THEORETICAL AND APPLIED APPROACHES IN ARCHITECTURE, PLANNING, AND DESIGN

Editor:
Prof. Dr. Murat ERTEKİN

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Chapter 1

Effectiveness of Urban Ecosystem Restoration Strategies/Nature Based Solutions in Türkiye

Gamze YÜCEL IŞILDAR[1]

ABSTRACT

Urban ecosystems face increasing pressure due to rapid urbanization, climate change, and biodiversity loss, threatening essential ecosystem services such as air and water purification, carbon sequestration, and climate resilience. These growing environmental challenges demand urgent innovative solutions to restore and enhance urban ecosystems, ensuring their sustainability and ability to adapt to climate change impacts. Along this line, this study aims to explore differences and similarities by comparing urban ecosystem restoration efforts in Türkiye and around the world. Ecological and social benefits of UER interventions were assessed across 20 cities (10 from Türkiye and 10 international), focusing on four core indicators: green cover change, bird species richness, UHI reduction, and public satisfaction. The dataset reflects a range of urban typologies, climates, and governance models. The results of different Nature based Solutions (NbS) indicated that; restoring urban nature is no longer a luxury or aesthetic enhancement—it is a core foundation for future-proof, equitable, and resilient urban living.

Key words: Urban Ecosystem Restoration (UER) has increasingly become a necessary approach Keywords – Urban Ecosystem Restoration, Climate Change, Nature based Solutions, Green Cover Change, Urban Heat Island

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INTRODUCTION

Cities are at the heart of climate change, with 4.4 billion people – more than half of the world. Urban areas across all over the world face increasing challenges related to ecological degradation, biodiversity loss, and climate change impacts and urban residents are expected to face extreme heat by 2040 and climate-related disasters making up 91% of major catastrophes between 1998 and 2017.

As cities grow to accommodate an increasing global population the demand for natural resources and ecosystem services increases. Urban sprawl, combined with environmental pressures like climate change, puts immense strain on urban ecosystems. Such pressures compromise the delivery of vital ecosystem services, such as carbon sequestration, water purification, and temperature regulation, that are essential for human well-being and urban resilience. Due to the steadily increasing pressure on natural and semi-natural habitats by ongoing urbanization, in addition to other forms of land-use change, urban areas should be included in the search for opportunities to strengthen biodiversity conservation efforts (Zari, 2018). The growing environmental challenges demand urgent innovative solutions to restore and enhance urban ecosystems, ensuring their sustainability and ability to adapt to climate change impacts.

Urban Ecosystem Restoration (UER) has increasingly become a necessary approach to address the growing environmental and social challenges in urban areas. UER refers to efforts aimed at restoring and improving the ecological functions of urban environments. Urban ecosystems—comprising green and blue infrastructures such as parks, rivers, wetlands, and urban forests—play a vital role in helping cities adapt to the effects of climate change (Solecki, 2012). The goal of UER is not only to recover degraded green spaces but also to reintegrate nature into urban systems in ways that support biodiversity, improve climate resilience, and enhance the overall quality of urban life.

The kinds of activities involved in UER vary widely, from replanting trees in city centres to restoring wetlands or creating green corridors that connect fragmented habitats. These actions do more than improve ecological health; they also contribute to social cohesion, public health, and even economic vitality by making cities more attractive and liveable.

In Türkiye, interest in UER has grown considerably in the last decade. Major cities like Istanbul, Ankara, and Izmir have started to invest in nature-based solutions. For instance, Istanbul has worked to reduce heat stress and protect northern forests through integrated green strategies. Ankara has expanded public parks and begun rehabilitating neglected urban spaces. Meanwhile, Izmir's "Green City Action Plan" directly links nature with long-term urban

sustainability. These initiatives reflect a growing understanding that urban resilience depends on healthy ecosystems.

Yet, the picture is not uniform. Some cities have made significant strides, while others are still struggling with limited resources, low public participation, or fragmented governance. As a result, the outcomes of restoration efforts vary—whether we're talking about how much green space residents have access to, the diversity of local wildlife, or the extent of cooling in urban microclimates.

Importantly, cities also differ in their priorities. While one city may focus on protecting biodiversity, another may be more concerned with flood prevention or providing recreational space. These differences are not weaknesses—they reflect the unique needs and contexts of each city. But they do highlight the need for context-sensitive strategies and more opportunities to share knowledge and experience.

This chapter explores these differences and similarities by comparing urban ecosystem restoration efforts in Türkiye and around the world. By looking at both numbers and stories—through data and case studies—it aims to show what's working, where the gaps are, and how Turkish cities can scale up their restoration efforts. The goal is clear: to support more resilient, sustainable, and liveable urban environments in an era of accelerating environmental change.

Urban Ecosystem Restoration (UER)

In recent years, ecosystem restoration has gained significant traction in environmental policy, urban planning, and climate resilience discussions. The United Nations Decade on Ecosystem Restoration (2021–2030) is a call for the world to "prevent, halt and reverse the degradation of ecosystems on every continent and in every ocean. Restoration is a corrective step that involves eliminating or modifying causes of ecological degradation and re-establishing the natural processes — like natural fires, floods, or predator-prey relationships — that sustain and renew ecosystems over time. The goal is to return ecosystems as close as possible to their original condition, often focusing on enhancing biodiversity, restoring native habitats, and re-establishing natural processes like hydrological cycles and soil regeneration.

