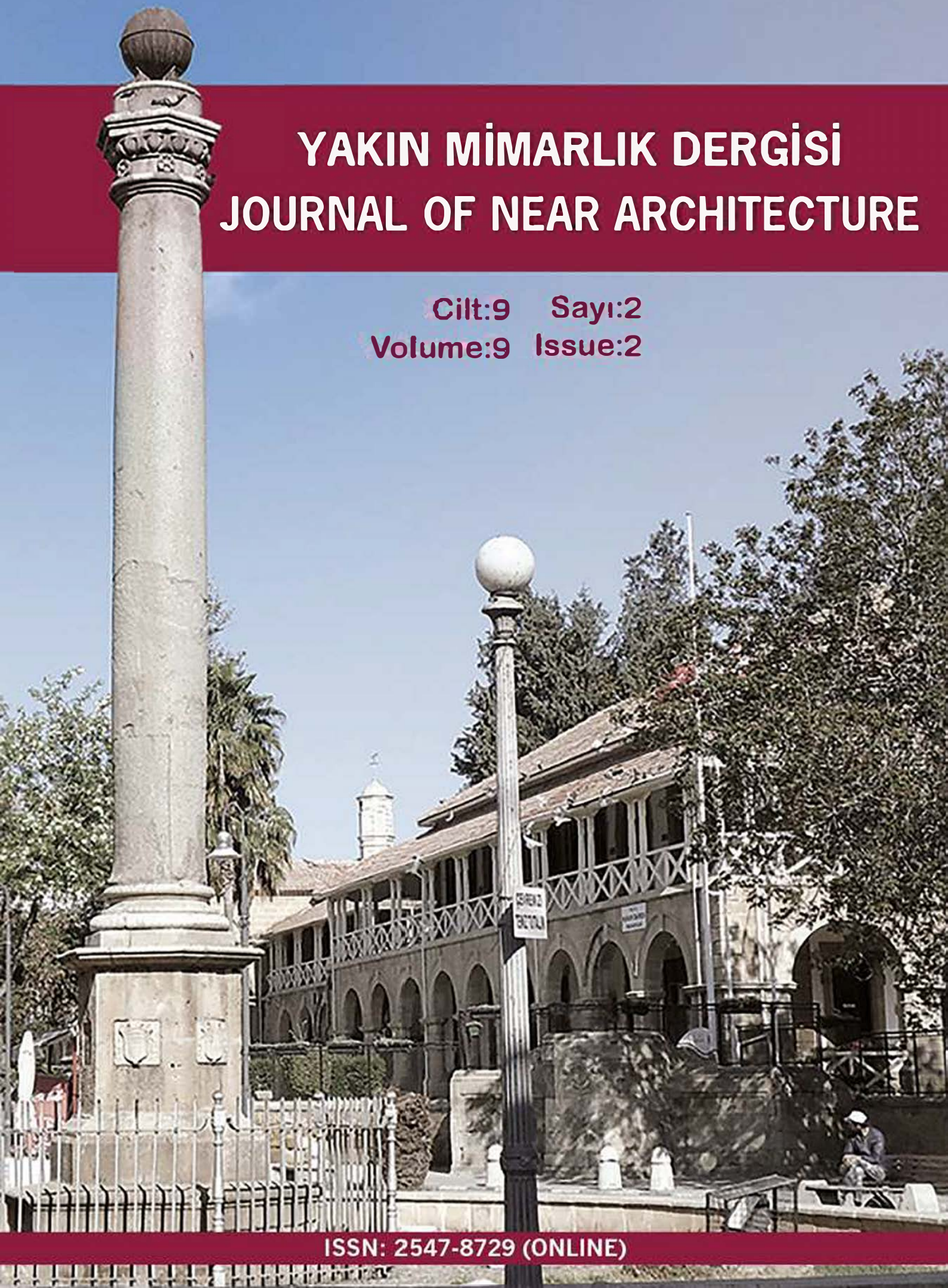

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EDİTÖRDEN

Değerli Okurlar,

Yeni bir sayımızla yine sizlerle birlikte olmaktan ve bu sayı ile yayın hayatımızın dokuzuncu yılını tamamlamaktan mutluyuz, gururluyuz.

Değerli hakemlerimizin çok özenli değerlendirmelerineticesinde yayınlanması onaylanan, farklı ve özel konuları içeren makalelerimizin, mimarlık için değerli katkılar sağlayacağını umuyoruz.

Yine bir akademik yılın başlangıcında, meslektaşlarımıza verimli bir çalışma dönemi dilerken, bilimsel araştırmalarının da değerli yayınlarla taçlanacağını biliyor ve bu konuda paydaş olmaktan mutluluk duyacağımızı belirtiriz.

6 Ekim 2025 tarihindeki Dünya Mimarlık Günü ‘nün teması, “Güç için Tasarım” olarak belirlenmiştir. Biz de tüm meslektaşlarımızın başarılı çalışmalarıyla her zaman güçlü olmasını diler, bu yayında katkısı olan ve emeği geçen herkese teşekkürlerimizi sunarız. Yeniden buluşana kadar sağlıkla, sevgiyle ve mimarca kalın.

Saygılarımla

Prof. Dr. Zihni Turkan

Baş Editör

EDITOR’S MESSAGE

Dear Readers,

We are delighted and proud to be with you again with a new issue and to complete our ninth year of publication with this issue.

We hope that our articles, covering diverse and specialized topics and approved for publication after the meticulous evaluations of our esteemed referees, will make valuable contributions to architecture.

As we begin another academic year, we wish our colleagues a productive academic year. We know that their scientific research will be crowned with valuable publications, and we are delighted to be a partner in this endeavor.

The theme of World Architecture Day on October 6, 2025, has been chosen as "Design for Strength." We wish all our colleagues continued strength through their successful work and extend our gratitude to everyone who contributed to and contributed to this publication. Stay healthy, full of love, and as architect until we meet again.

Regards

Prof. Dr. Zihni Turkan

Chief Editor

İÇİNDEKİLER

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Gaziantep ve Lefkoşa kenti surlariçi geleneksel konutlarının termal konfor açısından değerlendirilmesi

Evaluation of the traditional houses of Gaziantep and Nicosia walled city in terms of thermal comfort

Mizgine KARAASLAN [1]
Turgay SALİHOĞLU [2]

ÖZET

Sanayi Devrimi'nden sonra ortaya çıkan sosyal ve çevresel sorunlara karşı bir yanıt olarak yeniden tanımlanan sürdürülebilirlik kavramı, enerji tüketimini azaltan, kullanıcı konforuna öncelik veren ve mimaride doğal kaynakları en verimli şekilde kullanan yaklaşımları ortaya çıkarmıştır. Termal konfor, iç mekânda yaşam kalitesinin temel bir ölçütü olup, yapının kullanıcıya hava hareketleri, nem ve sıcaklık açısından ideal bir ortam sunmasını ifade etmektedir. Özellikle değişen iklim koşullarında, tüketilen enerjiyi minimum seviyeye indirerek doğal iklimlendirme olan termal konforu sağlamak, sürdürülebilir mimarinin başlıca hedeflerinden biri olmuştur. Bu araştırma, farklı iklim koşullarına sahip Gaziantep ve Lefkoşa Surlariçi'ndeki geleneksel yapıların, termal konforu nasıl sağladığını irdeleyip ve bu doğrultuda sürdürülebilir mimari anlayışına nasıl katkıda bulunduğunu değerlendirmektedir. Gaziantep'in karasal iklimine uyumlu şekilde inşa edilen geleneksel evler, dar sokaklar, kalın taş duvarlar, avlu düzenlemeleri, yerel taş kullanımı ve yüksek tavanlarıyla yazın serin, kışın ısı yalıtımını sağlayacak şekilde tasarlanmıştır. Lefkoşa Surlariçi'ndeki geleneksel evler de Akdeniz iklimine uyum sağlayacak şekilde taş ve kerpiç malzeme kullanımı, avlular, doğal havalandırma öğeleri ve yüksek tavanlarıyla yaz sıcaklarına karşı verimli çözümler sunmaktadır. Gaziantep ve Lefkoşa Surlariçi'ndeki geleneksel yapılar yönlenme, açıklık düzenlemeleri, mekânsal organizasyon ve malzeme seçimi gibi mimari öğeler, yaşam kalitesini artırmak ve enerji tüketimini azaltmak amacıyla tasarlanıp, termal konforu sağlamaktadır. Sonuç olarak, Gaziantep ve Lefkoşa Surlariçi'ndeki geleneksel yapılar, yerel iklimle uyumlu olarak şekillenip, kültürel ve estetik değerleri taşıyarak, aynı zamanda sürdürülebilir mimarinin modern ilkelerine rehberlik eden değerli örnekler olarak kabul edilmektedir.

Anahtar kelimeler: *Sürdürülebilir mimarlık, Termal konfor, Geleneksel yapılar, Gaziantep, Lefkoşa surlariçi.*

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ABSTRACT

The concept of sustainability, redefined as a response to the social and environmental problems that emerged after the Industrial Revolution, has led to approaches that reduce energy consumption, prioritize user comfort, and utilize natural resources in architecture in the most efficient way. Thermal comfort, a fundamental measure of indoor quality of life, refers to a building's ability to provide an ideal environment in terms of air movement, humidity, and temperature. Especially under changing climate conditions, achieving thermal comfort through natural climate control while minimizing energy consumption has become one of the main goals of sustainable architecture. This study examines how traditional buildings in Gaziantep and the Walled City of Nicosia, which have different climatic conditions, achieve thermal comfort and how they contribute to the understanding of sustainable architecture in this context. Traditional houses in Gaziantep, adapted to the continental climate, are designed to stay cool in summer and provide insulation in winter through features such as narrow streets, thick stone walls, courtyard arrangements, the use of local stone, and high ceilings. Likewise, traditional houses in the Walled City of Nicosia, adapted to the Mediterranean climate, offer efficient solutions to summer heat through the use of stone and adobe materials, courtyards, natural ventilation elements, and high ceilings. The architectural elements of traditional buildings in Gaziantep and the Walled City of Nicosia such as orientation, the arrangement of openings, spatial organization, and material selection are designed to enhance quality of life and reduce energy consumption, thereby achieving thermal comfort. In conclusion, the traditional buildings of Gaziantep and the Walled City of Nicosia, shaped in harmony with the local climate and reflecting cultural and aesthetic values, are recognized as valuable examples that also guide the modern principles of sustainable architecture.

Keywords: *Sustainable architecture, Thermal comfort, Traditional buildings, Gaziantep, Nicosia walled city.*

1. GİRİŞ

Sanayi Devrimi, insanlık tarihinin dönüştürücü bir süreci olarak 18. yüzyılın sonları ile 19. yüzyılı kapsayan bir dönemde yaşanmıştır. Bu dönem, tarihte önemli bir kırılma noktası olmuştur. Sanayileşme, teknolojik ilerlemeler ve büyük ekonomik büyüme getirirken, aynı zamanda kaynakların tükenmesi, ormansızlaşma ve kirlilik gibi çevresel sorunların ortaya çıkmasına da neden olmuştur. Ayrıca, artan sosyal eşitsizlikler ve zorlu çalışma koşulları gibi toplumsal sorunlar da gündeme gelmiştir. Tüketime yönelik kısa vadeli odaklanma ve kitlesel üretim, kaynakları hızla tüketen ve sürdürülemez döngüler oluşturan uygulamalara yol açmıştır. Fosil yakıt kullanımındaki artış, çevresel tahribatı daha da ağırlaştırırken, bu kaynaklara duyulan bağımlılık uzun vadede ciddi problemlere neden olmuştur. 20. yüzyılın ortalarında, sürdürülebilirlik kavramı, Sanayi Devrimi'nin ekonomi, toplum ve çevre üzerindeki olumsuz etkilerine bir tepki olarak gelişmiştir. Sürdürülebilirlik, mevcut ihtiyaçları karşılamanın yanı sıra, gelecek kuşakların kendi gereksinimlerini karşılama imkânlarını riske atmama prensibini ifade etmektedir. Bu kavram, çevresel, sosyal ve ekonomik unsurları bir araya getirerek kalkınmaya dengeli bir yaklaşım sunmayı amaçlayan bütüncül bir anlayışı temsil eder. Sürdürülebilirliğin temel hedefi, çevrenin, insanların ve toplulukların uzun vadeli refah ve sağlığını destekleyecek sistemler, yöntemler ve yaşam biçimleri oluşturmaktır (Allen, 2017; Schwab, 2019).

1970'li yıllarda bilim insanları, sosyal reformcular ve çevreciler, sadece ekonomik büyümeye odaklanmanın yeterli olmadığını, aynı zamanda toplumun ve çevrenin refahını da dikkate alan yeni bir kalkınma modeli gerektiğini vurguladılar. Bu dönem, insan yaşam kalitesini yükseltmeyi ve çevresel etkileri en aza indirmeyi hedefleyen sürdürülebilir mimarinin ortaya çıkışına da sahne olmuştur. Sürdürülebilir mimari, doğal kaynakları en verimli şekilde kullanan, enerji tüketimini minimuma indiren ve yaşam döngüsü boyunca çevre dostu olmayı hedefleyen yapıların tasarımı ile inşasını ifade eder. Bu yaklaşım, binaların yalnızca estetik açıdan hoş ve konforlu olmasını değil, aynı zamanda işlevselliklerini uzun vadede korumasını da amaçlar (Bennetts vd., 2003). Sürdürülebilir mimaride, çevreye verilen zararı en aza indirmek, enerji verimliliğini artırmak ve kullanıcıların yaşam kalitesini yükseltmek öncelikli hedefler arasında yer alır. Bu doğrultuda, yenilenebilir ve geri dönüştürülebilir malzemelerin tercih edilmesi, enerji tasarrufu sağlayan teknolojilerin uygulanması, doğal aydınlatma ve havalandırma sistemlerinin kullanılması gibi yöntemler ön plana çıkar. Böylece hem çevresel sürdürülebilirlik hem de ekonomik verimlilik sağlanırken, yapıların karbon ayak izi önemli ölçüde azaltılır ve performansları uzun vadede korunmuş olur (Şahinöz, 2019; Çiğan ve Yamaçlı, 2020).

Sürdürülebilir mimarinin temel unsurlarından biri, doğal iklimlendirmenin bir diğer deyimle termal konforun sağlanmasıdır. Bilim insanlarının ortaya koyduğu veya yeniden tanımladığı termal konfor, iç mekân sıcaklığını ideal düzeyde tutarak kullanıcıların enerji tüketimi yüksek sistemlere (örneğin, ısıtma cihazları veya klima) ihtiyaç duymadan rahat hissetmelerini ifade etmektedir. Kullanıcıların yaşam kalitesi açısından kritik bir unsur olan termal konfor, yalnızca bireylerin fiziksel rahatlığını ve sağlığını desteklemekle kalmaz, aynı zamanda bir binanın enerji tüketimini optimize ederek sürdürülebilirlik hedeflerine ulaşmasına da katkıda bulunur. İç mekân sıcaklıklarının mevsimsel koşullara uygun şekilde düzenlenmesi hem konfor seviyesini artırır hem de gereksiz enerji kullanımını önleyerek çevresel etkilerin azaltılmasına yardımcı olur. Bu nedenle termal konfor, enerji verimliliği, iklim dostu teknolojiler ve sürdürülebilir tasarım ilkeleriyle doğrudan ilişkilidir. Birbirini tamamlayan bu unsurlar, teknolojik ilerlemenin insan refahıyla ve çevrenin korunmasıyla dengelenmesini sağlayan bütüncül bir kalkınma yaklaşımının önemini açıkça ortaya koyar. Böyle bir yaklaşım hem mevcut yaşam standartlarını iyileştirmeyi hem de gelecek nesillerin sağlıklı, yaşanabilir çevrelere sahip olmasını güvence altına almayı hedefler (Gezer, 2013; Nagashima vd., 2018).

Hâlbuki tüm bu unsurların geleneksel mimaride var olduğunu görülmektedir. Çünkü geleneksel mimari, yüzyıllar boyunca gelişerek termal konfor sağlayan ortamlar oluşturmak amacıyla tasarlanmış çeşitli bina stilleri ve tekniklerini içermektedir. Termal konfor, insanların ne çok soğuk ne de aşırı sıcak hissettikleri, iç mekân sıcaklıklarının refah ve sağlık için uygun olduğu bir durumu etmektedir. Geleneksel konutlar ise, belirli bir bölge, kültür ya da tarihi döneme ait tasarımlar, malzemeler ve yöntemler kullanılarak inşa edilen yapıları tanımlamaktadır. Geleneksel yapılar, çevresel koşullar ve yerel iklimlere uyum sağlayarak, ideal termal konforu elde etmek için modern mekanik sistemlere, örneğin merkezi ısıtma ya da klima gibi, çok bağımlı olmadan özgün yöntemler geliştirmiştir.

Bu teknikler, yalnızca konfor sunmakla kalmaz, bunun yanı sıra sürdürülebilir olup, günümüzde çevre dostu ve enerji verimli binalar inşa etme çabalarına da uygundur (Bekar ve Altuntaş, 2021).

Bu çalışmada, Türkiye' den Gaziantep ve Kıbrıs'ın başkenti olan Lefkoşa Surlariçi geleneksel evleri, termal konfor şartları açısından detaylı bir şekilde incelenmiştir. Gaziantep'in geleneksel evleri, bölgenin sosyal yapısını, iklim özelliklerini ve zengin kültürel mirasını yansıtmaktadır. Anadolu'da Gaziantep kentindeki geleneksel evlerin örnek alınma nedeni, bölgenin iklimine uyum sağlayan yerel mimari özelliklere sahip olması ve kentin Tarihi İpek Yolu üzerinde yer alarak tarih boyunca insan hareketliliğinin yoğun olduğu bir uğrak noktası olmasıdır. Hem işlevsellik hem de yerel gelenekleri bir araya getiren bu yapılar, iklime duyarlı mimarinin mükemmel örneklerinden biridir.

Lefkoşa Surlariçi geleneksel evleri, Kıbrıs'ın mimari ve kültürel mirasının önemli bir unsuru olarak öne çıkmaktadır. Kıbrıs'ın başkenti Lefkoşa'nın tarihi surları içinde bulunan bu yapılar, adanın benzersiz kültürel etkilerini ve tarihini yansıtarak, Akdeniz iklimine uyum sağlayacak şekilde tasarlanmıştır. Kıbrıs Adası'nda Lefkoşa kentinin örnek olarak seçilmesinin sebebi, adanın zengin bakır madenlerine sahip olması, Akdeniz ticaret yolu üzerinde bulunması ve bölgedeki stratejik konumu sayesinde tarih boyunca sürekli insan hareketlerine sahne olmasıdır. Tüm bu insan hareketlerine rağmen, kendi kendine has bir geleneksel mimari oluşmuştur. Surlariçi geleneksel evlerinin mimarisi hem estetik açıdan hem de işlevsel olarak kendine özgü bir karakter sunmaktadır.