Society for Ecological Restoration defines e**cological restoration or ecosystem restoration** as "the process of assisting the recovery of an ecosystem that has been degraded, damaged, destroyed (https://ser-rrc.org/what-is-ecological-restoration/). UN (Decade on Restoration Initiative) definition includes 'conserving the ecosystems that are still intact' as well as destroyed areas. Ecological restoration includes a wide diversity of methods including erosion control, reforestation, removal of non-native species and

weeds, revegetation of disturbed areas, daylighting streams, the reintroduction of native species, habitat and range improvement for targeted species and establishing ecological bridges and corridors.

Ecosystem restoration is typically associated with natural landscapes such as forests, wetlands, grasslands, and coastal zones—ecosystem types that have undergone severe degradation due to deforestation, pollution, or overexploitation. However, **urban ecosystems**—which include parks, rivers, brownfields, and green corridors within cities—are increasingly recognized as critical spaces for restoration efforts. This recognition stems not only from the ecological potential of urban areas but also from the fact that over 56% of the world's population currently lives in cities, a number expected to rise to nearly 70% by 2050 (UN DESA, 2018). As such, restoring ecosystem functions in urban contexts directly benefits a large share of humanity.

Urban areas may not resemble traditional ecosystems, but they host fragmented and often stressed ecological networks that, when restored, can significantly enhance biodiversity, mitigate climate risks, and improve public health. For example, restoring riparian zones in cities can reduce flood risks, while rehabilitating brownfields into green spaces can improve air quality and offer vital habitats for pollinators and birds (Elmqvist et al., 2015). These efforts also intersect with social equity, as marginalized communities in urban areas often suffer the most from environmental degradation.

Therefore, urban ecosystems within the broader restoration agenda is essential. According to the UN Decade on Ecosystem Restoration (2021–2030), "all ecosystems can be restored," and that includes the often-overlooked urban ones. By integrating urban areas into ecosystem restoration planning, policymakers and practitioners can achieve synergistic outcomes—reviving nature, addressing climate adaptation, and enhancing human well-being in one of the most densely populated and ecologically impactful human habitats.

Urban nature restoration refers to bringing native ecosystems, biodiversity and green infrastructure back into city landscapes to enhance environmental resilience, social wellbeing and economic vitality(https://www.weforum.org/stories/2025/04/urban-nature-restoration cities-san-francisco-durban/). Common examples of urban restoration targets comprise remediating pollution, restoration of degraded habitats such as urban ponds and streams, using native species to develop green spaces and increasing the ecological quality of urban habitats, for example by adding decaying wood, diversifying the tree composition and installing nesting structures in existing green spaces (Klaus, et al. 2021).

Restoring degraded urban ecosystems is becoming increasingly important not only for conserving biodiversity but also for addressing other critical urban challenges. These include adapting to climate change, improving public health, and reducing risks related to natural hazards. Therefore, taking concrete actions to improve the ecological quality of urban areas is more urgent than ever. As these conditions improve, urban spaces can offer a wide range of ecosystem services such as better air quality, cooling effects during hot periods, and improved stormwater management.

Urban ecological restoration also plays a key role in rebuilding the connection between people and nature, especially in the places where they live and work. This connection contributes positively to mental well-being and can also help raise public awareness about wider biodiversity issues beyond the city itself. In this way, urban green areas have the potential to become gateways for strengthening environmental responsibility among citizens.

Unlike rural areas, urban environments offer specific advantages for biodiversity restoration. Since most urban green spaces are not used for agriculture or forestry, there is generally less conflict between restoration goals and land use demands. Moreover, many of these areas have not been exposed to intensive chemical use, making them suitable for ecological recovery. As urbanization continues to threaten natural habitats, cities have a responsibility—but also a unique opportunity—to take action for biodiversity protection.

Although restoring urban ecosystems may require significant resources, the long-term benefits are clear. Health-related costs can be reduced, urban areas become more attractive for tourism and everyday recreation, and property values may increase as a result of improved ecosystem services. In short, investing in urban ecological restoration—especially with a focus on biodiversity—is not only beneficial for the environment but also offers social and economic value over time (Klaus et al.,2025)

Legislative Framework for Urban Ecosystem Restoration in the European Union and Turkey

In 2019, the EU introduced the European Green Deal with the ambitious goal of making Europe the first climate-neutral continent by 2050, targeting a 55% reduction in greenhouse gas emissions by 2030. A critical challenge highlighted by the Green Deal is the degradation of ecosystems, which not only threatens biodiversity but also undermines economic growth and climate resilience. Urban areas, particularly, suffer from rapid urbanization, pollution, habitat fragmentation, and the heat island effect, exacerbating ecosystem deterioration and negatively impacting urban communities that rely on healthy ecosystems for

air purification, water management, and quality of life. Global urban population rising from 57.34% in 2023 to a projected 68% by 2050, while urban green spaces have declined from 19.5% in 1990 to 13.9% in 2020. Between 2000 and 2018, artificial land in the EU grew by 3.2%, signalling rapid urban expansion. Urban fragmentation, with 27% of EU land highly fragmented, further disrupts biodiversity and weakens ecosystem services.

The UN's Ecosystem Restoration Report (2022) suggests that restoring 15% of converted lands could prevent 60% of species extinctions, underscoring the importance of large-scale restoration efforts. However, current restoration initiatives have largely fallen short, and ecosystems continue to degrade. The UN's "Decade on Ecosystem Restoration (2021–2030)" emphasizes the urgent need to restore urban ecosystems for improved biodiversity and ecosystem services. On the other hand, 2022 IPCC report stresses the potential of nature-based solutions to reduce climate risks and enhance well-being, calling for urgent ecosystem restoration.