2. METODOLOJİ

Bu çalışmada, Gaziantep ve Lefkoşa Surlariçi'ndeki geleneksel evler termal konfor açısından araştırılıp değerlendirilmiştir. Çalışmada nitel araştırma yöntemi kullanılmış, yerinde fotoğraf çekimi, analiz ve gözlem gibi görsel-analitik yöntemler kullanılmıştır. Araştırmanın veri toplama sürecinde ise, her iki bölgede bulunan geleneksel yapılar, belirlenen mimari kriterlere göre incelenmiştir. Bu kriterler; arazi kullanımı ve yönlenme, mekân organizasyonu, yapı malzemesi, avlu, açıklıklar (kapı ve pencere) ve cumba gibi yerel mimarinin temel öğelerini kapsamaktadır. Bu analiz parametreleri, yalnızca geleneksel mimarinin fiziksel ve işlevsel özelliklerini değil, aynı zamanda sürdürülebilirlik ilke ve hedefleriyle olan ilişkisini de ortaya koymaktadır. Yerel malzeme kullanımı, doğal havalandırma, pasif ısıtma-soğutma çözümleri, gölgeleme elemanları ve iç-dış mekân ilişkileri gibi mimari unsurlar hem Gaziantep hem de Lefkoşa Surlariçi'ndeki çevresel sürdürülebilirliği destekleyen stratejiler olarak öne çıkmaktadır. Bu bağlamda çalışma, geleneksel mimarinin sürdürülebilir tasarım yaklaşımlarıyla nasıl örtüştüğünü ortaya koymayı amaçlamaktadır. Alan çalışması sırasında elde edilen bulgular, geleneksel yapıların çevresel koşullara ve yerel iklime göre nasıl tasarlandığını anlamaya yönelik incelenmiştir.

Her yapının sürdürülebilirlik potansiyeli, çevre ile etkileşimi ve kullanıcı konforu belirlenen kriterlere göre göz önünde bulundurulmuştur. Son olarak, elde edilen tüm değerlendirilip, her iki bölgenin yerel mimari yaklaşımları termal konfor (doğal iklimlendirme) çerçevesinde yorumlanmıştır.

3. ALAN ÇALIŞMASI

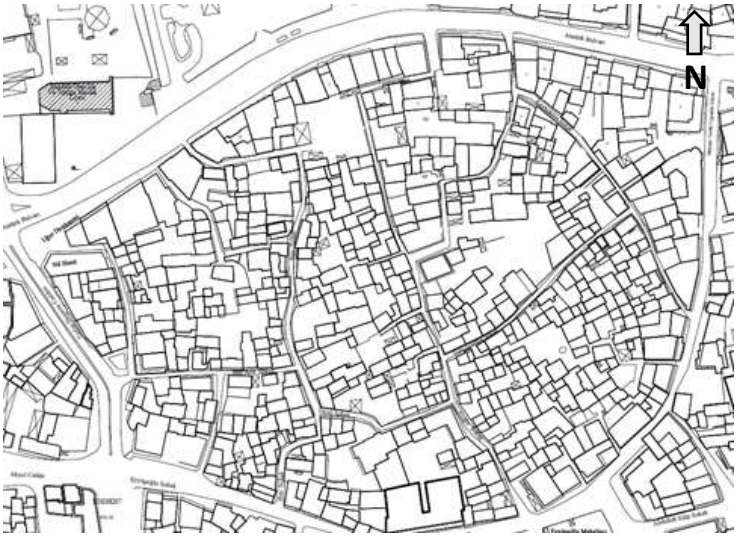
3.1. Gaziantep Kenti

Gaziantep kenti, Türkiye'nin güneydoğusunda bulunan, 2.500 yılı aşkın geçmişiyle dünyanın en eski yerleşim bölgelerinden biridir. Coğrafi açıdan, Gaziantep, Güneydoğu Anadolu ile Akdeniz bölgelerinin birleşim noktasında yer almaktadır ve bu stratejik konumu, farklı medeniyetler ve kültürler arasında bir köprü işlevi görerek tarihi bir rol üstlenmiştir. Gaziantep, karasal iklim ile Akdeniz iklimi arasında bir geçiş iklimine sahiptir. Yazlar sıcak ve kuru, kışlar ise soğuk ve yağışlı geçmektedir. Gaziantep'in en soğuk ayı Ocak, en sıcak ayları ise Temmuz ve Ağustos'tur. Gaziantep'te yılın en düşük sıcaklık değeri -17,5 C^{o}, en yüksek sıcaklık değeri ise 44,0 C^{o}, yıllık ortalama sıcaklık ise 14,9 C^{o}'dir (Uğur, 2004; Karaaslan, 2020).

3.1.1. Gaziantep Geleneksel Evleri

Gaziantep, Türkiye'nin güneydoğusunda yer alan ve zengin mimari ile tarihi mirasıyla öne çıkan önemli bir kenttir. Şehir, tarih boyunca birçok medeniyete ev sahipliği yapmış olup, bu birikim mimarisine de yansımıştır. Gaziantep'in geleneksel evleri, bölgenin kültürel çeşitliliğini ve yaşam tarzını yansıtan mimari yapılar arasında yer alır. Bu evler, taş malzeme kullanımı, yüksek duvarlar ve avlu düzenlemesiyle dikkat çeker. Genellikle sokaktan tamamen izole edilmiş olan bu avlular, özel yaşam alanlarını koruma amacı taşır. Evler, yerel iklim koşullarına uyumlu olarak inşa edilmiştir. Mahalle dokusu ise organik olarak gelişmiş, dar sokaklar ve çıkmaz sokaklarla şekillenmiştir. Gaziantep evleri, hem estetik hem de işlevsel özellikleriyle geleneksel mimarinin yaşatıldığı değerli örneklerdendir (Deringöl, 2015; Kaleoğlu Kanalıcı, 2012). Aşağıda, Gaziantep'in geleneksel mimarisine ait temel özellikler vurgulanmıştır:

Arazi kullanımı ve yönlenme: Gaziantep'te, konutların mekânlarının farklı yönlere bakması sağlanarak termal konfor artırılmıştır. Evler genellikle güneye yönelmekle olup, bazı yapılarda avlu etrafında konumlanan iki binadan biri güneye (kıble ev), diğeri kuzeye (poyraz ev) bakmakta olup, bu iki ev aynı aile tarafından yazlık ve kışlık olarak kullanılmaktadır. Bu düzenleme, güneş ışığından maksimum düzeyde faydalanma amacıyla tercih edilmiştir. Kuzeye bakan poyraz evler, bahar ve yaz aylarında güneşi arkalarına aldıkları için kullanılırken, güneye bakan bol güneş alan kıble evler ise kışın tercih edilmektedir. Kuzeye bakan evler, kullanım süresi daha kısa olduğu için genellikle iki katlıdır. Güneye bakan evler ise kullanım süresi daha fazladır, bu yüzden daha korunaklı olup, iç kapaklı pencerelere ve kalın duvarlara sahiptir, genellikle iki ya da üç katlıdır. Gaziantep'in geleneksel dokusunu oluşturan bölgelerde, arazi eğiminin az olması, parsel şekillerinin oluşumu ve yapıların parsel kullanımında esnek çözümler geliştirilmesine olanak tanımıştır. Gaziantep geleneksel evleri, genellikle dar parseller üzerinde uzun ve derin bir yerleşim planına sahip olarak inşa edilmiştir (Şekil 1). Bu yaklaşım, mevcut arazinin en verimli şekilde kullanılmasını sağlarken, aile için korunaklı ve özel bir alan sağlamaktadır. Ayrıca, topoğrafyaya uyum sağlama amacıyla bina yapımında zemine yapılan müdahalelerin minimum seviyede olduğu dikkat çekmektedir. Bu evlerde, bodrum katlarda mahzen ya da mağara kullanımının yaygın olduğu da görülmektedir (Yüce, 2010).



Şekil 1. Gaziantep yerel mimaride arazi kullanımı ve yönlenme (Gaziantep Şahinbey Belediyesi, 2025).

Mekân organizasyonu: Geleneksel Gaziantep evleri incelendiğinde, yüksek duvarların arkasında avlu etrafına yerleştirilmiş bir plana sahip olduğu gözlenmektedir. Mezopotamya bölgesinde sıkça rastlanan ve Gaziantep yerel mimarisinin önemli unsurlarından biri olan kabaltı da bu yapılarda öne çıkar. Kabaltı, aynı konuta ait iki yapının sokak üzerinde birleşmesiyle oluşan bir yapıdır ve yarı açık bir alan sunarak kışın ve yazın yağmurdan ve güneşten ve korunma imkânı sağlamaktadır (Şekil 2). Gaziantep geleneksel evleri mekân organizasyonu incelendiği zaman Erman ve Geyyas'ında (2022) belirttiği gibi, Gaziantep geleneksel evleri, komşularla bitişik nizamda, duvarlarla çevrili avluların etrafında inşa edilmiş tek bir yapıdan veya yazlık ve kışlık olmak üzere iki ayrı binadan oluşmaktadır. Binanın alt katında, avludan merdivenle inilen ve soğuk depo olarak kullanılan bir mağara yer alır. Üst katta ise, avludan merdivenle erişilen yaşam alanları bulunur. Mekânların yönüne bakıldığında, yatma ve yaşam alanlarının genellikle güneye baktığı dikkat çekmektedir. Açık veya doğramalarla kapatılmış eyvanlar, yazın yarı açık bir alan olarak güneşten korunma sağlar ve kapı ile pencereler aracılığıyla doğal iklimlendirme imkânı sunar. Kış aylarında ise eyvan, kış bahçesi etkisiyle sera etkisi yaratarak ısınmaya katkıda bulunur. Mutfak genellikle evin arka ya da yan kısmında konumlanır ve ana sosyal alanlardan ayrılmıştır. Gaziantep geleneksel evlerinin çoğunda, hamam evin daha özel ya da iç kısmında, genellikle mutfağa yakın bir yerde yer alır. Bu düzenleme, sıcak suya kolay erişim sağlamak açısından önemli bir rol oynamaktadır (Şekil 3). İklimsel özelliklere uygun olarak, geleneksel mimaride tavan yükseklikleri genellikle 3.5 ila 4.0 metre arasında, standart ölçülerden daha yüksektir. Bu yükseklik, sıcak bölgelerde sıcak havanın yukarıda birikmesine olanak tanıyarak oturma alanlarının serin kalmasını sağlar. Bu tasarım yaklaşımı, yaz aylarında iç mekânların daha konforlu ve yaşanabilir olmasını desteklemektedir.

Şekil 2. Yerel mimaride kabaltı (Taştan, 2019).

Şekil 3. Yerel mimaride mekân organizasyonu (Serinkaya, 2017).

Yapı malzemesi: Gaziantep yerel evleri, yığma yapı tekniğiyle taş malzeme kullanılarak inşa edilmiştir (Şekil 4). Taş malzemenin bölgede bolca bulunması, kolay işlenebilirliği ve yerel iklim koşullarına uyum sağlaması, bu malzemenin tercih edilmesinde belirleyici bir rol oynamıştır. Bu konuda Atalar'larda (2004) detaylı bir araştırma yapmıştır. Gaziantep'in geleneksel mimarisinde, sıcak yaz iklimine uyum sağlamak için binaların dış duvarlarında, yüksek ısıl kütleye sahip yerel taş olan havara taşı tercih edilmiştir. Bu taş, dış hava sıcaklıklarının yüksek olduğu yaz aylarında, ısı transferini yavaşlatarak sıcaklığın iç mekâna ulaşmasını engellemektedir. Gece, dış ortam sıcaklığı düştüğünde, duvarlar yüksek yüzey sıcaklıkları sayesinde hızla ısıl ışıma yaparak enerji kaybeder ve serinler. Bu özellik, kuru ve sıcak iklim koşullarında taş duvarların, ısıl yalıtımdan daha etkili bir enerji verimliliği sağladığını göstermektedir. Gaziantep geleneksel evlerinde, cephe duvarlar genellikle 60-100 cm kalınlığında taş duvarlarla inşa edilmiştir. İç mekânda ise tavan ve duvarlar ahşap malzemeyle kaplanmış, bu sayede ahşap, sıcak bir malzeme olarak iç mekânı taş duvarlardan yalıtmıştır (Şekil 5).

Şekil 4. Dış mekânda taş kullanımı (Yazar, 2025)

Şekil 5. İç mekânda tavanda ve duvarlarda ahşap kullanımı (Kaleoğlu Kanalıcı, 2022)

Avlu: Gaziantep geleneksel evleri, içe dönük bir tasarımla avlulu olarak inşa edilmiştir. Yüksek avlu duvarları, komşu binalar veya ana yapılar, özellikle güneşin tepede olmadığı saatlerde avlu içinde gölge alanlar oluşturmaktadır. Sokak üzerindeki avlu duvarlarının yükseklikleri genellikle 4.0 ila 7.0 metre arasında değişmektedir. Bu evlerde avlu genişliği, bina genişliğinin yaklaşık olarak üç katı büyüklüğündedir. Günlük yaşam alanı olarak kullanılan avlularda mahremiyeti sağlamak için konutlar arasındaki görsel bağlantılar mümkün olduğunca kesilmiştir. Avluların ortasında, gane adı verilen ve günlük işlerde de kullanılan havuzlar yer almaktadır. Bu havuzlar, ortamın nem oranını artırıp serinlik hissi yaratmaktadır. Ayrıca, avlunun bir köşesine veya ortasına dikilen çınar ve selvi gibi ağaçlar, yaz aylarında konut ve avlu içindeki ışıma ve güneş ışığı etkisini azaltmaktadır (Karslıgil Ünal, 2007), (Şekil 6).

Şekil 6. Gaziantep yerel mimaride avlu (URL 1).

Açıklıklar (kapı ve pencere): Yapılar yazlık ve kışlık olarak ayrılmış birden fazla binadan oluşuyorsa, cephelerdeki doluluk ve boşluk oranları da farklılık göstermektedir. Kışlık evler, daha az açıklıklı olarak tasarlanmaktadır. Pencerelerin iç kısmında iki kapaklı ahşap panjurlar yer almaktadır. Bu panjurlar, yazın doğrudan gelen güneş ışınlarını ve ışınımı engellerken, kışın soğuk havanın etkisini azaltır (Şekil 7). Gaziantep geleneksel evlerinde odalara genellikle sofalar üzerinden giriş yapılmaktadır. Sofadan odaya geçişi sağlayan kapının bir ya da iki tarafında, odanın diğer pencereleriyle aynı özelliklere sahip pencereler yer almaktadır. Bu pencereler, yarı açık bir alan olarak tasarlanan eyvanlar kullanılarak doğal aydınlatma ve çapraz havalandırma sağlamak amacıyla yapılmıştır (Atalar, 2004). Kuş pencereleri ise genellikle oda pencereleriyle aynı hizaya, biraz daha yukarıda konumlanmış, çeşitli şekillerde tasarlanmış pencerelerdir (Şekil 8). Bu pencereler, odanın daha iyi aydınlatılmasını sağlayarak, doğrudan gelen ışınımı engelleyip ve ısınan havanın yükselerek hava dolaşımını artırmaktadır. İç kısımlarında bir kapakla kapatılan kuş pencerelerinin, ortalama boyutları ise 35x60 cm'dir (Erman ve Geyyas, 2022).

Şekil 7. Gaziantep yerel mimaride panjur kullanımı (Yazar, 2025).

Şekil 8. Gaziantep yerel mimaride kapı ve Pencereler (Yazar, 2025).

Cumba: Cumba, bazı Gaziantep geleneksel evlerinde yer alan ve öne çıkan bir mimari unsurdur (Şekil 9). Estetik bir katkı sunmanın yanı sıra, cumba iç mekânın genişlemesine olanak tanır, doğal ışık miktarını artırıp ve dış manzaralara erişim sağlamaktadır. Fonksiyonel bir tasarım öğesi olan bu yapı elemanı, Gaziantep yerel evlerinde genellikle 1.0 - 1.5 metre uzunluğunda, dikdörtgen ya da kemerli şekillerde tasarlanmıştır. Geniş açıklıkları sayesinde cumba, hava sirkülasyonunu ve havalandırmayı iyileştirme konusunda da önemli bir rol oynamaktadır (Kaleoğlu Kanalıcı, 2012).

Şekil 9. Gaziantep yerel mimaride cumba (Dik, 2006).

3.2. Lefkoşa Surlariçi

Stratejik konumu ve coğrafi özellikleri nedeniyle Kıbrıs, tarih boyunca farklı kültürler ve toplumların uğrak noktası olmuştur. Tüm bu insan hareketlerine rağmen Kıbrıs'ın kendine has yerel bir mimarisi oluşmuştur. Bu yerel mimariyi Lefkoşa Kenti Surlar içinde de görmekteyiz. Lefkoşa Kenti, Akdeniz ikliminin etkisinde olmasına rağmen, iç bölgede bulunması nedeniyle daha çok karasal bir iklim özelliği taşımaktadır. Yazları sıcak ve kurak, kışları ılıman ve yağışlıdır Lefkoşa'da yılın en düşük sıcaklık değeri 9,0 Cº, en yüksek sıcaklık değerinin ise 40,0 Cº üzerinde olduğu görülmektedir (Gezer, 2013).

3.2.1. Lefkoşa Surlariçi Geleneksel Evleri

Lefkoşa Surlariçi'ndeki geleneksel evler, kentin tarihî dokusunu oluşturan önemli unsurlardan biridir ve bölgenin kültürel, iklimsel ve tarihi dinamiklerini yansıtan özgün yapılar arasında yer alır. Bu evler, çoğunlukla arka avlulu, tek ya da iki katlı olup, yerel malzeme ve mimari tekniklerle inşa edilmiştir. Yeniden işlevlendirme yoluyla günümüz koşullarına uyarlanarak yaşatılan bu yapılar, geçmişle kurulan fiziksel ve duygusal bağın sürdürülebilirliğini sağlar. Geleneksel yapı teknikleri, doğal havalandırma, gölgeleme ve yerel iklime uygun planlama gibi çevresel tasarım ilkeleriyle desteklenmiştir. Bu sayede evler, sadece estetik açıdan değil, aynı zamanda çevresel ve kültürel sürdürülebilirlik açısından da değer kazanmıştır. Her bir yapı, toplumun belleğini taşıyan birer kültürel miras öğesi olarak korunmakta ve geleceğe aktarılmaktadır (Altan, 2016; Pulhan, 1997). Aşağıda, Lefkoşa Surlariçi'nin geleneksel mimarisine ait temel özellikler vurgulanmıştır:

Arazi kullanımı ve yönlenme: Lefkoşa Surlariçi'ndeki geleneksel evlerin arazi kullanımı ve yönelimi, şehrin sosyal yapısıyla ve çevreyle uyum sağlama gerekliliği doğrultusunda şekillenmiştir. Sıkışık yapı düzeni ve dar sokaklar, Surlariçi'ndeki sınırlı alanın bir yansımasıdır (Şekil 10). Bu sınırlamalar, evlerin mevcut araziyi en etkin biçimde değerlendirecek şekilde tasarlanmasına neden olmuş, genellikle derin planlı ve dar cepheli olarak inşa edilmiştir. Evlerin yönelimi ise büyük ölçüde çevresel koşullara, özellikle de sıcak Akdeniz iklimine uyum sağlama ihtiyacına göre belirlenmiştir. Geleneksel yapılar, doğal unsurlardan yararlanarak yaşam konforunu artıracak şekilde yönlendirilmiştir. Sokaklar genellikle doğu-batı doğrultusunda uzanır. Konut yerleşiminde hâkim rüzgârlar belirleyici olup, kışın soğuk kuzey rüzgârlarından korunacak, yazın ise batı ve kuzeybatıdan esen serinletici rüzgârlardan faydalanacak düzenlenmiştir. Yapıların en uzun cephesi, günün en sıcak saatlerinde güneş ışığını en aza indirip gölgeyi artıracak bir doğrultuda konumlandırılmıştır (Oktay ve Önal, 1998).

Şekil 10. Lefkoşa Surlariçi yerel mimaride arazi kullanımı ve yönlenme (URL 2).

Mekân organizasyonu: Lefkoşa Surlariçi'ndeki geleneksel evlerin konut tipolojileri incelendiğinde, yapıların genellikle simetrik plan ve orta sofalı oldukları görülmektedir. Alt katta sokağa bakan iki oda ve avluda yer alan mutfak, hamam gibi ıslak hacimler bulunurken, üst katta yaşam odaları ve cumbalı bir orta sofa yer almaktadır. Geleneksel evler genellikle iki katlıdır; zemin kat hizmet amaçlı kullanılırken, üst katlar yatma alanları olarak düzenlenmiştir (Şekil 11,12). Bu dikey yapılaşma, sınırlı alanı etkin bir şekilde değerlendirme imkânı sunmuştur. Alt katlar daha az mahremiyet gerektiren işlevlere ayrılırken, üst katlar daha özel ve sakin yaşam alanlarını barındırmaktadır. Yaz aylarında serinlik sağlamak için iç mekânlarda tavan yüksekliği genellikle 3.5-4.0 metre arasında tasarlanmıştır, böylece insan boyunu (yaklaşık 1.75m) aşan yükseklikelerde sıcak hava birikimi önlenmektedir (Koşanlar, 2019).

Şekil 11. Lefkoşa Surlariçi yerel mimaride İki katlı yapılar (URL 3).

Şekil 12. Lefkoşa Surlariçi yerel mekân organizasyonu (URL 4).

Yapı malzemesi: Lefkoşa Surlariçi'ndeki geleneksel yapılarda cephe malzemesi olarak kerpiç ve taş kullanılmıştır (Şekil 13). Duvarlarda dolgu malzemesi olarak kerpiç bloklar kullanılırken, köşelerde Kıbrıs'a özgü yerel bir malzeme olan sarı taş düşey taşıyıcı eleman olarak görev yapmıştır. Ahşap, geleneksel yapıların birçok bölümünde önemli bir malzeme olarak öne çıkmaktadır. Kapı, pencere ve tavan yapımında yaygın olarak kullanılan ahşap, çok katlı evlerin üst katlarını destekleyen kirişlerde de sıkça tercih edilmiştir (Şekil 14). Bunun yanı sıra, panjur ve balkonların inşasında da kullanılan ahşap, gölgeleme ve güneşten korunma amacıyla tasarlanmıştır (Philokyprou vb., 2017).

Şekil 13. Cephede taş kullanımı (Yazar, 2024).

Şekil 14. Tavanda ahşap kullanımı (Yazar, 2024).

Avlu: Geleneksel evler, bitişik nizamda ve genellikle arka avlulu bir düzenle inşa edilmiştir. Mimari detayları ve boyutları mütevazı olan bu evlerin neredeyse tamamında, iç mekânlar çok işlevli bir avlunun etrafında şekillendirilmiştir. Surlariçi yerel mimarisinde avlu, en yaygın açık alan unsurudur ve Surlariçi'ndeki konutların çoğunda görülür. Avlular genellikle düzensiz veya dikdörtgen bir plana sahiptir ve bir ya da iki katlı yapılarla yüksek çevre duvarları tarafından çevrelenir. Evler, genellikle iç mekânlara ışık ve hava akışı sağlamak, aynı zamanda aile etkinlikleri için alan yaratmak amacıyla avlulu olarak tasarlanmıştır. Genellikle, günlük işler için kullanılan bu avlular, aynı zamanda mahremiyet sağlamaktadır. Lefkoşa Surlariçi' ndeki bazı evlerde küçük bir havuz ve birkaç ağacın yer aldığı avlular, yarı özel ya da özel bir dış mekân oluşturur. Havuz, alanın nem oranını artırarak serinlik hissi verirken, ağaçlar gölge sağlayarak güneş ışığının etkisini azaltır (Ekim, 2012; Laleci, 2017), (Şekil 15).

Şekil 15. Lefkoşa Surlariçi yerel mimaride arka avlu (Yazar, 2024).

Açıklıklar (kapı ve pencere): Lefkoşa Surlariçi'ndeki geleneksel evlerde kapılar, genellikle mütevazı yükseklikle sahip cephelerde yer alan ve ev sahibinin sosyal statüsünü dış dünyaya yansıtan önemli bir mimari öğedir. Bu evlerde zemin kattaki pencereler genellikle göz hizasından daha yukarıda konumlandırılmıştır ve çift kapaklı ahşap panjurlarla donatılmıştır. Panjurlar, yaz aylarında doğrudan güneş ışınlarını engelleyerek iç mekânı serin tutarken, kışın ise soğuk havanın etkisini azaltmaktadır (Şekil 16). Bu konuda Koşanlar (2019) da detaylı bir araştırma yapmıştır. Osmanlı döneminde inşa edilen bu yapıların temel tasarım nedeni mahremiyet sağlamaktı. Ancak, İngiliz dönemine geçişle birlikte, Surlariçi'ndeki geleneksel Osmanlı yapıları daha dışa dönük bir yapı kazandı ve sokak yaşamına daha açık hale geldi. Bu dönüşüm, zemin kattaki pencerelerin sayısında ve boyutlarında bir artışla kendini gösterdi.

Şekil 16. Lefkoşa Surlariçi yerel mimaride sokak cephesi (Yazar, 2024).

Cumba: Lefkoşa Surlariçi'ndeki geleneksel evlerin en belirgin özelliklerinden biri olan cumba, süslü kornişler veya ahşap panjurlar gibi dekoratif detaylarla zenginleştirilmiş olup, evin kültürel kimliğini ve zanaatkârlığını sergileyen bir mimari unsurdur. Lefkoşa'nın sıcak yazları ve ılıman kışlarıyla karakterize edilen Akdeniz iklimi, cumbaların tasarımında etkili olmuştur. Lefkoşa Surlariçi'ndeki geleneksel evlerde yer alan cumbalar, iç mekâna daha fazla doğal ışık girmesini sağlamaktadır. Duvarın dışına doğru taşarak daha geniş bir pencere açıklığı oluşturur ve özellikle üst katlardaki odaların güneş ışığından daha yoğun biçimde yararlanmasına imkân tanımaktadır. Ayrıca, cumbalar havalandırma işlevi de görür; uzun pencere yapıları, hava akışını artırarak iç mekânın serinlemesine yardımcı olur (Turkan, 2018), (Şekil 17). Bununla birlikte, cumbalar yalnızca işlevsel değil, aynı zamanda estetik bir değere de sahiptir. Surlariçi bölgesindeki geleneksel evlerin en belirgin özelliklerinden biri olan cumbalar, sokaklarda çıkıntılı bir yapı dizisi oluşturarak evlerin dış cephelerine görsel bir zenginlik katmaktadır.

Şekil 17. Lefkoşa Surlariçi yerel mimaride cumba (Yazar, 2024).

4. GAZİANTEP ve LEFKOŞA KENTİ SURİÇİNDEKİ GELENEKSEL EVLERİN TERMAL KONFOR (DOĞAL İKLİMLENDİRME) AÇISINDAN DEĞERLENDİRİLMESİ

Gaziantep ve Lefkoşa Surlariçi, yerel iklimlerine uygun mimari tasarımlar sergileyerek, geleneksel yapıların stratejik yönlendirme ve doğal havalandırmayla termal konforu sağladığı görülmektedir.

Gaziantep'teki yerel konutların termal konforu sağlamasının esas nedeni, bölgenin kuru, sıcak yazları ve yağışlı, soğuk kışlarına yönelik tasarım stratejileri ve mimari özelliklerin bir sonucudur. Dar sokaklar, yüksek duvarların oluşturduğu gölgeler sayesinde doğrudan güneş ışığına maruz kalma süresini azaltırken, evler, güneş ışığını ve doğal havalandırmayı en üst seviyeye çıkarmak için dikkatlice yönlendirilmiştir. Örneğin, yapılar genellikle iki farklı yönelime göre yerleştirilmiştir; biri yazın serinlik sağlamak amacıyla kuzeye, diğeri ise kışın ısınma amacıyla güneye bakacak şekilde yerleştirilmiştir. Gaziantep'in yerel yapılarındaki kabaltı yapısı, iki binanın bir araya gelerek yarı kapalı alan oluşturmasıyla yağmurdan ve güneşten korunmayı sağlamaktadır. Yaşama alanları güneye doğru yerleştirilerek kış aylarında güneşten daha fazla yararlanmayı sağlayıp, eyvan ise kışın ısınma, yazın ise serinlik sağlamaktadır. Hamam ve mutfak gibi alanlar, yapının işlevselliğini artıracak şekilde evin iç kısımlarında yer almaktadır. Bu tasarım ilkesi, Gaziantep'in iklimine uygun olarak işlevsellik ve rahatlık sunmaktadır. Ayrıca, yapılardaki kuş pencereleri ve yüksek tavanlar yaklaşık 3,5 ila 4.0 metre, sıcak havanın yükselmesini sağlayarak, iç mekânın serin olmasına katkı sağlamaktadır. Yerel malzeme olarak havara taşının kullanılması, yapılarda termal konfor açısından önemli bir rol oynamaktadır. Geleneksel yapılardaki kalın taş duvarlar, ısı depolama kapasitesiyle, gündüzleri ısıyı emip geceleri ise ısıyı yavaşça salarak iç mekândaki sıcaklığın dengelemesine yardımcı olmaktadır. Ayrıca, yapıların tasarımında, yaşam alanlarını doğrudan güneş ışığından koruyan, evin içinde serin ve gölgeli alanlar oluşturan avlular yer almaktadır. Bu avlular, gane (havuz) adı verilen su öğelerini içermektedir, bu da ortamdaki nem oranını arttırıp havayı serinletmektedir. Bir diğer deyimle evaporatif soğutma elde edilmiştir. Ayrıca asma ya da servi gibi ağaçların varlığı da gölge sağlayarak yazın serinliği arttırıp, termal konfora katkıda bulunmaktadır. Bazı geleneksel yapılarda bulunan cumba ise, evin içinde havanın dolaşmasına olanak tanır, yaz aylarında termal konforu sağlamak için büyük bir öneme sahiptir.

Lefkoşa Surlariçi'ndeki geleneksel yapılar da, mimarinin belirli kültürel miras bağlamında ve iklime nasıl uyum sağladığına dair önemli veriler sunmaktadır. Bu yapılar, yerel Akdeniz iklimini anlamayı yansıtarak, ılıman kışlar ve sıcak yazlara göre karakterize edilip, fonksiyonel ve estetik değerleri korurken, termal konforu en üst seviyeye ulaştırmak üzere tasarlanmıştır. Surlariçi'nin sıkışık yerleşimi ve dar sokakları, doğal havalandırmayı artırarak, yapıların doğrudan güneş ışığı almasını engelleyecek şekilde yönlendirilmesine imkân tanımaktadır. Lefkoşa Surlariçi'ndeki bazı evlerdeki avlular, küçük havuzlar ve ağaçlar ile yarı özel veya özel dış mekânlar oluşturur; havuz, nem oranını artırarak serinlik sağlarken, ağaçlar gölge yaparak güneş ışığının etkisini azaltır ve bu sayede evaporatif soğutma elde edilmiştir. Cumba gibi unsurlar ve tavan yüksekliği yaklaşık olarak 3.5 ile 4.0 metre olan yapılar, hava akışını sağlayarak iç mekânın serin olmasını sağlamaktadır. Ayrıca, kerpiç, taş ve ahşap gibi yerel malzemeler, yapıların termal kütlesiyle birleşip, gündüzleri ısıyı emerek geceleri ise serbest bırakarak iç ortam sıcaklıklarını düzenlemektedir (Tablo 1).

Tablo 1: Gaziantep ve Lefkoşa Surlariçi geleneksel evlerinin yerel mimari karakteristikleri

Kriter	Gaziantep	Lefkoşa Surlariçi
Arazi Kullanımı ve Yönlenme	Yapılar genellikle kuzey ve güney yönlerinde konumlanarak mevsimlere göre güneşten maksimum fayda sağlanmaktadır. Dar sokaklar ve yüksek duvarlar sayesinde gölgelenme artırılmaktadır.	Yapılar sıkışık yerleşim düzeninde yer almakta, dar sokaklar aracılığıyla doğal havalandırma sağlanmaktadır. Güneş ışığından korunmak için yönlenme stratejik şekilde ayarlanmaktadır.
Mekân Organizasyonu	Yaşam alanları güneye yerleştirilerek kışın ısınma sağlanmaktadır. Eyvan yazın serinlik, kışın ısınma amacıyla kullanılmaktadır. Hamam ve mutfak iç kısımlarda yer almakta, kabaltılar yarı açık alan oluşturarak gölge ve koruma sağlamaktadır.	Avlular, yarı özel alanlar olarak organize edilmekte, yaşam alanları bu avlular etrafında şekillenmektedir. Mekânlar, yaz aylarında serinliği artıracak şekilde ağaç ve havuz gibi unsurların etrafında konumlandırılmaktadır.
Yapı Malzemesi	Havara taşı gibi yerel malzemeler kullanılmaktadır.	Kerpiç, taş ve ahşap gibi yerel malzemeler kullanılmaktadır.
Avlu	Avlular, iç mekânları doğrudan güneşten koruyarak gölgeli ve serin alanlar yaratmaktadır. Gane (havuz)	Avlular, küçük havuzlar ve ağaçlarla donatılarak serinlik sağlamakta ve yarı özel açık mekânlar oluşturmaktadır. Su ve bitki öğeleri

	ve ağaçlar ile evaporatif soğutma sağlanmaktadır.	sayesinde ortam nemi artırılarak evaporatif serinlik elde edilmektedir.
Açıklıklar (Kapı, Pencere)	Kuş pencereleri, 3,5–4,0 m tavan yüksekliği sıcak havanın yükselmesini sağlamaktadır.	Pencere ve kapı açıklıkları, yapının iç hava dolaşımını artıracak şekilde yerleştirilmiştir. 3,5–4,0 m tavan yüksekliği hava akışını artırmaktadır.
Cumba	Bazı evlerde bulunan cumbalar hava dolaşımına katkı sağlamakta, yazın iç mekân serinliğini artırmaktadır. Özellikle hava akımını yönlendiren bir unsur olarak kullanılmaktadır.	Cumbalar iç hava dolaşımını artırmakta ve güneşten korunma sağlamakta, iç mekânda termal dengeye yardımcı olmaktadır. Hem estetik hem işlevsel olarak önemli bir mimari öğedir.

Sonuç olarak, farklı iklim koşullarına sahip Gaziantep ve Lefkoşa Kenti Surlariçi geleneksel yapıları, iklime duyarlı mimari çözümleriyle, sürdürülebilir mimari açısından önemli örnekler sunmaktadır. İki farklı bölgede de geleneksel yapılar, termal konforu sağlamak amacıyla yerel iklimle uyumlu, özenli mekânsal organizasyon ve doğal malzemeler gibi tasarım yaklaşımlarını bir araya getirmiştir. Gaziantep ve Lefkoşa Kenti Surlariçi'ndeki, yerel malzemelerin kullanımını, stratejik yönlendirmeyi ve doğal havalandırmayı ön planda tutan sürdürülebilir yapı teknikleri geliştirilmiş, böylece mekanik soğutma ve ısıtma sistemlerine olan bağımlılık minimum seviyeye indirgenmiştir. Bu yerel yapılar, termal konforu sağlayarak, aynı zamanda kültürel kimlik duygusunu yaratarak bugün ile geçmiş arasındaki bağı güçlendirmektedir. Yaklaşımlar iklimsel koşullara göre değişse de, her iki bölgede geleneksel tasarımın çağdaş ihtiyaçlara iklim dostu ve sürdürülebilir bir şekilde nasıl karşılık verebildiğini ortaya koymaktadır.

5. SONUÇ

Bu araştırma, Gaziantep ve Lefkoşa Surlariçi'ndeki geleneksel yapıların, termal konfor bağlamında incelenmesini ve bu geleneksel yapıların yerel iklim şartlarına nasıl uyum sağladığını ortaya koymaktadır. Farklı iklim koşullarına sahip iki bölgede, yerel mimari, çevresel faktörlere bağlı olarak gelişip, hem kullanıcı konforunu sağlayıp hem de sürdürülebilirlik prensiplerini de desteklemiştir. Geleneksel yapıların termal konfor bağlamında incelenip değerlendirilmesi, sürdürülebilir mimari yaklaşımının geçmişte nasıl uygulandığını anlamak açısından son derece önemlidir. Geleneksel konutlar, doğanın sunduğu kaynakları etkin bir şekilde kullanarak ve yerel iklim koşullarını göz önünde bulundurarak, kullanıcılarına konforlu ve sağlıklı yaşam alanları sunmuştur. Bu yapılar, çağdaş mekanik sistemlerin olmadığı dönemlerde, iç mekân sıcaklıklarını düzenlemek için doğal unsurlardan yararlanmış ve böylece enerji gereksinimi en aza indirilmiştir.