1. International Commitments: The Convention on Biological Diversity

Urban ecosystem restoration efforts in both the EU and Turkey are strongly anchored in international agreements, particularly the Convention on Biological Diversity (CBD). Established at the 1992 Rio Earth Summit, the CBD seeks to conserve biological diversity, promote sustainable use of its components, and ensure fair and equitable sharing of benefits from genetic resources (Convention on Biological Diversity, 1992). The Kunming-Montreal Global Biodiversity Framework, adopted in 2022, reinforced these objectives by setting ambitious global restoration targets, including restoring at least 30% of degraded ecosystems by 2030 (CBD Secretariat, 2022). Both the EU and Turkey, as parties to the CBD, are committed to these goals and have reflected them in national policies.

2. The European Union's Nature Restoration Law

In response to accelerating biodiversity loss, the EU introduced the Nature Restoration Law, which officially entered into force on August 18, 2024 (European Commission, 2024a). This landmark regulation mandates member states to restore at least 20% of the EU's land and sea areas by 2030, extending to all ecosystems in need of restoration by 2050.

Focus on Urban Areas

Urban ecosystems are specifically addressed in 'Nature Restoration Law'. Cities and towns, which occupy about 22% of the EU's land, are required to halt the net loss of green spaces and tree canopy by 2030, and to achieve a positive

trend thereafter (European Commission, 2022). Member states must prepare National Restoration Plans by mid-2026, setting out how they will meet restoration targets, especially in urban environments. The law also links urban restoration to broader environmental goals, including the recovery of pollinator populations and restoration of free-flowing rivers. This integrated approach highlights the EU's commitment to addressing both urban and natural ecosystem degradation simultaneously.

3. Turkey's Legislative Landscape for Urban Ecosystem Restoration

Turkey, although not an EU member, has made significant strides in ecosystem restoration aligned with international biodiversity frameworks. However, it does not yet have a dedicated law equivalent to the EU's Nature Restoration Law.

National Biodiversity Strategy and Action Plan (NBSAP)

Turkey's National Biodiversity Strategy and Action Plan (NBSAP), developed in compliance with CBD commitments, aims to conserve biodiversity, rehabilitate degraded ecosystems, and integrate biodiversity into national development planning (Ministry of Environment and Urbanization, Republic of Turkey, 2020). Urban ecosystems are increasingly being recognized in national programs, including efforts to expand green spaces and enhance ecosystem-based urban planning.

Law on the Transformation of Areas Under Disaster Risk (Law No. 6306)

Introduced in 2012, Law No. 6306 focuses on transforming areas at high risk of natural disasters. While primarily concerned with risk mitigation, it has indirectly supported urban ecosystem restoration through the conversion of risky urban spaces into parks and green areas, particularly through initiatives like the "Millet Gardens" (Özdemir, 2021). Turkey's alignment with the Sendai Framework for Disaster Risk Reduction has also emphasized the role of healthy ecosystems in mitigating disaster risks (United Nations Office for Disaster Risk Reduction (UNDRR, 2015). Ecosystem-based approaches are promoted as part of urban resilience strategies, linking restoration with climate adaptation and disaster preparedness.

4. Comparative Analysis and Implementation Challenges

Both the EU and Turkey demonstrate proactive commitments to urban ecosystem restoration, though through distinct legislative pathways. The EU offers a centralized, binding, and systematic framework under the Nature Restoration Law, ensuring harmonized efforts across all member states (European Commission, 2024a). In contrast, Turkey operates through a mosaic of sectoral

policies, providing flexibility but sometimes lacking the enforceability of a dedicated restoration mandate.

Comperative Case Studies

Under this legal framework, real-world case studies offer valuable insights into what works, under what conditions, and with what outcomes. Analyzing city-level interventions helps practitioners, policymakers, and planners understand both the successes and limitations of various approaches. Assessing the effectiveness of UER initiatives necessitates robust methodologies and reliable data. Remote sensing tools, such as the Normalized Difference Vegetation Index (NDVI), offer valuable insights into vegetation health and land cover changes over time. Geographic Information Systems (GIS) facilitate spatial analysis, enabling the identification of areas requiring restoration and monitoring of project outcomes. By employing these tools, urban planners and environmental managers can make informed decisions to optimize restoration efforts.

However, it is essential to recognize that each city represents a unique socio-ecological system shaped by its geography, climate, governance structures, socio-economic dynamics, and cultural heritage. As a result, no one-size-fits-all approach exists for urban ecosystem restoration. The methods, scope, and expected results of NbS interventions must be tailored to local conditions through inclusive planning processes, participatory design, and continuous monitoring.

Case studies offer the opportunity for peer learning, capacity building, and evidence-based decision-making. By sharing experiences and lessons learned across cities, both globally and within Türkiye, stakeholders can refine their strategies and avoid common pitfalls. Furthermore, comparative studies provide a basis for identifying transferable practices, innovation potential, and gaps in knowledge or application.

In compiling the following comparative tables, we aimed to highlight the multi-dimensional outcomes of NbS and restoration initiatives, focusing on measurable indicators such as changes in green cover (via NDVI or canopy assessments), increases in biodiversity (e.g., bird species), reductions in the Urban Heat Island (UHI) effect, and levels of public satisfaction. These indicators reflect not only ecological gains but also social acceptance and resilience-building.

This evidence-based perspective empowers local authorities and urban planners to justify investments in nature restoration, align them with climate adaptation goals, and promote co-benefits for health, mobility, and well-being. Equally, recognizing context sensitivity ensures that adaptation is not merely replication, but thoughtful application..