Gaziantep ve Lefkoşa'daki geleneksel mimari, sağladığı termal konfor yöntemleriyle günümüz sürdürülebilir mimarlık ilkelerine doğrudan katkı sunmaktadır. Her iki kentte de görülen kalın taş duvarlar, yerel malzeme kullanımı, avlular, doğal havalandırma, yüksek tavanlar ve gölgeleme unsurları, yalnızca işlevsel ve estetik değil, aynı zamanda çevresel sürdürülebilirliği destekleyen özellikler sunmaktadır. Bu örnekler, geleneksel yapıların iklim odaklı çözümleriyle modern sürdürülebilir tasarımlara ilham verdiğini göstermektedir. Bu yerel yapılar, sıcak yaz aylarında serinliği sağlamak, soğuk kış aylarında ise ısı kaybını önlemek amacıyla, doğal kaynaklardan faydalanarak termal konforu ve düşük enerji tüketimini elde etmeyi başarmıştır. Bu geleneksel konutlar hem termal konforu sağlayıp hem de kültürel ve toplumsal sürdürülebilirliği desteklemektedir. Yapıların avlu gibi sosyal alanlar etrafında oluşması, toplumsal dayanışmayı artıran ve komşuluk ilişkilerini güçlendiren bir yapının oluşmasını sağlamıştır. Ayrıca yerel malzeme kullanımı, doğal kaynakların etkin bir şekilde kullanılmasını sağlamıştır. Yerel mimarinin bu şekilde enerji etkinliği, sosyal dayanışma ve çevresel etki gibi unsurları bir arada sunma şekli, günümüzdeki sürdürülebilir mimarlık anlayışı için değerli bir miras oluşturmaktadır.

Sonuç olarak, geleneksel yapılar, çevresel sürdürülebilirliği destekleyen ve termal konforu doğal yöntemlerle sağlayabilen yapılar olarak, günümüz mimarlık anlayışına ilham vermektedir. Çağdaş mimarinin karşılaştığı sürdürülebilirlik ve enerji verimliliği sorunları, yerel mimari öğelerinin tekrar değerlendirilmesiyle büyük oranda çözülebilir. Bu yapılar, doğal kaynakları verimli kullanarak, enerji tüketimini azaltıp, çevresel, kültürel ve toplumsal sürdürülebilirliği de desteklemektedir. Dolayısıyla, geleneksel mimarinin bugünün yapılarına entegre edilmesi, yarının daha enerji verimli ve çevre dostu yapılarının da temelini oluşturacaktır.

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3d spaces in architecture: Structural examples and user experience in Bitlis

Mimaride 3 boyutlu mekânlar: Bitlis'te yapısal örnekler ve kullanıcı deneyimi

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ABSTRACT

After the outbreak of the pandemic in 2020, which had a global impact, the concept of space, both as a definition and as an experience, has moved far away from traditional frameworks that only describe a physical realm. It has introduced "Virtual Spaces" into our lives, making it necessary to reconsider the concept of space. This study focuses on the city of Bitlis and its 3D virtual representations of its historical sites, taking into account the richness of its cultural heritage, while investigating what differences emerge between physical and virtual spaces in terms of user experience. The research includes elements of historical heritage that already have virtual data in the digital environment, such as Ahlat Seljuk Square Cemetery, Bitlis City Center, İhlasiye Medrese, Hizan City Center, and the Döküktaş Church. The differences in the navigation schema between virtual and physical spaces were evaluated based on users' experiences in virtual spaces. In this context, a field study was conducted with 22 participants, limited to some questions and tasks directed at them. Thus, the reasons behind the differences in navigation experiences between virtual and physical spaces, based on the users' experiences, were explored. The results of interviews conducted through a virtual platform revealed the user's virtual space experience and the variety of this experience.

As a result, it was observed that the increase in virtual space data enhances the visibility of the city and sparks curiosity in individuals, thus creating a desire to physically experience the space. Additionally, due to Bitlis' scattered urban texture, it was found that 3D representations of historical sites enable a richer spatial experience.

Keywords: *3D Spaces, Bitlis, Cultural heritage, Physical space, Virtual space.*

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Bu makale, Narin Onat'ın Dicle Üniversitesi Fen Bilimleri Enstitüsü'nde yapmış olduğu "Tarihsel Süreçte Kamusal Mekânın Değişim ve Dönüşümünün Kavramsal Analizi: Gelenekselden Sanala" isimli doktora tezinden üretilmiştir.

ÖZET

2020'de patlak veren ve küresel bir etki yaratan pandeminin ardından mekân kavramı, hem bir tanım hem de bir deneyim olarak, yalnızca fiziksel bir alanı tarif eden geleneksel çerçevelerden çok uzaklaşıp, "Sanal Mekânları" hayatımıza sokarak mekân kavramının yeniden ele alınmasını gerekli kılmıştır. Sanal olanın mimarideki tezahürünü kullanıcı merkezli bir bakış açısıyla fiziksel olanla karşılaştırmayı amaçlayan bu çalışma, kültürel mirasının zenginliğini göz önünde bulundurarak Bitlis şehrine ve tarihi mekanlarının 3 boyutlu sanal temsillerine odaklanmaktadır. Araştırma, Ahlat Selçuklu Meydan Mezarlığı, Bitlis Şehir Merkezi, İhlasiye Medresesi, Hizan Şehir Merkezi ve Dökütaş Kilisesi gibi dijital ortamda halihazırda sanal verisi bulunan tarihi miras unsurlarını içermektedir. Sanal ve fiziksel mekânlar arasındaki navigasyon şemasındaki farklılıklar, kullanıcıların sanal mekânlardaki deneyimlerinden yola çıkılarak değerlendirilmiştir. Bu kapsamda 22 katılımcı ile kendilerine yöneltilen bazı soru ve görevlerle sınırlı bir saha çalışması gerçekleştirilmiştir. Böylece kullanıcıların deneyimlerinden yola çıkılarak sanal ve fiziksel mekânlar arasındaki gezinme deneyimlerindeki farklılıkların nedenleri araştırılmıştır. Sanal bir platform üzerinden gerçekleştirilen görüşmelerin sonuçları, kullanıcının sanal mekân deneyimini ve bu deneyimin çeşitliliğini ortaya koymaktadır.

Sonuç olarak, sanal mekân verilerindeki artışın kentin görünürlüğünü artırdığı ve bireylerde merak uyandırarak mekânı fiziksel olarak deneyimleme isteği yarattığı gözlemlenmiştir. Ayrıca Bitlis'in dağınık kent dokusu nedeniyle tarihi mekanların 3 boyutlu temsillerinin daha zengin bir mekansal deneyim sağladığı tespit edilmiştir.

Anahtar Kelimeler: *3 boyutlu mekânlar, Bitlis, Kültürel miras, Fiziksel mekân, Sanal mekân.*

1. INTRODUCTION

Space, by definition, is a complex and multifaceted concept, and as such, it has been considered a concept worthy of research for many disciplines. In its most general definition, the concept of space—used to describe the limited, physical things in which we live and act—is the domain of disciplines such as philosophy, mathematics, sociology, politics, and even history. Architecture, on the other hand, can be defined as a practice that, without considering the characteristics of space or its context, is relatively less open to debate. This situation is directly related to the fact that space has been approached for many years as a geometric and volumetric void (Zevi, 1999 and Hasol, 1999). Thus, technological, sociological, and historical contexts have been incorporated into the spatial dimension of architecture only later.

First defined by Aristotle as "a dynamic field consisting of places that contain all directions and characteristics" (Partorekes, 1992), the concept of space is described by Karabey as a multidimensional perception. Heidegger, on the other hand, explains the concept of space as "Space includes linear orientations, measurable, calculable dimensions (2018). The essence of space is the extension within this void" (Aydınlı, 2003).

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Although architecture needs to conceptualize space as an object related only to its physical qualities without taking into account the evolutionary process of contemporary architecture, space reminds us of itself with a meaning far beyond these qualities. The concept of space, which was initially associated with a geometric concept, has transformed with Cartesian thought, abstracting its meaning and taking the position of an object opposite the subject (Lefebvre, 2014). Therefore, it is not possible to speak of a purely objective, volumetric, or self-contained spatiality. As Lefebvre states, "… until the 1970s, space referred to something defined mathematically (1991)." At this point, Casey expresses the changing meaning of space, which has undergone both conceptual and social fragmentation, as "the inclusive volumetric void in which things are located, an arena of action that is at once physical, historical, social, and cultural" (1997). Thus, space diverges from the definition accepted by architecture as "a part of science's quantitative and analytical aspect" (Portugali, 2006), repositioning itself technologically, socially, and historically.

Neither purely object or physical; nor abstract and cognitive. But at the same time, it is something produced formally or socially within its context. When considered alongside the concept of time rather than as a static and lifeless physical space, it refers to a perceived, fluid, variable, and living production. This living space, identified with the body, is the space of experiences, emotions, and excitement. For this reason, Lefebvre argues that every living being is a body-space and relates this to the person's self-production there and, consequently, to the production of their space (2014). Lefebvre produces the concept of the spatial triad by referring to the contradictions, relationships, partnerships, or conflicts that space contains. This conceptualization can be explained as "spatial production, spatial representation, and representational space," based on the experience-based concepts of "perceived, designed, and lived" and derived from linguistic production (Lefebvre, 2014).

Even when considered solely in these contexts, space encompasses a meaning that is too broad to be confined to a purely physical assessment. Space, which can be experienced in multiple dimensions, is reproduced practically and theoretically by establishing relationships with other spatial formations. Rather than being merely a physical phenomenon, space can also be explained in terms of perception, interaction, and communication, acquiring a subjective and abstract character alongside measurable and objective data. "Architecture does not consist of the width, length, and height of the structural elements surrounding space.

Space is defined through these elements. In reality, space is the defined void that is experienced and moved within, surrounded by these elements" (Zevi, 2015). Modern thought re-conceptualizes space as absolute space. Thus, the concept of boundaries comes into play, and geometric rules are defined.

Like Newton's understanding of absolute space, it is generally expressed by abstracting it from qualities other than physical, geometric, volumetric, and three-dimensional qualities. However, spaces are a multidimensional and multifaceted concept that carries traces of many disciplinary dimensions, such as physical, social, psychological, philosophical, historical, environmental, and ideological.

Technology and new media channels add a new dimension to this versatility of space, transforming its concrete and abstract characteristics. In other words, they have added a dimension that diversifies the language of communication and opens up new possibilities in spatial design. In this new dimension, space has become a concept that can be placed in entirely new contexts, differentiating design, experience, perception, and form, and promising new discourses about space as it differentiates. Especially after the Covid-19 pandemic that began in 2020, the relationship with the virtual world (space) has become stronger due to physical limitations. This situation has led to changes in the nature of computer games, the proliferation of new media platforms, the widespread use of social networks, and, of course, an increase in virtual spaces in the field of architecture. Spaces that cannot be physically experienced are being recreated using virtual environment data, offering a new and unmediated experience. In this virtual space where personal experiences take center stage, a mental space formation that allows for the perception of all senses rather than just a visual experience comes into play. This visually centered experience enables the space to change dimensions, shift locations through mental associations, and facilitate the formation of new identities.

The concept of 'space' is as important for social, economic and political issues as it is for architecture. In recent years, especially as a result of technological developments, space is not only something we experience physically, but also something that allows for virtual travel and experience. Space, both in terms of definition and experience, has moved far away from a space defined only by the physical in traditional patterns and has made it necessary to reconsider space by introducing 'Virtual Spaces' into our lives. Aiming for a near-real experience, virtual technologies have tried to adapt the experience of space to virtual spaces by imitating the processes that take place in physical space. Spaces formed by interconnected areas bring with them the necessity of establishing a ground for circulation, just like in the physical world. The space that finds meaning virtually has now become a space that is rethought with different concepts. These concepts can be characterized as virtual wandering, the digital experience of the virtual or simply relating to the physical.

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In order for a space to be experienced virtually, it should have various qualities just like physical spaces and there should be various auxiliary tools to provide these qualities. From this point of view, it is clear that virtual space is a matter that needs to be considered at least as much as physical space in the design phase, so it should include more than just an environment where physical space is imitated. (for conclusion) The interfaces provided by virtual reality offer highly advanced tools for imitating architectural spaces and modeling them close to reality (Henry and Furness, 1993). During the experience of the space, the user's recognition of the space to be navigated, the design of the interface where the user can explore the use of appropriate tools, and the creation of a visual effect that evokes the feeling of being in a real physical space have pointed to a new problematic for architecture. In addition, in the area described by virtuality, unlike physical space, the relationship of space with scale should be taken into consideration with the fact that the issue of scale can evolve to the point of misleading the person at any moment. In addition to the factors that will facilitate the movement of the person in the space, it should not be ignored that the visual experience also corresponds to a personal experience of space, since the personal connection with the space is completely visually constructed (Figure 1).

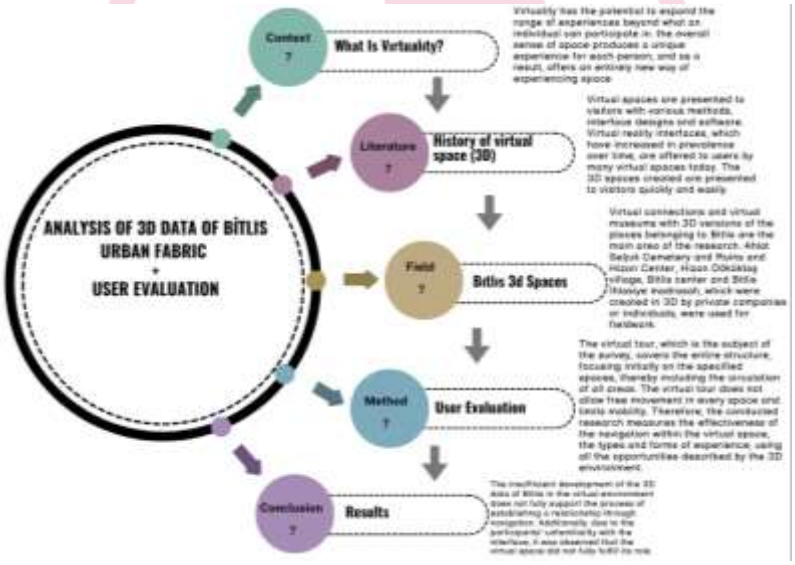

Figure 1. Methodology of the study

Virtual museums and 3D spaces - the most common ones in Turkey - are one of the places where we can experience more navigation and visual communication processes in virtual spaces. While in the physical space the museum or space experience is usually planned to relate to social memory, personal experience, publicness, freedom, can this be the case in virtual space? In other words, the question of whether the purpose of the experience promised by the physical can be exactly adapted to the virtual, and even if so, whether it will have the same effect is particularly important in the context of this study (Figure 1).

The physical museum, which is built on a systematic transfer of knowledge, provides an experience by simply existing in that space, touching, hearing and seeing the space. As a result of this experience, the space formed in one's mind points to a multifaceted cognitive fiction. However, in the virtual museum, rather than being in that space in person, being in the virtual world, using its tools and staying within the limitations described by it, a completely different experience is experienced. This experience is quite different from the physical one even in the sense that it takes place only on a visual ground. The software for virtual spaces and 3D spaces, which are presented only in the virtual world and focused on visual experience, aims to shape this experience with the tools it offers.

1.1. Literature Review

The first works involving virtual space and architecture appeared at the end of the last century. Over time, with the evolution and popularization of technology, studies have been conducted that have enabled the spread of virtual space in various fields, including the representation of cultural heritage. Research on the use of the changing concept of space in architectural practice with digital technologies is mostly explained in relation to the concepts of advantages-disadvantages, opportunities, possibilities, change, architectural education, and publicness. The study titled "Preserving cultural heritage with digital design and NFT technologies: Innovative approaches in architectural education" by Özeren et al. not only investigates the impact of digital technologies on architectural education, as in other studies, but also presents research on the use of digital technologies in the preservation of cultural heritage. (2024) Because cultural heritage elements, by their very nature, are an area where all traditional discourses related to the concept of space can be produced. But at the same time, it is an area where, in addition to all traditional narratives, the virtual space is conceptualized, experienced, and discourse is produced using digital data.

İbrahim and colleagues (2021) published a study investigating the effects of virtual reality on the study of architectural history, according to which users virtually visited famous buildings such as Le Corbusier's Villa Savoye and Frank Lloyd Wright's Fallingwater. According to the research results, the continuous structure of the virtual space was found to be more effective in acquiring spatial knowledge compared to the traditional spatial experience. In 2021, Chan and colleagues used virtual reality for the remote teaching of architectural history, reconstructing the Parthenon in Rome in a virtual environment by adding interactive and audiovisual tools. In this study, which was created based on user experience, the ways in which users expressed their experiences regarding the relationship between architectural structure and history were evaluated (Chan et al., 2021). In this study, a comparative analysis of traditional and virtual spaces was also conducted.

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Ashraf Gaafar (2021) conducted a user-based study on the use of a meta database (i.e., a multi-user immersive virtual reality aimed at teaching architectural history) in architectural heritage education in Egypt. The research, conducted in a remote education (virtual) environment using virtual data, is based on conducting architecture education entirely virtually by replacing traditional users with avatars.

1.2. Materials/ Preliminaries

Virtual connections and virtual museums with 3D versions of places belonging to Bitlis are the main area of research. Ahlat Seljuk Cemetery and Ruins, one of the virtual museums created by the Ministry of Culture and Tourism, and Hizan Center, Hizan Döküktaş village, Bitlis center and Bitlis İhlasiye madrasah, which were created in 3D by private companies or individuals, were used for fieldwork. Due to the lack of 3D data on Bitlis other than the selected places, the study was limited to the specified areas. With the surveys conducted with the users, the specified areas were experienced.

1.3. Methods

The method of the study is to evaluate how the navigation scheme between virtual and physical space differs from each other and how users experience virtual space. Accordingly, the field study was conducted with 22 participants. Thus, the reasons behind the user-based navigation experience in virtual space were tried to be clarified. As a result of the interviews conducted on a virtual platform, the user's virtual space experience and the diversity of this experience were determined, and the tourism potential that will be provided to the city as a result of the diversification and spread of this experience was questioned.