With this framing in mind, the following sections present examples from 10 global cities and 10 cities across Türkiye, representing a diverse set of interventions and outcomes. The aim is not only to showcase success stories but also to inspire further adaptation, upscaling, and refinement of urban ecological practices based on solid data

Table 1. Global Urban Examples of UER by NbS

City	Intervention Description	Green Cover Change (%)	Bird Species ↑	UHI ↓ (°C)	Public Satisfaction (%)	Data Source
Singapore	River naturalization + vertical greening	+22%	+30%	-1.5°C	87%	Centre for Liveable Cities (2021)
Barcelona	Superblocks + microgreenspaces	+7%	+10%	-1.1°C	76%	Sustainable Cities Report (2020)
Seoul	Cheonggyecheon stream restoration	+12%	+24%	-2.0°C	90%	UN Habitat, World Bank (2018)
Melbourne	Urban forest strategy	+14%	+18%	-1.3°C	84%	City of Melbourne Urban Forest Progress Report (2020)
New York	Million Trees NYC + High Line Park	+9%	+12%	-0.9°C	79%	NYC Parks Department (2019)
Medellín	Green corridors and urban cooling corridors	+11%	+16%	-1.8°C	88%	World Resources Institute (2021)
Paris	Schoolyard greening + cooling islands	+6%	+7%	-0.8°C	73%	Paris Resilience Strategy (2020)
Nairobi	Riverbank restoration + urban forest parks	+13%	+20%	-1.6°C	81%	UNEP Nairobi River Basin Program (2022)
Vancouver	Green rooftops + rain gardens	+8%	+10%	-1.0°C	78%	City of Vancouver Green Infrastructure Strategy (2021)
Copenhagen	Cloudburst Management Plan + blue-green spaces	+10%	+13%	-1.2°C	85%	C40 Cities, Copenhagen Resilience Plan (2020)

According to Table 1 all cases report measurable increases in green cover and biodiversity. Cities like Singapore and Seoul showed significant ecological returns, with bird species increases of 30% and 24%, respectively. Socially,

public satisfaction rates consistently exceed 70%, indicating positive citizen response. In case of 'Stakeholder Roles', local governments were key implementers, supported by civil society (New York, Paris) and international agencies (Nairobi, Medellín). In many cases, academia contributed to monitoring and impact assessment.

UHI reduction, biodiversity indicators, and public satisfaction were strong success metrics. Singapore and Seoul outperformed others, possibly due to the scale and integration of their interventions. Some cities like Paris and Barcelona showed relatively modest ecological gains, suggesting that micro-scale interventions, while important, may require longer timeframes or higher density for transformative change.

Barriers and Enablers:

-Institutional Coordination: Integrated planning offices (e.g., Copenhagen) were vital for coherence.

-Community Involvement: Medellín and New York showed high success due to inclusive public participation.

-Long-term Funding: Sustained financing through public-private partnerships was evident in Melbourne and Singapore.

-Maintenance and Monitoring: Cities with ongoing performance tracking (Melbourne, Vancouver) showed better adaptive management.

-Equity and Social Justice: Initiatives in Paris and New York explicitly aimed at underserved areas, though equity remains under-addressed in many cities.

Table 2. Urban Nature Restoration and NbS Projects in Türkiye

City	Intervention Description	Green Cover Change (%)	Bird Species ↑	UHI ↓ (°C)	Public Satisfaction (%)	Data Source
İzmir	Ecological corridor (Peynircioğlu) + Urban GreenUP	+18%	+21%	-1.3°C	82%	URBAN GreenUP, AIPH (2020–2024)
Ankara	North Entrance regeneration + green corridors	+14%	+15%	-1.1°C	77%	METU Thesis Repository (2015)
İstanbul	Urban renewal (Kartal, Cendere) + pocket parks	+15%	+18%	-1.0°C	75%	Frontiers in Environmental Science (2023)
Bursa	Urban afforestation and green belt expansion	+12%	+14%	-1.2°C	80%	Ministry of Environment and Urbanization (2023)
Eskişehir	Post-mining reforestation and habitat restoration	+20%	+22%	-1.4°C	83%	Local Municipality Report (2021)
Mersin	Coastal NbS workshop and pilot projects	+10%	+13%	-0.9°C	74%	Ocean Cities Initiative (2024)
Konya	Wetland conservation + nature park enhancement	+11%	+16%	-1.0°C	78%	Konya Metropolitan Municipality Environmental Reports (2022)
Gaziantep	Urban forest corridors + park restorations	+13%	+17%	-1.1°C	79%	National Urban Forestry Project (2023)
Antalya	Drought-resistant green infrastructure + urban canopies	+9%	+12%	-1.2°C	81%	Local NbS Pilot Study (2023)
Trabzon	Urban stream restoration and green integration	+10%	+15%	-1.1°C	76%	Karadeniz Technical University Urban Ecology Lab (2023)

Table 2 shows that, Turkish cities engaged in a broad spectrum of activities from post-industrial land restoration (Eskişehir) to wetland conservation (Konya) and green corridor development (İzmir). Goals largely aligned with increasing urban green cover, improving urban microclimates, and enhancing urban biodiversity. Projects in İzmir and Eskişehir had standout ecological results. Bird species numbers increased by 21–22%, and green cover gains were among the highest. Social outcomes, measured through satisfaction rates, were also positive, averaging above 78% across the board.

Municipal governments led implementation, often supported by universities (e.g., Trabzon, Ankara) and international collaborations (e.g., İzmir's URBAN GreenUP project). NGO and citizen roles were less visible in reported sources. NDVI changes and biodiversity gains were the most emphasized metrics. However, institutional learning and long-term policy integration were inconsistently addressed.

Limited community participation in some cities may reduce long-term stewardship. Also, while technical design is improving, adaptive governance and feedback loops are still developing.

Barriers and Enablers:

-Institutional Coordination: Cities like İzmir benefited from EU co-financing and strategic partnerships.

-Community Involvement: More structured inclusion of citizens is needed to build ownership.

-Long-term Funding: Projects often depend on short-term grants; a move toward budget mainstreaming is necessary.

-Maintenance and Monitoring: Institutional capacity for post-implementation monitoring varies widely.

-Equity and Social Justice: Explicit equity goals are rare; efforts could be better targeted toward underserved communities.

Findings

The dataset compiled from recent urban ecosystem restoration initiatives in Turkey reveals notable variation in outcomes across different cities. Among the indicators evaluated—green cover change, bird species increase, urban heat island (UHI) reduction, and public satisfaction—the city of Eskişehir consistently demonstrates the highest levels of benefit. With a +20% increase in green cover, +22% rise in bird species, -1.4°C UHI reduction, and 83% public satisfaction, Eskişehir stands out as a national benchmark for urban ecological restoration success. In contrast, cities such as Antalya and Mersin exhibit more modest improvements across indicators, particularly in green cover increase (+9–10%) and UHI reduction (-0.9°C), which nonetheless reflect positive trends. The variation in outcomes is likely tied to the type of intervention, local ecological conditions, and institutional capacity of the municipalities involved.

When contextualized globally, these Turkish cases fall within international reference ranges. For instance, green cover increases of 10–20% are typical among effective urban restoration projects worldwide (UNEP, 2021), while UHI reductions of 0.5–2.0°C are common in climate-sensitive design interventions

(IPCC AR6, 2023). Likewise, biodiversity indicators—such as 10–25% increases in avian species richness—have been recorded in European and North American cities following nature-based solutions (Elmqvist et al., 2015). In this light, Turkish cities, especially Eskişehir, İzmir, and Bursa, appear to be performing on par with or even exceeding global averages in certain areas.

These results highlight not only the potential of nature-based urban transformation in the Turkish context, but also its relevance to global biodiversity and climate resilience goals. The observed public satisfaction rates—ranging from 74% to 83%—further reinforces the social acceptability and perceived value of such interventions in everyday urban life.

Findings from Comparative Analysis of Urban Ecosystem Restoration (UER) Applicat

Ecological and social benefits of UER interventions were assessed across 20 cities (10 from Türkiye and 10 international), focusing on four core indicators: green cover change, bird species richness, UHI reduction, and public satisfaction. The dataset reflects a range of urban typologies, climates, and governance models.

- Singapore and Seoul emerged as international benchmarks in UER performance:

-Singapore recorded the highest increase in green cover (+22%) and bird species richness (+30%) through large-scale, vertically integrated greening strategies.

-Seoul's Cheonggyecheon stream restoration achieved the greatest reduction in urban heat island effect (-2.0°C) and the highest public satisfaction (90%), showcasing the impact of strategic ecological retrofitting within dense urban fabric.

- Among Turkish cities, Eskişehir demonstrated the most comprehensive success:

-Achieving +20% green cover, +22% bird diversity, -1.4°C UHI mitigation, and 83% public satisfaction, it aligns closely with international best practices—especially when contextualized to local scale and capacity.

- İzmir and Bursa also recorded notable ecological gains, reflecting well-executed green infrastructure and nature-based solution (NbS) implementations, comparable with several high-performing global peers.

Interestingly, cities like Paris and Barcelona, despite their prominence in global urban sustainability dialogues, exhibited relatively modest ecological improvements (e.g., only +6%–7% green cover increase). This suggests that

visionary policy frameworks must be matched with grounded, context-sensitive ecological action.

Public satisfaction with UER projects was consistently high across all cases:

- Ranging from 73% to 90%, both Turkish and international cities demonstrate that urban residents broadly value restored green and blue spaces, regardless of cultural or regional context.
- This highlights the social acceptability and political feasibility of NbS and ecological restoration as urban policy tools.

Overall, findings reinforce the notion that cities must be understood and managed as dynamic ecological systems:

- UER contributes not only to reversing environmental degradation, but also supports public health, psychological well-being, and climate resilience.
- As urban areas continue to grow, embedding ecosystem restoration into mainstream urban planning will be essential for meeting global sustainability and livability goals.

The comparative evidence from Türkiye and global cities affirms a clear takeaway. Restoring urban nature is no longer a luxury or aesthetic enhancement—it is a core foundation for future-proof, equitable, and resilient urban living.

Recommendations

Develop comprehensive urban ecosystem baselines

Cities should establish robust ecological inventories, mapping existing green assets, degraded zones, and biodiversity hotspots to inform strategic restoration priorities.

Prioritize equity and accessibility

Restoration efforts must ensure that all citizens—especially vulnerable groups—benefit from ecosystem services. This includes distributing green space investments evenly across neighborhoods.

Scale up successful pilot projects

As shown in Eskişehir, İzmir, and Medellín, local pilots can be highly impactful. These should be systematically evaluated and scaled through regional or national support programs.

Encourage participatory design and stewardship

Urban restoration gains legitimacy and long-term success when residents are involved in design, monitoring, and maintenance processes. Public satisfaction is not only an outcome, but a driver of sustainability.

Implement long-term ecological monitoring

Both ecological (e.g., species richness) and social indicators (e.g., satisfaction, usage patterns) must be monitored to adapt management strategies over time.

Integrate urban restoration into climate action plans

Urban ecological restoration should be recognized as a core tool in reducing heat vulnerability, improving air quality, and enhancing urban resilience against extreme weather events.