2. WHAT IS VİRTUALİTY?

Radio, cinema, television, Web 1.0, Web 2.0 and now Web 3.0. At this point, the speed of digitalization has reached such a state that it has created the need for a definition. What Thomas Friedmann called “Globalization 3.0” (Friedmann, 2005) Klaus Schwab called “The Fourth Industrial Revolution” (Schwab, 2016), and Azhar called “The Exponential Age” (Azhar, 2021). These definitional changes, which emphasize the change of digital processes, cause changes not only at the level of definition but also in practical life Cyberspace, which allows people to 'be' in the same places regardless of their geographical location, and multimedia, which can be created with sound, image and movement, bring new forms of spatial experience. This environment, which we conceptualize as 'virtual space' or 'virtual environment' in Turkish, becomes a new type of public space plane thanks to the mass communication network on which it is built, and contains images of space beyond space and place.

While its technological infrastructure methods provide advantages with new instrumentality, the new virtual space that emerges reproduces the concept of space, and continues to spread rapidly thanks to its potential to expand day by day.

Nowadays virtualization is not only a form of remote telepresence, but also a simulation of some dynamic changes in the virtual environment. Virtual environments provide the perception of movement in the visual field by changing the direction, path and speed of the viewer. The concept behind virtual reality is that it conveys the feeling of "being there." (Negroponte, 1975). Although virtual reality has been experimented with since the 1960s, mostly for computer games, until recently VR devices have been inadequate as consumer processing power has become indistinguishable for virtual environments (Kopiec, 2018). The inadequacy of VR technology has led to the development of enriched environments (Figure 2).

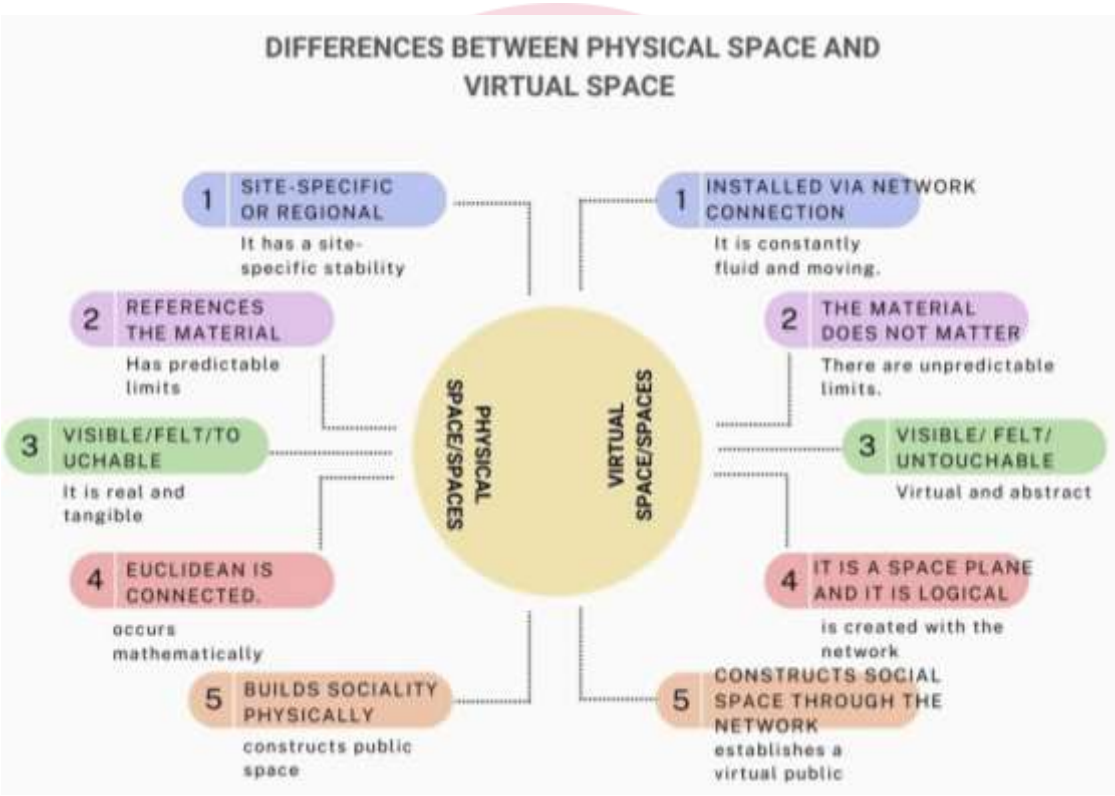

Figure 2. Differences between Physical Space and Virtual Space (source: created by the author)

The blurring of boundaries between physical and virtual spaces leads us to the fact that digital space is not completely disconnected from physical space(Figure-2). Beyond the built environment, this intersection creates an ideal environment for the designer to communicate and interact with spatial ideas, with the physical and virtual working together. Designers have begun to find ways to transfer the actions derived from this interaction and the results of these actions into cybernetic space.

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In line with the changing spatial usage practices with technological developments in recent years, virtual space requires the creation of more creative spaces for the user. These spaces have a position that triggers creativity, becoming more experiential, dynamic, open to transformation rather than being monumental in an absolute way, and changing the forms of publicness. This creative space in virtual space is essentially the space of the visitor. This space belongs to the people who use it and changes with them and their expectations. It is an environment where users learn, are inspired and develop themselves, and is represented in the visitor's memory as if it were a physical space. This technological interface now serves as a communication between the user and the user of the virtual space.

This form of communication is much different from the boundaries defined by physical space and changes the perception of time-space. From the 1990s to the 2015s, when technological developments gained momentum especially in the practice of architecture, one could speak of a kind of space in limbo, that is, a virtual space wandering around the boundaries of physical space. However, in 2015 and beyond, we can say that space rapidly ceased to be an object, lost its materiality and turned into a 'thing' that is perceived differently by everyone. This 'thing' is no longer the space of the physical world, and its speed, spatial definitions and boundaries have changed.

Surfing the web, switching between links, does not only refer to changes of location in a two-dimensional environment. It also refers to a circulation between virtual spaces. This circulation refers to a different spatiality that operates very differently from the activity of the concept of time in physical space, a spatiality that can be entered but cannot be touched, a spatiality that establishes a close connection with the physical as well as the mental experience. It points to a spatiality that promises more than a 2D or 3D visualization. Rather than a spatiality defined only by the interface, there are new mental spaces produced by the mind that thinks with the images given. The mind leaps from space to space, acquiring a new spatiality through images and the given interface. The mind is now beyond the limits of the body and therefore beyond the limits of physical space. Space, too, exists in different ways in virtual space with the images it transforms in minds, as a signifier. Real and virtual spaces are consistently superimposed; the virtual is seamlessly embedded in the physical. What virtuality offers is to make this parallel virtual world visible, to produce architecture as an enabling platform. Virtuality has the potential to expand the range of experiences beyond what an individual can participate in. the overall sense of space produces a unique experience for each person; and as a result, offers an entirely new way of experiencing space (Uğurlu and Yakın, 2015).

2.1. History of virtual space (3D)

We can see that the first examples of virtual spaces were archives or information sources. Launched in 1991 under the name 'The Museum Inside the Telephone Network', the online exhibition was able to reach only a few countries with internet access in those years. In the early 1990s, Apple created an art museum consisting of 3D virtual spaces produced with Quick Time Virtual Reality (QTVR) technology (Huhtamo, 2010) In Turkey, the first step was taken in 1990 when Topkapı Palace decided to share a part of its collection in the virtual environment (Atagok and Ozcan , 2001). Virtual spaces are presented to visitors with various methods, interface designs and software. Virtual reality interfaces, which have increased in prevalence over time, are offered to users by many virtual spaces today. The 3D spaces created are presented to visitors quickly and easily.

2.2. Navigating Virtual Space

The architectural element called space basically exists through the processes of navigating and establishing visual relationships. In virtual space, this situation should be in a position to support the person's navigational processes such as navigating and visual cognitive processes as well as describing the space. For the physical form of the space, orientation is relatively much easier than in virtual space, as it is the result of the simultaneous activation of the five sensory organs. Human beings first disassemble the information they receive from their environment and then tend to make sense of them by grouping them. The 'readability' of the cities we live in depends on their ability to be grouped into their elements (Lynch, 2012).

This situation is just like the process of breaking a sentence into its elements; finding or making sense by breaking it into parts... The roads, borders, regions, nodes and sign elements that make up the elements of the city work in harmony and undertake the task of guiding the user navigating the city (Lynch, 2012). The aforementioned elements help both orientation and navigation as elements offered by the physical environment.

When physical space is taken as a basis, we can talk about static elements and moving creatures moving between and around them. This makes it possible to move comfortably in the space, to collect information about the space and to establish information that can describe it in the mind. In virtual space, a web interface design with visual elements is necessary to present spatial arguments. An interface design should provide ease of use for the visitor beyond the aesthetics of the visual elements. Navigation not only depends on the visual acquisition of information about the space, but also on the physical movement of the person, which we can call displacement. Sebok categorizes the visual information and physical tasks performed during navigation into three groups: orientation, wayfinding and navigation (Sebok and et al 2014).

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Navigation can be defined as a goal-oriented movement of a person that includes two elements: navigation and orientation (Montello, 2005) of the route one needs to follow to get there (Montello, 2005). Orientation is moving towards the target in space (Figure 3).

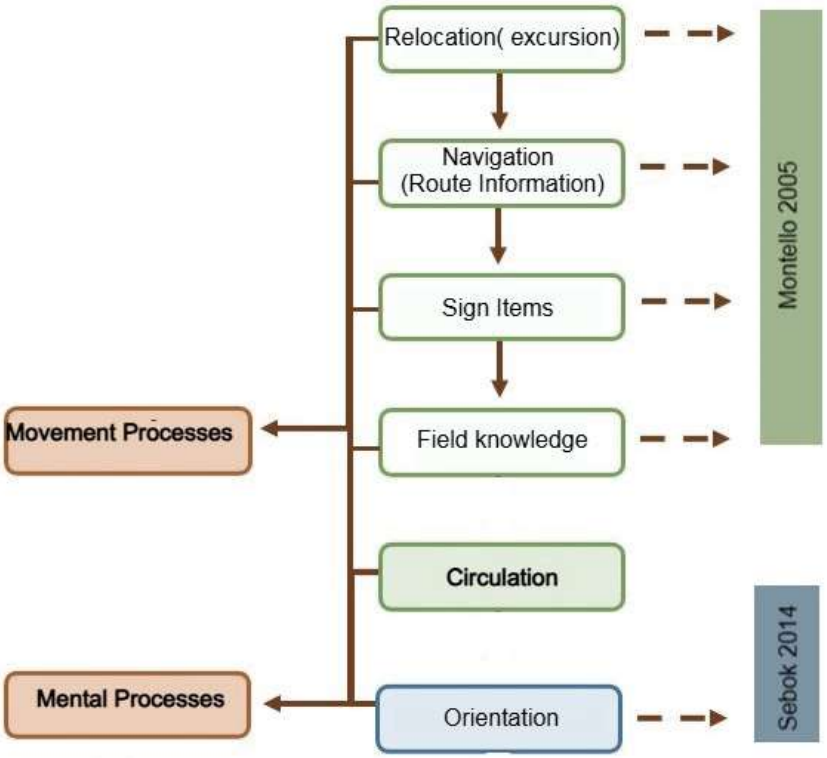

Figure 3. Navigation items in virtual space(Made by the author based on sources (Sebok and et al 2014) and (Montello, 2005)

In the created virtual space, variables such as placed sign elements, architectural differentiations, visual access tools, and the density of hand tools affect orientation(Figure-3). The realization of orientation and wayfinding tasks depends on the person's visual understanding of the space during the space experience, positioning it correctly in the mind and recording it in the mind with the mapping technique. Lynch mentions various cue elements to facilitate making sense of space and orientation. These are place-specific images that express location and that the person determines as a reference point (Lynch, 2012). Cue elements support the 'orientation' ability by helping the user to determine their position in space. This helps to draw a route to the space and to have an experience in this direction. Spatial knowledge, which develops with the experience of orientation and organization, is to comprehend the position of objects in the space and their distance to each other (Thorndyke and Goldin, 2012). Moving around the space, maps, photographs, verbal information, sign elements contribute to route and area knowledge (Thorndyke and Goldin, 2012).

Just like in physical spaces, spatial navigation is of great importance in virtual spaces. It has been observed that navigation, which involves visual cognitive practices such as navigation, wayfinding, locating or positioning as well as movement, is provided by various tools and spatial focal points presented in 3D spaces. While these spatial focal points can be made from the definitions of the physical world, the language and use of the tools have no equivalent in the physical world. In this respect, how does the experience of virtual space using these tools differ from the experience in physical space? The answer to this question is important in the context of the study.

As in physical spaces, circulation in virtual spaces depends on the person's ability to create a map with visual data about the space and to reach spatial orientation. Every movement of the body in physical space changes the field of vision, making it easier for us to collect information about the space and record it visually. Thus, the wider the field of view, the more effective the perception and orientation of the space. In virtual spaces, orientation is provided by maps and landmarks presented as data. This situation allows to reach spatial experience in the virtual environment without moving the body, only by moving and orienting the eye. As Sebok says, this navigation offers the opportunity to experience the virtual environment through various auxiliary tools (Sebok and et al 2014).

It is very difficult to obtain all the information about the space from one's point of view (Darken and Sibert, 1996). Especially due to the limited field of view in virtual environments, it is not possible to perceive even small-scale spaces from a single point of view. Therefore, in order to explore the space in the virtual environment, the ability to move in the space gains great importance. Realization of movement with minimum effort is the main purpose of virtual environments. In the interface developed in this direction, placing predetermined movement routes in the space has been an option (Campbell, 1995). As it can be understood, the acquisition of spatial information can be based on the person's experience of the virtual space and the time spent there. At the same time, maps, compasses and similar tools that we use in physical space can shape the experience of space as auxiliary tools that can be used in virtual space.

Virtual spaces produced with QTVR technology can be experienced through the control and orientation of panoramic images (Sylaiou et al, 2017) It is the ability to move that makes the space virtually effective and therefore makes navigation possible. It is important for the user to focus on the other information offered by the 3D space with the least difficulty while reaching from one specified space to another. In this respect, it is necessary to be able to perform the actions that the five sensory organs we use in physical space can do with auxiliary tools in virtual space. It is necessary to have the ability to rotate in the virtual space, to move away and zoom in, as well as tools that provide circulation between floors.

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3. A VIRTUAL SPACE PHRASE: BITLIS 3D SPACES

After the outbreak of the 2020 pandemic, which was effective all over the world, space, both in terms of definition and experience, has moved far away from an area defined only by the physical in traditional patterns and made it necessary to reconsider the space by introducing 'Virtual Spaces' into our lives. Aiming for a near-real experience, virtual technologies have tried to adapt the experience of space to virtual spaces by imitating the processes that take place in physical space.

In this framework, the study, which aims to compare the manifestation of the virtual in architecture with the physical on a user-based basis, focuses on the city of Bitlis and the data of the historical areas of the city in 3D virtual environment, considering the richness of cultural heritage. Virtual connections and virtual museums with 3D versions of the places belonging to Bitlis are the main area of the research. Ahlat Seljuk Cemetery and Ruins, one of the virtual museums created by the Ministry of Culture and Tourism, and Hizan Center, Hizan Döküktaş village, Bitlis center and Bitlis İhlasiye madrasah, which were created in 3D by private companies or individuals, were used for fieldwork. Due to the lack of 3D data on Bitlis other than the selected places, the study was limited to the specified areas. The study was basically shaped in line with these objectives.

Analyzing how 3D data created specifically for Bitlis is experienced by users, User-oriented determination of the differentiating aspects of Bitlis virtual spaces from physical space, User-oriented determination of navigation, orientation, focus and description of virtual spaces.

3.1. The Method Followed In The Research

The method used in the study involved participants navigating through the specified 3D environments, experiencing the space, and expressing this experience through various questions. Each experience content aimed to measure navigation, wayfinding, information retrieval, and mobility skills at different rates, and it was structured as the user interpreting the spatial experience. Additionally, it was important for participants to interpret the differences between physical and virtual spaces through Bitlis.

In the first step of the research, which was conducted through individual interviews, the link to the survey containing the tasks and the virtual tour links were shared with the participants. A brief introduction to the spaces and the research was provided, and the survey questions were shared. No detailed information about the 3D environments was given, and participants were expected to explore them on their own. The 3D experience, which was to proceed simultaneously with the tasks, was conducted by participants sharing their screens via the Zoom platform. This aimed to create observational and verbal data based on the participants' reactions during their virtual space experiences.

Additionally, throughout the virtual tour, the researcher and participants remained in communication, with the researcher intervening when necessary to ask questions. The expected sequence for participants was as follows: navigating the 3D environment, acquiring spatial information, and explaining their experience using the survey questions. Therefore, the tasks progressed step by step.

3D environments created from images obtained from the physical space offer a more realistic virtual tour experience that enhances the user's sense of presence in that space. One of the most important elements for navigation in the interface is the guidance tool, which provides direction. (Figure 4, 5, 6, 7, 8, 9, 10, 11)

Figure 4. Hizan Döküktaş Church exterior view (virtual data)

Figure 5. Hizan Döküktaş Church interior view (virtual data)

This tool, when clicked, allows the user to move right, left, up, and down during the navigation, and also facilitates the transition from one area to another. In this regard, it is a tool that provides time-saving during the virtual tour experience and allows for quick navigation through the space (Figure 4, 5).

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Figure 6. Hizan Center square view (virtual data)

Figure 7. Hizan Center general view (virtual data)

Additionally, spatial descriptions consisting of small images at the bottom of the virtual environment are another key tool for navigation. During the space experience, the user can either draw a navigation route indicated by arrows or navigate by clicking on the images. These 3D environments, which allow movement in the desired direction by holding down the mouse button, perform the actions that the eye can do in the physical world (Figure 6, 7).

Figure 8. Bitlis Center general view (virtual data)

Figure 9. Bitlis Ihlasiye madrasah image (virtual data)

The use of spatial reference points is common among the techniques for setting objectives in virtual museums (Figure 9). These points, accessible through a menu, are displayed as soon as the screen opens and allow the user to navigate to the desired space. They also facilitate an overview analysis of the space. By placing numerous tools in virtual environments, which encompass tasks such as movement, wayfinding, reaching a goal, space experience, and memory formation, the completion of these tasks positively impacts the use of the space. (Figure 8, 9).

Figure 10. Entrance and interior view of Ahlat Seljuk Square Cemetery Ruins (virtual data)

Figure 11. Entrance and interior view of Ahlat Seljuk Square Cemetery Ruins (virtual data)

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The nature of acquiring information about the space in virtual museums depends on the ease of use and effectiveness of the tools provided by the interface. Virtual environments produced with QTVR technology can be experienced thanks to the control and navigation of panoramic images. According to Sylaiou, what makes the space effective virtually and thus enables navigation is the ability to move (Sylaiou et al, 2017).