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Chapter 2

Bauhaus Principles and Reflection on Design by Women

Burçin SALTIK[1]

ABSTRACT

The Bauhaus school was a revolution in itself, it had an entirely different approach to teaching students and that is what made it famous and a milestone in design education. But what is often forgotten is that apart from important men at Bauhaus, there was this group of women at Bauhaus who made innumerable contributions to making it the Bauhaus it ultimately became. They became the masters of their respective arts and this was an entire journey that displays their hard work and determination to learn. They made many artifacts not only in the women-dominated weaving workshops but also in the ceramic, wood, and metal departments. This research aims to explain Bauhaus movement, the impact of the women at Bauhaus movement, and their concept on design. The examined examples has been chosen among the valuable units in order to be clear and compare the way the supporters express their examples.

Keywords: Bauhaus Movement, Women at Bauhaus, Bauhaus Design

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1. INTRODUCTION

The *Staatliches Bauhaus*, commonly known as the Bauhaus was a German Art School that combines arts, craft, design, and architecture under one roof. Bauhaus School established in Weimar in 1919 by architect Walter Gropius to teach modern arts and architecture. In under two decades from 1919 to 1933, when it moved first to Dessau, then Berlin under director Mies van der Rohe, the institution revolutionized the art-world with its controversial, cultish ideals, leaving a legacy of inspired ideas and inspiratory that not only impacted Western art education and cultural production philosophy of the 20th-century, but radically altered the look of material culture, from architecture to book production (Ambler, 2018; Droste, 2006; Heathcote, 2019; Hochman, 1997; Ott, 1997; Whitford, 1992).

Enduring contributions in fields from architecture to graphic arts and visual culture is seen today, as Bauhaus continues to generate social conversations and research criticism, one century into its founding (100 Years of Bauhaus, n.d.; Rix-Standing, 2019). But what truly makes the Bauhaus core ideology a cultural shift is that it's teaching principles and ideologies emphasized cooperation between, and integration of, creative arts and the knowledge of technologies of production.

This is an observable trait particularly for furniture design, whereby ergonomic comfort, material utility, spatial functionality and durability are equally as important as artistry (Emmons, Hendrix & Lomholt, 2012).

2. MATERIALS AND METHOD

The year 2019 will mark the 100th birthday of the Bauhaus. As that date approaches, this bias toward the school's male students is being revised, and its many integral female members recognized by scholarship and institutional exhibitions. Weavers, industrial designers, photographers, and architects like Anni Albers, Marianne Brandt, and Gertrud Arndt not only advanced the school's historic marriage of art and function; they were also essential in laying the groundwork for centuries of art and design innovation to come after them.

The Bauhaus approach is evident from Gropius's note that "no difference between the beautiful and the strong gender, absolute equality, but also absolute equal duties. No deference to the ladies" (Wortmann, 1993)

Female students, for instance, were encouraged to pursue weaving rather than male-dominated mediums like painting, carving, and architecture. Bauhaus founder Walter Gropius encouraged this distinction through his vocal belief that men thought in three dimensions, while women could only handle two.

Below, highlight 10 female Bauhaus members who contributed fundamental work, instruction, and innovation to the school over the course of its relatively short existence, between 1919 and 1933, and bolstered its lasting legacy.

3. RESULTS AND DISCUSSION

Women at Bauhaus

1. Anni Albers

Albers arrived at the Bauhaus in 1922, with the hope of continuing the painting studies that she had begun at the School of Arts and Crafts in Hamburg. By 1923, however, she was spending most of her time in the school's weaving workshop, where she became a quick master of the loom. Influenced by Paul Klee and "what he did with a line, a point or a stroke of the paintbrush," Albers used weaving to develop a signature visual vocabulary of hard-edged patterns. Her early tapestries would go on to have a considerable impact on the development of geometric abstraction in the visual arts, along with the work of several of her Bauhaus peers, including her husband, Josef Albers, who she met at the school.

Albers explored the functional possibilities of textiles with focus and passion; in 1930, she designed a cotton and cellophane curtain that simultaneously absorbed sound and reflected light. In 1931, she was appointed to helm the weaving workshop and became one of the first women at the Bauhaus to assume a leadership role. Several years after immigrating to the U.S. in 1933, she began to teach at the influential Black Mountain College in North Carolina. Albers became famous for the fabrics she crafted for large-scale companies like Knoll. She was also the first female textile artist to have a solo exhibition at the Museum of Modern Art in New York, in 1949.

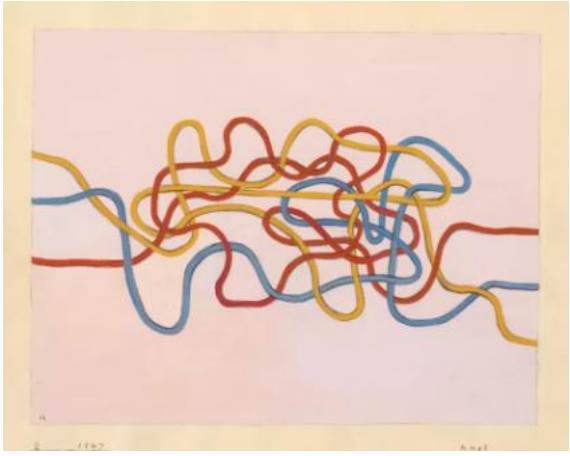

Figure 1. Anni Albers, Knot 2, 1947. © 2017 The Josef and Anni Albers Foundation/Artists Rights Society (ARS), New York Photo: Tim Nighswander/ Imaging 4 Art