This is important in terms of allowing the user to focus on other information provided by the museum with minimal difficulty while moving from one space to another. From this perspective, the abilities of the five senses we use in physical spaces need to be replicated in virtual spaces through supporting tools. These include the ability to rotate within the space, zoom in and out, and the ability to navigate between floors. Additionally, features such as mapping or visual elements, which are very useful in physical spaces, are also crucial tools for interpreting the virtual space. Maps, which support memory formation about the space and the objects it contains, should indicate the user's position within the virtual environment (Sebok et al, 2014).

3.2. Interview Texts and Analyses

The main goal of the study is to investigate how various tools embedded in virtual environments support users in wayfinding, spatial experience, and information acquisition. To this end, a field study was conducted with 22 participants. The participants' professions—architect, urban planner, and civil engineer—were taken into consideration, as they are familiar with planning drawings. It was required that the users had experienced the specified 3D environment at least once in a physical setting, as this would highlight the differences between physical and virtual experiences. This condition allowed the researcher to gather more detailed data during and after the participants completed the tasks. Since the research did not involve entering a virtual environment with a random circulation forecast, constant communication with the participant was maintained. Additionally, during the virtual tour, interventions or additions were made when necessary by the researcher. The virtual tour, which is the subject of the survey, covers the entire structure, focusing initially on the specified spaces, thereby including the circulation of all areas. The virtual tour does not allow free movement in every space and limits mobility. Therefore, the conducted research measures the effectiveness of the navigation within the virtual space, the types and forms of experience, using all the opportunities described by the 3D environment. Since the user has previously experienced the physical version of these 3D environments, their first experience of the virtual environment is crucial for the survey data. This is because it is important to determine how the user, familiar with the physical space, initially struggles or does not struggle when transitioning to the virtual environment.

In this context, the following questions were asked to the users during and after their navigation of the 3D environments, and the answers provided were analyzed.

- The first question pertains to the circulation of the Ahlat Seljuk Cemetery and the Archaeological Site and was asked as follows: "What distinguishes the circulation in a virtual museum from that of a physical museum? Could you please explain?"

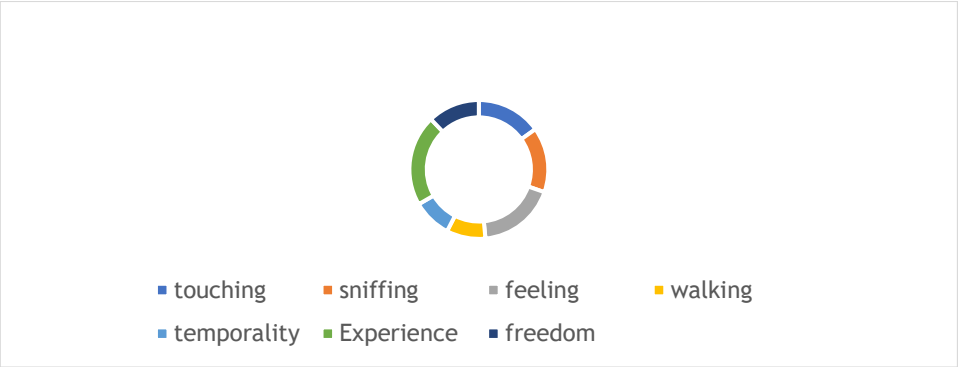

Figure 12. Graphic expression formed in line with the answers given to Question-1

All users who responded to the question stated that physical and virtual experiences are completely different. As seen in the graphical representation (Figure 12) created based on the responses, users expressed how navigation in a physical environment differs from navigation in a virtual environment.

These differences are mostly associated with the five senses, and it has been observed that virtual environments do not provide the same experience as physical environments in terms of smell, touch, and sensation. "…a person exploring a virtual environment will see the world from a perspective similar to that of a camera mounted on their head, rather than from a fixed camera position and perspective." (Chan, 1997). It has also been noted that the features of walking and being in a specific time frame, present in physical spaces, are not present in the virtual environment, creating a sense of incompleteness in the experience. Some users stated that virtual environments, with their ability to enter and exit any location and move quickly, provide a better experience than physical environments in this regard. Chan explains this situation as follows: "The success of creating a VR environment is not whether the virtual world created is as real as the physical world, but whether the created world is so real that viewers can suspend their disbelief and create the experience of being there for a while" (1997), (Figure 13, 14).

- The second question was asked to gain a more general inference regarding virtual environments based on the 3D experiences, and it is as follows: "Considering the 3D tours conducted, would you still feel the need to physically experience a space that we navigated through using the navigation tools in the virtual environment, even though it has never been physically experienced? Why?

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Figure 13. Answer to Question-2

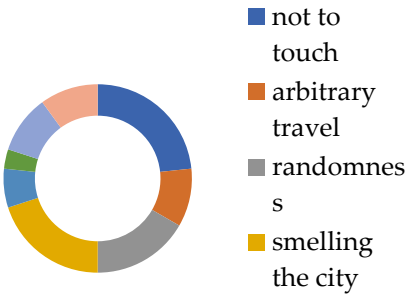

Figure 14. Graphic expression of those who said yes to Question-2

All responses to Question-2 were affirmative, with users emphasizing that it is not possible to fully experience a city they have never visited physically just through a virtual experience, and that physical navigation is absolutely necessary(Figure-13). Due to all the answers being "yes," the following question was asked to the users: "(If the answer is yes) What exactly do you base the experience of a space on? For example, which of the five senses would alter the experience?"

Users stated that the experience of a space is mostly related to touch and smell, and they mentioned that the ability of individuals to act randomly or arbitrarily also affects the experience of the space. It was observed that the limitation of route following within the specified network boundaries in the virtual space creates a disadvantage, meaning that the arbitrariness present in physical space does not exist in the virtual environment. It was emphasized that individuals are alone during their experience in virtual space, making physical spaces, in this respect, more enjoyable and public than virtual spaces (Figure-14). Architectural spatial structures are perceived and experienced through all senses and emotions. Appealing to all senses, space is perceived not only through its tactile, olfactory, and auditory characteristics but also through its luminous properties (Rasmussen, 2010).

Users associated space experience with time, stating that the fact that time in the virtual space does not align with real time and the inability to establish a time-space relationship influenced their affirmative response. Physical space is determined by its elements, measurable distances, and the interrelationships of the objects within it (Arnheim, 1977) (Usta, 1994). Perception and sensation of space means feeling it with all the senses rather than just perceiving it visually.

The third question was asked to determine whether the virtual environment is perceived as something different from the physical space. Therefore, the following question was directed to the users: "Considering the 3D tours conducted, do you feel detached from the physical space while navigating through the virtual space?"

Seven users stated that they experienced detachment, eight users mentioned that the detachment was partial, and seven users said that they never felt detached. This result reveals that 68% of users are at least partially disconnected from the physical space. This suggests that the attachment to the virtual environment is mostly based on the physical space (Figure 15).

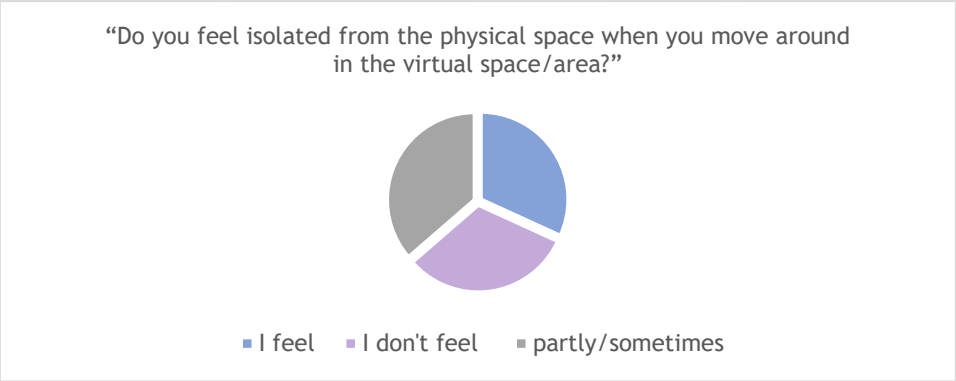

Figure 15. Response distribution graph of Question-3

For those users who expressed feeling detached, the following fourth question was directed to them: "What do you think is responsible for the detachment, and are there any VR tools you used? Are they contributing to this detachment?"

Users generally describe what leads to detachment with concepts such as focus, becoming part of the flow, temporary pleasure, immobility, concentration, quick access, easy access, inability to touch but still feeling, mental disconnection, guiding perception, visual intensity, and mental confusion (Figure 16). The majority of users indicate that the detachment arises from the mind's focus on the virtual world, suggesting that a cognitive process begins when the space changes, and as a result, the individual experiences a cognitive presence in the virtual environment.

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While this situation may trap the person in the physical world, it mentally transports them within the virtual world. Such an experience is the fundamental reason for a person's spatial perception of the virtual world.

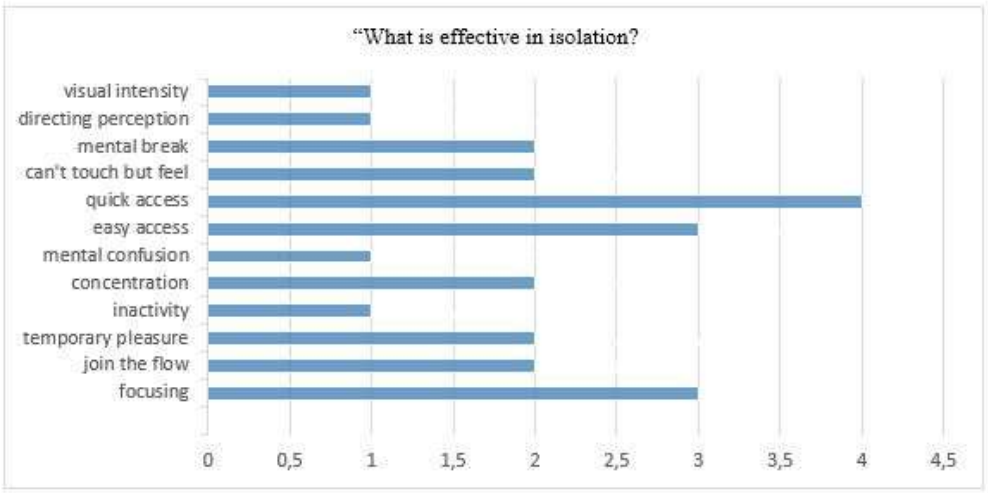

Figure 16. Justification scatter plot for Question-4

4. CONCLUSION

The conducted research is based on a survey study aimed at evaluating the factors that influence the formation of the process of establishing a relationship between virtual spaces and the physical environment, as well as how these processes differ from physical space. Based on the experiences of the participants, the study identifies the advantages and disadvantages of using virtual spaces, thereby providing resources for further development. Since it is observed that the interfaces and navigation signs of all 3D spaces and museums in Turkey are the same, it is thought that this study will serve as a pilot study, leading the way for other studies.

The insufficient development of the 3D data of Bitlis in the virtual environment does not fully support the process of establishing a relationship through navigation. Chan describes the spatial counterpart of this deficiency as follows: "In virtual space, viewers can navigate the space and perceive a computer-generated 3D image as a perspective view. When creating a realistic scene, buildings can be modeled using any 3D solid modeling software. However, in the field of VR, the fundamental issue is to provide a realistic representation in order to accurately represent reality and achieve an immersive effect." (1997). Additionally, due to the participants' unfamiliarity with the interface, it was observed that the virtual space did not fully fulfill its role.

Users expressed that the fast progression of the space's visual representation and its immediate fixation to the starting point when the Ahlat Seljuk Cemetery Archaeological Site's virtual museum interface first opened negatively impacted their perception of the space.

It is important to expand the boundaries of the virtual environment to include the exterior of the museum and an overhead view. Furthermore, it was observed that other 3D data were insufficient compared to physical data and not suitable for spatial navigation.

All participants attempted to explore the space and access information within the space with the help of directional arrows during each task. This situation leads to the idea that increasing the number of directional arrows would have a positive impact on reading the space. It was observed that users experienced difficulties when using the forward and backward arrows during navigation. Some users found the speed of progression too fast and argued that the arrows acted like teleportation tools and needed to slow down. Previous research on virtual spaces has emphasized the importance of adjustable speed.

Furthermore, it was observed that the increase in virtual space data enhances the visibility of the city and sparks curiosity in individuals, which in turn raises the desire to experience it physically. Additionally, due to Bitlis having a scattered settlement structure, there was a problem with spending too much time on navigation, making it possible for people to quickly experience the 3D representations of historical sites within limited time.

5. RECOMMENDATIONS

- The recommendations provided in light of the research are aimed at improving the visitor's navigation, experience, and relationship-building practices in the virtual environment and with the physical space.
- Having a site plan image is important for users to understand where they are. Therefore, adding an external view of the virtual space can facilitate navigation.
- Additional information points have been positively received by users in terms of experience diversity, and increasing their number is recommended. Additionally, these extra information tools should also be placed for location identification, and users should be able to click on them to see where they are when needed.
- It is important for spaces/objects outside the field of view to capture the visitor's attention. As a solution, it is suggested to use an arrow indicating that there is a partition or section in that area.
- Along with the names of spaces used in the physical museum, the floor of each space should be indicated in parentheses on the interface, and the names should be aligned according to the floor order.

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Analysis of vernacular dwellings in Iraq: A comparative study of Erbil citadel and old Akre

Irak'taki Geleneksel Konutların Analizi: Erbil Kalesi ve Eski Akre'nin Karşılaştırmalı İncelemesi

Riman Mohammed Said Bashir DHUOKI [1]
Çiğdem ÇAĞNAN [2]

ABSTRACT

This research aims to analyze and compare vernacular architecture of Erbil Citadel and Old Akre, two historic settlements located in Iraq's Mediterranean climatic zone, with goal of identifying their embedded sustainable design principles and highlighting their cultural and environmental significance. Employing a qualitative research approach, the study draws upon detailed field observations, and a comprehensive review of academic literature to examine key architectural and structural elements. These include street configuration, dwelling attachment, open space organization, material selection, structural systems, roof construction, façade treatments, and design of doors and windows. Erbil Citadel, designated as a UNESCO World Heritage site, is characterized by compact urban planning, inward-oriented courtyard houses, narrow and meandering streets, and use of traditional materials such as mud brick and timber. These features contribute to thermal comfort, privacy, and efficient land use. In contrast, Old Akre presents an organically evolved terraced layout, adapted to steep mountainous terrain. It utilizes local stone and lime in construction and fosters a strong sense of community through shared rooftops and communal terraces that also serve functional purposes. The comparative analysis reveals how both sites demonstrate context-sensitive responses to climatic, topographical, and social factors,

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making efficient use of locally available resources while maintaining cultural continuity. These findings underscore importance of vernacular architecture as a viable framework for contemporary sustainable design. By extracting lessons from traditional practices, the study contributes to discourse on climate-responsive and culturally integrated architecture, advocating for a more inclusive approach to sustainable urban development that draws on historical and regional wisdom.

Keywords: *Vernacular architecture, Sustainable design, Thermal comfort, Mediterranean climate, Iraq.*

ÖZET

Bu araştırma, Irak'ın Akdeniz iklim kuşağında yer alan iki tarihi yerleşim olan Erbil Kalesi ve Eski Akre'nin geleneksel mimarisini analiz etmeyi ve karşılaştırmayı amaçlamakta; bu yapılarda gömülü olan sürdürülebilir tasarım ilkelerini belirlemeyi ve onların kültürel ve çevresel önemini vurgulamayı hedeflemektedir. Nitel bir araştırma yaklaşımı benimsenen çalışmada, detaylı saha gözlemleri ve akademik literatürün kapsamlı bir incelemesi yoluyla temel mimari ve yapısal unsurlar ele alınmıştır. Bu unsurlar; sokak düzeni, konutların yerleşim biçimi, açık alan organizasyonu, malzeme seçimi, yapısal sistemler, çatı yapımı, cephe düzenlemeleri ile kapı ve pencere tasarımlarını kapsamaktadır. UNESCO Dünya Mirası Listesi'ne dâhil edilen Erbil Kalesi; kompakt kent planlaması, içe dönük avlulu evleri, dar ve dolambaçlı sokakları ile kerpiç ve ahşap gibi geleneksel malzemelerin kullanımıyla karakterize edilir. Bu özellikler, termal konfor, mahremiyet ve alanın verimli kullanımı açısından katkı sağlar. Buna karşılık Eski Akre, sarp dağlık araziye uyarlanmış organik olarak gelişmiş bir teras yerleşimine sahiptir. Yapımında yerel taş ve kireç kullanılır; paylaşılan çatı ve teraslar yoluyla topluluk hissini güçlendiren ve işlevsel olarak da kullanılan ortak alanlar oluşturur. Karşılaştırmalı analiz, her iki yerleşimin de iklimsel, topoğrafik ve sosyal koşullara duyarlı çözümler sunduğunu ve yerel kaynakları verimli kullanırken kültürel sürekliliği koruduğunu ortaya koymaktadır. Bu bulgular, geleneksel mimarinin çağdaş sürdürülebilir tasarım için geçerli bir çerçeve sunduğunu vurgular. Geleneksel uygulamalardan elde edilen derslerle, çalışma iklim duyarlı ve kültürel olarak bütünleşik mimarlık tartışmalarına katkı sağlamakta; sürdürülebilir kentsel gelişime yönelik daha kapsayıcı, tarihsel ve bölgesel bilgiye dayalı bir yaklaşımı savunmaktadır.