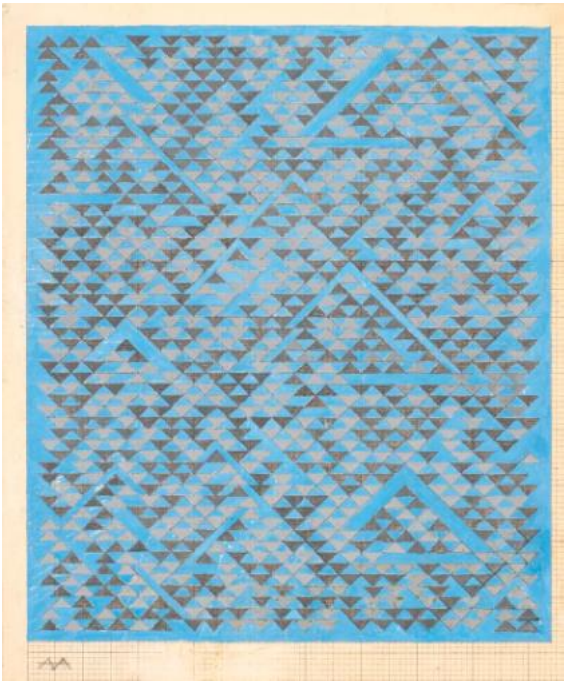

Figure 2. Anni Albers, Study for A, 1968. © 2017 The Josef and Anni Albers Foundation/Artists Rights Society (ARS), New York Photo: Tim Nighswander/ Imaging 4 Art.

2. Marianne Brandt

Brandt's early work so impressed László Moholy-Nagy that, in 1924, he opened a space for her in the metal workshop, a discipline that women had previously been barred from. She went on to design some of the most iconic works associated with the Bauhaus. These include an ashtray that resembles a halved metal ball, an edition of which is housed in MoMA's collection, and a silver tea infuser and strainer, which was her first student design and today is owned by both the Met and the British Museum, among other institutions.

During her years at the Bauhaus, Brandt became one of Germany's most celebrated industrial designers. And after Moholy-Nagy stepped down as head of the metal workshop in 1928, it was Brandt who replaced him, beating out her male counterparts for the position. During the same year, she developed one of the most commercially successful objects to come out of the school: the best-selling Kandem bedside table lamp. After leaving the Bauhaus in 1929, Brandt became director of the design department for the metalware company Ruppelwerk Metallwarenfabrik GmbH.

Figure 3. No. 15 Kandem Table Lamp, 1928
Chamber

Figure 4. Théière et passe-thé, ca., 1924

3. Gertrud Arndt

Arndt's ambition was to become an architect, but it was only after she landed at the Bauhaus in 1923 that she realized architecture classes were not yet available at the school. She ended up crafting geometrically patterned rugs in the weaving workshop. One of these textiles famously decorated the floor of Bauhaus founder Walter Gropius's office. But despite Arndt's success at the loom, it was her photography practice, which she honed outside of the structured Bauhaus

workshops, that would become most influential to modern and contemporary artists.

As a self-taught photographer, Arndt began by shooting the buildings and urban landscapes around her. She also assisted her husband's architecture firm by photographing their construction sites and buildings. It was Arndt's series of imaginative self-portraits titled "Mask Portraits," however, that ultimately shaped her legacy. The series—which shows Arndt performing a range of traditional female roles, and wearing a profusion of veils, lace, and hats—is now seen as an important precursor to feminist artists like Cindy Sherman.

Figure 5. Study on color at Bauhaus Weimar, probably circa 1924

4. Gunta Stölzl

Stölzl was one of the earliest Bauhaus members, arriving at the school in 1919 at the age of 22. The same year, she penned confident diary entries that would foreshadow her success as a leading designer of the era. "Nothing hinders me in my outward life, I can shape it as I will," one reads. "A new beginning. A new life begins," goes another. While she experimented with a diverse range of disciplines at the Bauhaus, Stölzl focused on weaving, a department that she helmed from 1926 to 1931. There, she was known for complex patchworks of patterns, composed of undulating lines that melt into kaleidoscopic mosaics of colored squares. They took the form of rugs, wall tapestries, and coverings for Marcel Breuer's chairs.

After being driven from Germany by the Nazi regime for marrying a Jewish man, fellow Bauhaus student Arieh Sharon, Stölzl established the hand-weaving company S-P-H-Stoffe in Zurich with former Bauhaus peers Gertrud Preiswerk and Heinrich-Otto Hürlimann. She ran the company until 1967 and designed countless popular carpets and woven textiles. "We wanted to create living things

with contemporary relevance, suitable for a new style of life," she once said. "It was essential to define our imaginary world, to shape our experiences through material, rhythm, proportion, color and form."

Figure 6. Gunta Stölzl, The African Chair, Image Source: Bauhaus 100

Figure 7. Gunta Stölzl, Wall Hanging, 1924. © 2017 Artists Rights Society (ARS), New York / VG Bild-Kunst, Bonn. Courtesy of The Museum of Modern Art, NY.

5. Benita Koch-Otte

Koch-Otte had already taught drawing and handicraft at a girls' secondary school for five years before she joined the Bauhaus, shifting her focus to her own studies. There, with fellow weaver and painter Stölzl, Koch-Otte used textiles to explore new approaches to abstraction. To further develop their skills, the two also took classes at the nearby Dyeing Technical School and the Textile Technical School.

Koch-Otte married the director of the Bauhaus photography department, Heinrich Koch, in 1929. Together, they relocated to Prague when the Nazi regime rose to power. After her husband's unexpected death, however, Koch-Otte returned to Germany. There, she became director of a textile mill, and continued to teach until the very end of her life—and her fabrics are still in production today.