Anahtar Kelimeler: *Yöresel mimari, Sürdürülebilir tasarım, Termal konfor, Akdeniz iklimi, Irak.*

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1. INTRODUCTION

Vernacular architecture is defined by its adaptation to local needs, materials, and cultural traditions, evolving over time to harmonize with the environmental, cultural, social, technological, and historical context of its surroundings. Despite its informal and often unplanned nature, this architectural style has profoundly influenced the development of design and architecture throughout history (Samalavičius & Traškinaitė, 2021). The term "vernacular" comes from the Latin vernaculus, meaning "native, domestic, or indigenous," emphasizing its deep-rooted connection to specific regions and communities. Vernacular architecture is characterized by building techniques that utilize locally sourced materials and traditional practices to address the unique needs of a region. Historically, vernacular architecture has been one of the most direct and practical ways to meet human shelter needs, yet it has been largely sidelined by the rise of modern architecture (Kutlu & Bekar, 2023). Recently, however, the growing urgency of sustainability and rising energy costs have prompted a resurgence of interest in this approach. Architects are revisiting regionalism and traditional building methods, recognizing their inherent energy efficiency and ecological benefits. These structures not only reflect the identity and cultural heritage of their communities but also offer sustainable solutions that align with contemporary environmental concerns (Usluer & Çağnan, 2021). A crucial aspect of vernacular architecture is its integration of the building with its surrounding environment. Housing is not merely about the physical structure; it also involves understanding and adapting to the unique climate, geography, and ecosystem of an area. Achieving sustainable housing goals requires an in-depth study of these environmental factors and the creative use of locally available resources and techniques. This approach ensures that housing is not only functional and resilient but also environmentally conscious and cost-effective (Noah & Çağnan, 2021). Furthermore, studying vernacular architecture across diverse environments can provide invaluable insights into the principles of sustainable design. Each region presents unique challenges and opportunities, from extreme climates to scarce resources, and vernacular solutions often embody ingenious adaptations to these conditions. By examining and integrating these time-tested methods with modern innovations, architects and planners can create designs that are not only sustainable but also culturally and environmentally meaningful. This blend of tradition and innovation underscores the enduring relevance of vernacular architecture in shaping a sustainable future for the built environment (Petruccioli, 2016).

Erbil Citadel is a unique urban site located atop an archaeological mound, formed through the ongoing accumulation and evolution of various civilizations. Unlike other large mound, the evidence of this process in the Citadel has been preserved to the present day, offering a rare glimpse into a cultural evolution that is not found elsewhere.

Erbil Citadel is situated in the heart of Erbil, in Iraq. This expansive urban complex spans nearly 11 hectares and is built on an archaeological mound formed by the buildup of historical layers over at least six millennia. While it rests on a man-made mound, its layout resembles that of a hilltop town, positioned on the relatively flat surface atop the mound (HCECR, 2012; Jasim et al., 2020). Akre City is a historic location in Iraq and serves as the center of the Akre district, one of six districts in Duhok Governorate. Its historic area is recognized as a cultural heritage site in Iraq's national inventory, known as the Atlas of Archaeological Sites in Iraq, published by the Ministry of Culture and Information in 1970 through the Directorate General of Antiquities. The historic area of Akre is believed to have been inhabited as early as the 7th century BC. William Wigram and Edgar Wigram noted in 1922 that Akre is among the oldest settled regions in the area (Ismael & Hasan, 2023).

The research aims to analyze and compare the vernacular architecture of Erbil Citadel and Old Akre, two traditional sites in Iraq, to highlight their sustainable design principles and cultural significance. The study focuses on how these architectural styles adapt to local climatic and topographical conditions, utilize locally available materials, and reflect the region's cultural heritage. To achieve this aim, the study employs a qualitative research approach, utilizing various scientific publications and field analysis to investigate key architectural and structural features that contribute to sustainability. The research examines the elements such as Street Shape and Texture, Dwellings Attachment, Open Space Arrangement of Dwellings, Construction Materials, Main Structural Components, Roof Construction System, Facade Characteristics, and Doors and Windows. By doing so, it advocates for the preservation and adaptation of traditional building practices as a means to address modern challenges in sustainable urban development.

2. LITERATURE REVIEW

To gain a deeper understanding of vernacular architecture, especially in Iraq, it is crucial to review the principles of vernacular architecture both globally and within various Iraqi regions. This exploration sheds light on the similarities and differences in architectural styles, focusing on how they respond to environmental conditions, cultural practices, and local climates.

2.1. Vernacular Architecture and Its Insights from Iraq

In response to growing environmental challenges, there has been a renewed interest in the sustainable qualities of vernacular architecture. This form of architecture is often compared to contemporary buildings, which are typically linked to harmful environmental traits, such as high carbon footprints, excessive energy consumption, and pollution. Vernacular architecture, with its eco-friendly designs, passive technologies, and connection to traditional practices, offers valuable insights for creating more sustainable built environments.

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It is no longer seen merely as a nostalgic relic of the past but as a source of knowledge that can guide modern construction (Olukoya & Atanda, 2020). Vernacular architecture, shaped by cultural, local, and regional influences, is created without formal professional expertise. It adapts to the local climate, available materials, and traditional craftsmanship while embodying the culture and way of life of the community. This architecture uses locally sourced materials and methods known to local craftsmen, helping define regional identity and distinction (Hu, 2023). As climates vary across regions, vernacular architecture responds to these conditions by incorporating techniques that improve energy efficiency and thermal performance. These methods, such as passive cooling, heating, and ventilation, align with bioclimatic design principles. By using natural materials and environmental solutions, vernacular architecture achieves a harmonious balance between sustainability and functionality (Raof et al., 2020).

Iraq's traditional houses vary greatly across its regions, reflecting the country's diverse climate and local resources. The climate spans from a hot desert environment, where temperatures exceed 50°C, to colder mountainous areas with temperatures dropping as low as −10°C. Vernacular architecture in Iraq adapts to these varying conditions, with buildings made from materials like natural limestone, mud-brick, and reed, chosen for their suitability to the local environment. In central and northern Iraq, for example, homes often feature thick mud-brick or limestone walls for climate adaptation and natural fortifications for security. These houses reflect cultural values, blending with the surroundings while fostering tight-knit communities. The settlement patterns and building forms in these areas align with the microclimatic conditions and the collective skills of the community, showcasing the region's environmental sustainability (Rostam, 2017). In southern Iraq, the marshlands present unique physical characteristics, where dwellings are built on artificial floating islands made of reeds and mud. These homes are reinforced annually to protect against flooding. The marshlands are rich in biodiversity, home to many plant and animal species, and the communities here have practiced sustainable resource management for thousands of years. This lifestyle reflects a deep connection to the wetland environment, with traditional resource conservation methods passed down through generations. Overall, the vernacular communities of Iraq offer effective, sustainable solutions to the region's topographic and climatic challenges, demonstrating a harmonious cultural adaptation to their surroundings through shared building expertise (Znad, 2024).

2.2. Sustainable Architecture

The term "sustainability" encompasses a wide range of goals that often overlap with concepts like green architecture, environmental or ecological design, sustainable building, and other related terms, sometimes being used interchangeably.

Sustainability in architecture can also be defined by contrasting it with its opposite: it involves innovative thinking, processes, and methods that move away from conventional approaches in the operation, design, construction, and planning of the built environment, which often overlook wider social, economic, and environmental factors. Sustainable architecture represents a design approach aimed at reducing the environmental impact of buildings, optimizing energy efficiency, and improving the health and well-being of their occupants (Aliamin, 2021). One of the key principles of sustainable architecture is reducing resource consumption. This involves maximizing the efficient use of resources and materials throughout a building's lifecycle, from its construction to eventual demolition. Sustainable design focuses on incorporating recycled, reclaimed, and renewable materials to decrease dependence on raw resources. Sustainable architecture also prioritizes efficient water usage, significantly reducing the consumption of vital resources. Another essential element of minimizing environmental impact is the reduction of pollution and waste. Sustainable architecture seeks to minimize the environmental footprint of buildings by emphasizing pollution prevention and waste reduction (Iwuanyanwu et al., 2024). In sustainable architecture, energy efficiency is realized through a combination of passive design approaches. These approaches focus on optimizing factors like thermal mass, building orientation, and natural ventilation to reduce energy consumption for cooling, heating, and lighting. For example, placing windows strategically maximizes natural daylight, cutting down the need for artificial lighting. Additionally, leveraging thermal mass and prevailing winds in the design helps regulate indoor temperatures. A passive design that utilizes locally-driven techniques aims to create comfortable, energy-efficient, and affordable buildings, much like vernacular architecture. Both approaches emphasize sustainable design practices tailored to local conditions and resources, focusing on minimizing energy consumption while ensuring livability and cost-effectiveness (Gil-Ozoudeh et al., 2022).

3. METHODOLOGY

This study employs a qualitative research approach, integrating field observations, visual documentation, and a review of scientific publications to examine the vernacular architecture of Erbil Citadel and Old Akre. The analysis criteria were carefully selected based on their relevance to sustainable architectural principles and their recurring presence in vernacular building practices. These criteria were also informed by literature on bioclimatic and climate-responsive design, which emphasizes passive environmental strategies, material efficiency, spatial organization, and community integration.

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The selected architectural and structural analytical categories are Street Shape and Texture, Dwellings Attachment, Open Space Arrangement of Dwellings, Construction Materials, Main Structural Components, Roof Construction System, Façade Characteristics, and Doors and Windows, allow for a comprehensive assessment of architectural responses to climate, topography, and social needs. Each of these elements contributes to sustainable performance by enhancing thermal comfort, resource use efficiency, and cultural resilience.

By aligning the analysis with sustainability-focused indicators found in vernacular and contemporary ecological design research, the study provides a framework that not only documents historical architecture but also extracts lessons applicable to modern sustainable development (Figure 1).

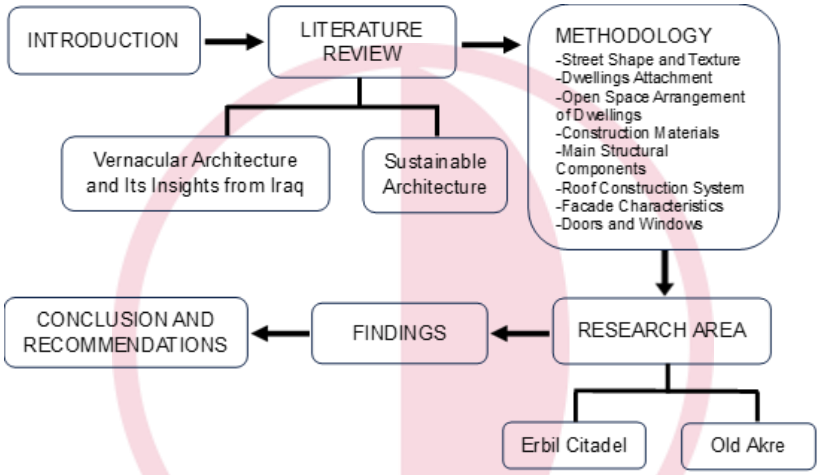

Figure 1. Research structure chart.

4. RESEARCH AREA

Erbil Citadel and Old Akre, found in different regions of Iraq, experience same unique climates based on their geographical locations (Figure 2). Erbil Citadel is situated on a mound, while Old Akre is located in a mountainous area.

Figure 2. Iraq map showing location of Erbil Citadel and Old Akre (Ali et al., 2016).

4.1. Erbil Citadel

Erbil Citadel is situated on a man-made mound, and its design resembles that of a hilltop settlement, located on the relatively level surface at the top of the mound (Figure 3). Most of the Citadel is currently occupied by residential homes, along with a few public and religious buildings. Historical records indicate that there were once additional administrative, religious, and military structures, including fortification walls that have since vanished. This layout contrasts with other fortified citadels that have preserved their ancient structures, complete with massive enclosing walls. Most historic buildings in the Citadel date from the mid-19th to the early 20th century, though some are older, originating from the mid-18th century onward. The historic architecture primarily consists of residential homes but also includes several mosques, a hammam, and other religious or social buildings, such as takiyas (used for gatherings of Sufi communities) and diwakhanas (houses for hosting guests or community meetings) (Mahmood, 2019), (Figure 4).

Figure 3. Erbil Citadel (HCECR, 2012b)

Figure 4. The outside facades of Citadel (HCECR, 2012a)

Erbil's climate is categorized as Mediterranean according to the Köppen climate classification. This means the city experiences mild, wet, and humid winters, alongside long, extremely hot summers. January is the wettest month, while no rainfall occurs between June and September. (Table 1) provides an overview of Erbil's climate conditions throughout the year. July sees the highest temperatures, reaching up to 42°C, while January has the minimum temperature recorded at 1.5°C (Sulaiman et al., 2022).

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Table 1. Climatic Data of Erbil Citadel (Climate-Data, 2024).

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature °C (°F)	6.3 °C (43.4) °F	8.3 °C (46.9) °F	12.5 °C (54.6) °F	18 °C (64.4) °F	24.6 °C (76.2) °F	31.2 °C (88.1) °F	35 °C (94.9) °F	34.6 °C (94.3) °F	29.4 °C (84.8) °F	22.7 °C (72.8) °F	13.4 °C (56.1) °F	8.2 °C (46.8) °F
Min. Temperature °C (°F)	1.4 °C (34.6) °F	2.6 °C (36.7) °F	6.1 °C (43) °F	11 °C (51.8) °F	16.6 °C (61.9) °F	22.4 °C (72.4) °F	26.2 °C (79.1) °F	25.9 °C (78.6) °F	21.1 °C (70) °F	16.1 °C (61) °F	7.8 °C (46.1) °F	3.3 °C (38) °F
Max. Temperature °C (°F)	12 °C (53.6) °F	14 °C (57.2) °F	18.5 °C (65.4) °F	24.3 °C (75.8) °F	31.2 °C (88.2) °F	38.1 °C (100.6) °F	41.9 °C (107.4) °F	41.7 °C (107.1) °F	36.7 °C (98) °F	29.5 °C (85.1) °F	19.8 °C (67.6) °F	14 °C (57.2) °F
Precipitation / Rainfall mm (in)	104 (4)	96 (3)	91 (3)	64 (2)	22 (0)	1 (0)	0 (0)	0 (0)	1 (0)	28 (1)	64 (2)	89 (3)
Humidity(%)	68%	67%	59%	49%	32%	19%	17%	17%	21%	31%	51%	64%
Rainy days (d)	8	7	7	6	3	0	0	0	0	2	5	6
avg. Sun hours (hours)	7.0	7.9	9.6	11.3	12.6	13.1	12.9	12.2	11.2	10.0	8.5	7.1

Street Shape and Texture: The urban layout of Erbil Citadel features an ovoid design defined by a complex network of narrow, winding streets that radiate from a central entrance. Major alleys extend outward from the southern Grand Gate, interwoven with a natural web of smaller pathways leading to more secluded residences. The irregular, twisting streets and unevenly shaped plots reflect a gradual, organic development process, characteristic of settlements that have evolved over time. The streets transition seamlessly from wider thoroughfares to narrower, more private zones near residential areas, often ending in cul-de-sacs or semi-private spaces. Public spaces naturally emerge at intersections, creating a dynamic hierarchy of spatial organization (Abdulkareem, 2012), (Figure 5).

Figure 5. Map showing street shape and texture in Citadel (HCECR, 2012b).

Dwellings Attachment: The typical house layout often includes two adjacent rooms, each with its own entrance, designed for both functionality and privacy. These houses are commonly attached along their sides or backs, with entrances opening directly onto the street. In some cases, multiple entrances lead to a shared courtyard or access point, forming small, community-oriented cul-de-sacs. The structures are usually one or two stories tall, and many features semi-basements that not only enhance privacy but also provide a sense of enclosure and thermal comfort (Mahmood, 2019), (Figure 6).

Figure 6. The houses are attached in Citadel (HCECR, 2012a).

Open Space Arrangement of Dwellings: The houses in Erbil Citadel are arranged in compact blocks, frequently sharing walls with neighboring structures to maximize space and enhance communal cohesion. Each house features a courtyard, a vital element of the design that provides natural ventilation, light, and a private outdoor space for the household. These courtyards are sometimes entirely enclosed by buildings, creating a secluded environment, but more commonly, they are flanked by rooms on two sides and bordered by the walls of neighboring houses or the adjacent alley. The typical layout includes two adjacent rooms, each with its own entrance, offering functional and flexible living spaces (Figure 7, 8). Entrances generally face the street, ensuring accessibility while maintaining a balance between openness and privacy. This arrangement reflects the traditional architectural approach, emphasizing both practical use of space and the cultural need for privacy and family-centered living (Gandreau & Moriset, 2013).

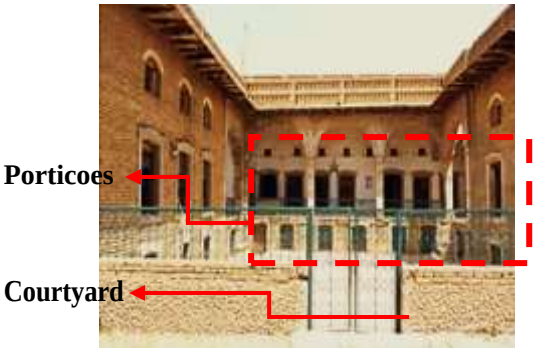

Figure 7. Erbil Citadel dwelling with courtyard (Gandreau & Moriset, 2013).

Figure 8. Inside Sheikh Jamil Afandi house courtyard (Mirani, 2010).

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Construction Materials: These historic buildings are predominantly constructed from fired brick, typically bonded with mud mortar, a method that reflects the traditional craftsmanship of the region. In the Citadel, fired brick masonry with mud mortar, occasionally mixed with lime for added durability, is a hallmark of the architectural style. Modern additions, introduced in the late 20th century, incorporate more advanced brickwork techniques, blending historical aesthetics with contemporary construction methods. Timber frameworks are widely used for roofs and floors, showcasing a practical and sustainable design approach, while some porticoes are adorned with visible timber columns, adding to the architectural charm and structural integrity of the buildings (Gandreau & Moriset, 2013), (Figure 9, 10).

Figure 9. Dwellings construction materials in Citadel (Al-Yaqoobi, 2012).

Figure 10. Timber columns of porticoes in Citadel (HCECR, 2012b).

Main Structural Components: Many houses incorporate remnants of older structures, with no single building representing a single construction period. This layering of construction over existing structures and foundations reflects a continuous and dynamic process of regeneration, characteristic of an archaeological mound. The walls of the Citadel showcase a distinctive construction technique, featuring two outer layers encasing an inner rubble core, all bonded with mud mortar (Figure 11, 12). The brickwork is often irregular, with lateral walls built in the same manner but thinner, maintaining structural coherence. Wider, tile-like bricks strategically link the outer layers to the core, demonstrating a thoughtful balance between strength, flexibility, and resilience to environmental pressures. This method highlights the adaptive reuse of materials and the enduring ingenuity of the region's architectural traditions (HCECR, 2012b).

Figure 11. Section of wall in Citadel (HCECR, 2012b).

Figure 12. Wall construction in Citadel (Palumbo, 2011).

Roof Construction System: In the Erbil Citadel, the roofs are predominantly flat and supported by round timber beams, a design that ensures both practicality and aesthetic appeal. High-status homes often utilize poplar planks for their roofing, reflecting the wealth and status of the inhabitants, while traditional constructions rely on unshaped oak coppice poles, showcasing the resourcefulness of local builders. Above the beams, layers of compacted mud and lime are carefully applied, providing additional insulation and stability. This layered roofing system rests on woven matting and reeds, which further contribute to the building's thermal efficiency, keeping interiors cool in summer and warm in winter. This approach to roofing illustrates a blend of functionality and tradition, allowing for adaptation to the region's climate while maintaining the integrity of the citadel's architectural heritage (Abdulkareem, 2012), (Figure 13, 14).

Figure 13. Dwelling roof of Citadel (HCECR, 2011).

Figure 14. Dwelling roof of citadel restored in1980 (Mirani, 2010).

Facade Characteristics: Today, the perimeter of the Citadel is defined by house façades built on or in front of earlier fortifications. These façades are closely aligned, creating the impression of a formidable fortress when viewed from outside. The earliest homes are noted for their intricately decorated brickwork. In later constructions, the façade may be shaded by a colonnade or porticoes, some of which have wooden columns with decorative capitals, while larger houses may feature an arcade with columns and alabaster arches.

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The facades of Erbil Citadel were intentionally left unplastered and unwhitewashed, preserving the original appearance of the construction materials. The mud brick serves as the primary building material for the facades, highlighting the traditional construction methods that are well-suited to the local environment (Al-Shwani, 2011), (Figure 15, 16).

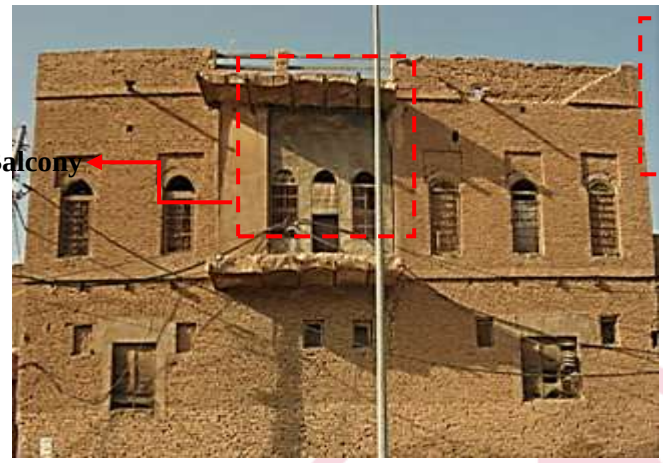

Figure 15. Dwelling facades of Citadel (Al-Shwani, 2011).

Figure 16. Decoration in Citadel (Cravero, 2011).

Doors and Windows: The doors and windows in Erbil Citadel vary in size, reflecting the unique characteristics of each dwelling. Typically, rectangular or arched, their shapes contribute to the architectural charm of the structures. The windows are often enhanced with decorative wrought metal grilles at the front, which not only serve functional purposes, such as security and ventilation, but also add an ornamental touch (Figure 17). These features further accentuate the historic appeal of the buildings, blending aesthetic elegance with practicality in the citadel's design (Al-Shwani, 2011).

Figure 17. Design of doors and windows in Citadel (HCECR, 2012b)

4.2. Old Akre

Throughout history, various significant powers have ruled the area, including the Medes, Assyrians, Romans, Islamic empires, and the British, all of whom have left a rich legacy. The city features the emblem of the Bahdinan Emirate, which governed it from 1376 to 1843. The historic area of Akre was established on the steep hillside beneath the old castle, overlooking the orchards in the valley. It includes three residential neighborhoods: the Jewish neighborhood, Gorava, and Qapaki, along with the historic bazaar. In the historic area, the buildings are organically arranged on the hillside, creating a terraced appearance (Spät, 2019), (Figure 18).

Figure 18. Old Akre (Municipality of Akre, 2012).

Akre is renowned as the City of Four Seasons due to its distinct experience of all four seasons. The city has a Mediterranean climate according to Köppen climate classification, characterized by hot summers and rainy winters. Summers are warm, with maximum temperatures reaching up to 38°C, while winters are relatively cold, often dropping below freezing, and snowfall is common (Table 2). The Mediterranean Sea and the region's mountainous terrain play a significant role in bringing rain to Akre (Ismael, 2015).

Table 2. Climatic Data of Old Akre (Climate-Data, 2024).

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature °C (°F)	2.1 °C (35.8) °F	4.2 °C (39.6) °F	8.7 °C (47.6) °F	13.9 °C (56.9) °F	19.9 °C (67.9) °F	27 °C (80.5) °F	31.2 °C (88.1) °F	30.9 °C (87.7) °F	25.8 °C (78.4) °F	18.8 °C (65.8) °F	10 °C (50.1) °F	4.3 °C (39.8) °F
Min. Temperature °C (°F)	-2.5 °C (27.5) °F	-1.1 °C (30) °F	2.5 °C (36.4) °F	7 °C (44.6) °F	12.1 °C (53.8) °F	17.8 °C (64) °F	22.1 °C (71.8) °F	22 °C (71.5) °F	17.4 °C (63.3) °F	12.1 °C (53.7) °F	4.5 °C (40.2) °F	-0.3 °C (31.4) °F
Max. Temperature °C (°F)	7.6 °C (45.7) °F	9.8 °C (49.7) °F	14.5 °C (58.1) °F	19.9 °C (67.8) °F	26.4 °C (79.5) °F	33.9 °C (93) °F	38.1 °C (100.6) °F	38.1 °C (100.6) °F	33 °C (91.4) °F	25.4 °C (77.8) °F	16 °C (60.8) °F	10 °C (50) °F
Precipitation / Rainfall mm (in)	149 (5)	140 (5)	142 (5)	104 (4)	39 (1)	3 (0)	0 (0)	0 (0)	1 (0)	39 (1)	93 (3)	137 (5)
Humidity(%)	71%	71%	66%	62%	47%	26%	21%	20%	24%	39%	58%	68%
Rainy days (d)	8	8	9	8	5	1	0	0	0	3	5	7
avg. Sun hours (hours)	6.4	7.0	8.6	10.8	12.4	13.2	13.0	12.2	11.2	9.6	8.1	6.6

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Street Shape and Texture: Public areas emerge naturally at intersections, creating a dynamic spatial hierarchy that reflects the organic growth of the community. The structures are interconnected by a complex network of narrow, zig-zag alleys, some of which lead to cul-de-sacs, adding an element of discovery and surprise for those navigating the space. The historic buildings, often of significant architectural value, are connected vertically by staircases, which offer views of the surrounding area while contributing to the layered spatial experience (Figure 19, 20). As user explore, the network of alleys transitions unpredictably from lively public spaces to more intimate, private areas, blurring the boundaries between public and private life (Ismael, 2024).

Figure 19. Map showing street shape and texture in Old Akre (Ismael & Hasan, 2023).

Figure 20. Staircases as vertical movement in Akre (Malaika & Raswol, 2014).

Dwellings Attachment: Because of the terraced layout, it's common for residents to engage in activities on the roofs of the houses below, fostering a sense of shared space and community. Most of these buildings are one or two stories tall, and at times, multiple houses share the same roof, creating informal communal areas. Despite the presence of lower houses, the design ensures that the views of those above are never obstructed, promoting a sense of openness. This effective use of space fosters social cohesion and interaction, reflecting the trust among residents. The terraced design of the historic buildings not only maximizes available space but also enhances the area's sense of community, highlighting the value and significance of Akre's historic area as a unique and well-integrated urban environment (Ismael, 2024), (Figure 21).

Figure 21. Dwellings arranged on hillside (Ismael, 2015).

Open Space Arrangement of Dwellings: In Old Akre, the terraced layout defines open spaces where the roofs of lower-level homes serve as balconies or terraces for the homes above (Figure 22). This innovative design maximizes limited space and allows residents to enjoy communal and private areas simultaneously. The linear organization of these terraces integrates open space into the natural slope of the terrain, creating a smooth transition between public and private realms. This seamless blend fosters a sense of interconnectedness among residents, enhancing the social fabric of the area while preserving the intimate, communal atmosphere of the historic district (Malaika & Raswol, 2014).

Figure 22. Old Akre dwellings with terraced layout (Ismael, 2024).

Construction Materials: The traditional materials used in Akre's historic architecture, including natural and curved stones, lime, and wood, are carefully chosen to harmonize with the local environment. Natural stones, curved to suit the terrain, form the foundation of many structures, while lime is used for its durability and insulation properties, and wood adds warmth and flexibility. This reliance on locally available materials not only ties the architecture closely to its surroundings but also emphasizes sustainability and functionality. The materials' natural origins reflect Akre's commitment to maintaining a built environment that respects both its cultural heritage and the demands of its landscape (Malaika & Raswol, 2014), (Figure 23, 24).

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Figure 23. Used materials for construction in Old Akre (Ismael & Hasan, 2023).

Figure 24. Lime plaster for interior finishes in Old Akre (Ismael & Hasan, 2023).

Main Structural Components: The thick masonry walls of Akre are constructed using local natural stones, sometimes bonded with mud mortar, providing strength and stability (Figure 25). These materials are well-suited to the region's climate, offering thermal mass to regulate indoor temperatures. Lime plaster is typically used to finish the interior, creating a smooth, breathable surface that enhances durability while allowing the structure to maintain moisture balance. This simple yet effective construction system not only reflects the traditional building practices of the area but also ensures a comfortable living environment, blending practicality with the region's architectural heritage (Ismael, 2015).

Figure 25. Wall construction of Akre (Spät, 2019).

Roof Construction System: The flat roofs of Old Akre are supported by round timber beams, which provide a sturdy framework for the structure. Unshaped oak coppice poles are laid over the beams, creating a natural, yet resilient surface. To enhance weather resistance and thermal comfort, a layer of reeds and matting is first placed, followed by compacted mud and lime. This layered roofing system effectively insulates the interior, protecting it from harsh weather conditions while maintaining a comfortable temperature inside. The combination of these traditional materials reflects a deep understanding of the local environment and an emphasis on sustainability in building practices (Ismael & Hasan, 2023), (Figure 26, 27).

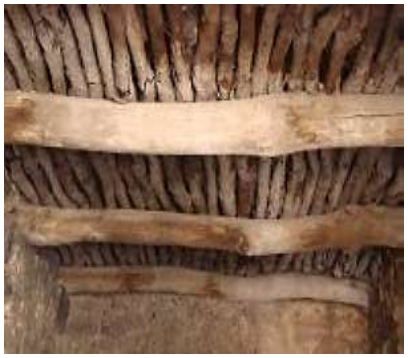

Figure 26. Dwelling roof of Akre (Ismael, 2015).

Figure 27. Roof intergration with wall of dwelling in Akre (Ismael & Hasan, 2023).

Facade Characteristics: In Old Akre, the facades prominently feature stone as the foundational material, underscoring its natural availability and durability. The use of local stone not only contributes to the strength and stability of the buildings but also enhances the aesthetic harmony with the surrounding landscape. Some dwellings in the area feature balconies, adding verticality to the structures while offering residents outdoor spaces with scenic views. These balconies blend seamlessly with the architectural style, reflecting the traditional design principles of integrating private and communal spaces within the historic context of Akre (Ismael, 2024), (Figure 28).

Figure 28. Dwelling facade of Akre (Ismael & Hasan, 2023).

Doors and Windows: The doors and windows in Old Akre display variations in size, reflecting the individuality of each dwelling and contributing to the unique character of the neighborhood. Their shapes are typically rectangular or arched, enhancing the architectural appeal. Many windows are further embellished with decorative wrought metal grilles at the front, serving both functional and ornamental purposes (Figure 29, 30). These metal details not only provide added security but also contribute to the aesthetic richness of the buildings, highlighting the historic craftsmanship and adding to the overall timeless beauty of Old Akre's architectural landscape (Malaika & Raswol, 2014).

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Figure 29. Different types of windows in Old Akre (Ismael, 2015).

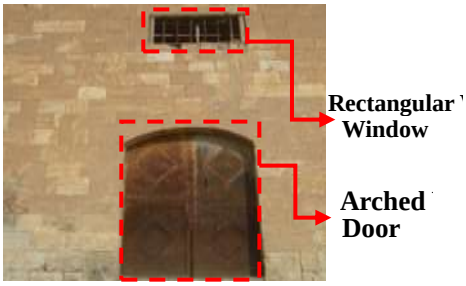

Figure 30. Door of dwelling in Old Akre (Ismael, 2015).

5. FINDINGS

The comparative analysis of Erbil Citadel and Old Akre reveals distinct architectural and urban design features shaped by their environmental, topographical, and cultural contexts (Table 3). In terms of street layout, Erbil Citadel exhibits a meandering pattern, with streets narrowing near residential zones and culminating in cul-de-sacs or semi-private spaces. Public nodes are located at intersections, indicating a hierarchical spatial arrangement. In contrast, Old Akre's narrow, zigzagging alleys and staircases reflect the adaptation to steep terrain and support vertical circulation, linking different elevation levels across the settlement. Dwelling attachment in Erbil is characterized by structures connected at the sides or backs, often with shared entrances or courtyards, contributing to spatial compactness. In Old Akre, houses are arranged in terraces along the hillside, with overlapping rooftops and shared open spaces. This configuration allows efficient land use and supports communal interaction in a topographically constrained environment. Regarding open space, Erbil Citadel dwellings typically include courtyards enclosed or partially bordered by adjacent buildings. These courtyards provide natural light, ventilation, and private outdoor areas. In Old Akre, the sloped layout results in the rooftops of lower homes serving as open terraces for the upper homes, forming a layered system of semi-private outdoor areas. In terms of construction materials, Erbil Citadel primarily uses fired brick bonded with mud mortar, occasionally reinforced with lime. Timber is used for flooring and roofing structures. Old Akre employs local stone, lime, and wood, materials that respond effectively to the region's climatic and geological conditions. Structural systems differ accordingly. Erbil Citadel walls typically consist of double layers with a rubble-filled core. The construction method enhances structural stability and insulation. In Old Akre, thick stone masonry walls bonded with mud mortar and finished with lime plaster provide both thermal mass and structural integrity. Both settlements use flat roofs supported by timber beams. In Erbil, layers of reeds, matting, and compacted mud with lime are applied for insulation. Old Akre follows a similar system, demonstrating consistency in climate-responsive design despite geographic differences.

Façade treatments in both cases are left unplastered, exposing the natural texture of the building materials mud brick in Erbil and stone in Akre. Some buildings in both locations include balconies, although these are more commonly observed in Akre due to the terraced terrain. Doors and windows in both settlements vary in size and are typically rectangular or arched. Decorative wrought-iron grilles are present, serving both security and ventilation functions while contributing to visual coherence.

Table 3. Comparison analysis of Erbil Citadel and Old Akre vernacular architectural characteristics.

Comparison Elements	Erbil Citadel	Old Akre
Street Shape and Texture	Meandering streets with transitions from wide to narrow, leading to cul-de-sacs. Public spaces at intersections	Narrow, winding alleys with sudden shifts from public to private spaces. Vertical connections via staircases
Dwellings Attachment	Houses connected at sides or backs, with shared street entrances and cul-de-sacs. One or two stories, semi-basement	Terraced houses on hillside, often with shared rooftops. One or two stories, with communal roof use
Open Space Arrangement of Dwellings	Houses feature courtyards bordered by structures, often with neighboring walls	Linear terrace dwellings built along the slope, with shared roof spaces for open areas
Construction Materials	Fired brick masonry with mud mortar, occasional lime; timber frameworks for roofs and floors	Natural stone, lime, and wood used in construction
Main Structural Components	Two outer layers with a rubble core held by mud mortar. Irregular brickwork and thinner lateral walls	Thick masonry walls with natural stones, mud mortar, and lime plaster interior

Table 3. Comparison analysis of Erbil Citadel and Old Akre vernacular architectural characteristics (cont.).

Roof Construction System	Flat roofs supported by round timber beams, compacted mud/lime mixture, reeds, and woven matting	Flat roofs supported by round timber beams,

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		compacted mud/lime, with reeds and matting
Facade Characteristics	Unplastered, unwhitewashed facades revealing mud brick. Some dwellings feature balcony	Unplastered, unwhitewashed facades revealing stone. Some dwellings feature balcony
Doors and Windows	Varied sizes and shapes (rectangular or arched) with decorative wrought metal on windows	Varied sizes and shapes (rectangular or arched) with decorative wrought metal on windows

The objective comparison indicates that both sites apply region-specific architectural strategies that respond to environmental constraints and cultural practices. These findings form the basis for further assessment of sustainability performance and architectural resilience in vernacular settlements.

6. CONCLUSION AND RECOMMENDATIONS

This comparative study of vernacular architecture in Erbil Citadel and Old Akre highlights how traditional built environments respond effectively to climatic, topographical, and social conditions using locally available materials and context-sensitive design approaches. While the two sites differ in geography, one a man-made mound, the other a mountainous hillside, they demonstrate shared principles of sustainability through passive environmental strategies, community-oriented planning, and efficient material use. Erbil Citadel presents an inward-oriented layout, using courtyard-based housing, compact urban form, and thermally adaptive materials such as mud brick and timber. Old Akre, with its terraced structure, integrates seamlessly with the landscape, applying stone and lime construction and shared rooftop spaces to optimize land and social interaction. These findings confirm the viability of vernacular architecture as a foundation for sustainable urban development. More importantly, the study contributes to the development of a methodological framework for sustainable design by identifying and analyzing architectural criteria such as spatial organization, material selection, and construction systems that directly influence environmental performance.

These elements can inform the adaptation of vernacular principles in contemporary architecture, particularly in regions with similar climatic or topographical conditions. Based on the findings, the following recommendations are proposed to support the formation of a sustainable design methodology:

- Establish a Sustainability Framework: Develop a structured set of criteria based on vernacular features such as passive ventilation, local materials, compact spatial organization, and social integration to guide sustainable architectural assessment and design in similar climatic and geographic contexts.
- Adapt Vernacular Strategies into Contemporary Design: Translate key findings into practical design principles for modern architecture, emphasizing thermal performance, material efficiency, and the use of communal open spaces.
- Integrate into Architectural Education: Include vernacular architecture case studies and sustainability-based design thinking in academic curricula to strengthen awareness of climate-responsive and culturally relevant practices.
- Encourage Pilot Applications and Practice-Based Research: Promote collaboration between researchers, architects, and communities to apply vernacular principles in experimental sustainable housing or urban regeneration projects.
- Support Conservation through Policy: Advocate for planning policies that protect vernacular heritage while encouraging its adaptation to current environmental standards, ensuring the continuity of traditional techniques within sustainable development frameworks.

By grounding future sustainable design practices in the proven principles of vernacular architecture, this study offers a transferable methodological base for resilient, context-specific architectural solutions in Iraq and beyond.

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