Figure 8. Benita Koch-Otte, *Woven Wall Hanging,* 1923-24.
Manufactured by Bauhaus Weaving Workshops, Weimar.
Courtesy of The Museum of Modern Art, NY.

6. Otti Berger

Berger was one of the most creative members of the weaving workshop, with a more expressive and conceptual approach than that of many of her contemporaries. After Stölzl abdicated her seat as head of the department in 1931, Berger assumed the position and established her own curriculum, but remained there only until 1932, when she set out on her own.

Berger went on to open her own textile atelier in Berlin, and began the process of applying for a visa, with the goal of relocating to the U.S. There, she planned to join Moholy-Nagy's New Bauhaus school in Chicago and escape Hitler's regime (she was Jewish), but her application stalled. While waiting for approval, she returned to Croatia, where she was arrested by the Nazis and taken to

Auschwitz. She died there in 1944, but her fabrics live on in collections from the Met to the Art Institute of Chicago.

Figure 9-10. Courtesy of Rogers Fund, by exchange, 1955

7. Ilse Fehling

Fehling had a natural talent for creating sculptural forms and theater designs, skills that she honed further while at the Bauhaus. There, she took classes with painter Paul Klee and sculptor Oskar Schlemmer, among others, between 1920 to 1923. Her objects and theater sets married whimsy and function; in 1922, she patented a rotating round stage for stick puppets.

After leaving the Bauhaus, she moved to Berlin and established a multifaceted freelance practice, splitting her time between concocting costume and stage designs and sculptures, the latter of which were celebrated in a solo show at Fritz Gurlitt Gallery in 1927. After studying in Rome in the early 1930s, Fehling returned to Germany, where her sculptures—forged in metal and stone and fusing cubism and corporeality—were deemed "degenerate." She pushed on, continuing to develop her diverse oeuvre throughout her long life.

Figure 11. A rare statuette of a bathing female nude. Brown patinated bronze, 1943

8. Margarete Heymann

At just 21 years old, Heymann refused to follow the majority of her female peers into the Bauhaus's weaving workshop, convincing Gropius to open up a place for her in ceramics. There, the young, free-thinking artist began to create angular objects, composed of triangles and circles and spangled with constructivist patterns and colorful glazes. She left just a year later, though, after butting heads with her teacher Gerhard Marcks.

Heymann and her husband went on to establish a workshop, Haël-Werkstätten, that produced her designs. They were a quick hit, selling at chic shops in Europe, Britain, and the U.S. alike, but Heymann was forced to sell the company in 1934. As European political conflict stirred, Heymann, who was Jewish, fled to England to escape persecution. There, she established a new company, Greta pottery, and would later devote her days to painting.

Figure 12. Margarete Heymann-Marks, Kandinsky Inspired Teacup, 1929. Courtesy of The Ellen Palevsky Cup Collection, Gift of Max Palevsky. Courtesy of Los Angeles County Museum of Art

Figure 13. Margarete Heymann-Marks, Haël Werkstätten, *Disk Handle Teacup and Saucer*, 1930. Courtesy of The Ellen Palevsky Cup Collection, Gift of Max Palevsky. Courtesy of Los Angeles County Museum of Art.

9. Lou Scheper-Berkenkamp

Like many of her Bauhaus contemporaries, Scheper-Berkenkamp was a passionate colorist, an interest she pushed in the school's mural painting workshop, where she was one of only several women. Her work took her to Moscow with her husband, Bauhaus peer Hinnerk Scheper, where the couple established an "Advisory Centre for Colour in Architecture and the Cityscape," and concocted color schemes for the exteriors and interiors of buildings across the Russian capital.

After the Bauhaus shuttered in 1933, Scheper-Berkenkamp worked as a freelance painter in Berlin and published a number of whimsical children's books, coming-of-age narratives told through the lens of fantastical adventures. Tales like "The Stories of Jan and Jon and their Pilot Fish" (1947) are today considered part of the children's book canon. They were some of the first to pair surrealistic drawings with outlandish plots; two of the books have recently been re-released by the Bauhaus Archive in Berlin.

After her husband's death, Scheper-Berkenkamp took over his color design business, spearheading the schemes for Hans Scharoun's Philharmonie building in Berlin, the Egyptian Museum in Berlin, and the Berlin Tegel airport building, among others.

Figure 14. Figurines of the Triadic Ballet at the Staatsgalerie Stuttgart, 1922

10. Alma Siedhoff - Buscher

Siedhoff-Buscher was one of the Bauhaus's few women to switch from the weaving workshop to the male-dominated wood-sculpture department. There, she invented a number of successful toy and furniture designs, including her "small ship-building game," which remains in production today. The game manifested Bauhaus's central tenets: its 22 blocks, forged in primary colors, could be constructed into the shape of a boat, but could also be rearranged to allow for creative experimentation. The toy could also be easily reproduced.

Siedhoff-Buscher also became known for the cut-out kits and coloring books she designed for publisher Verlag Otto Maier Ravensburg. But her most pioneering work proved to be the interior she designed for a children's room at "Haus am Horn," a home designed by Bauhaus members that exemplified the movement's aesthetic. Siedhoff-Buscher filled it with modular, washable white

furniture. She designed each piece to “grow” with the child: a puppet theater could be transformed into bookshelves, a changing table into a desk.

Figure 15-16. Alma Siedhoff-Buscher. © Klassik Stiftung Weimar.

4. CONCLUSION

Educational Opportunities;

Initially, women were discouraged from applying to the Bauhaus, as it was predominantly male. However, as the school evolved, women began to enroll and were encouraged to participate in workshops, particularly in textiles and crafts, which were viewed as more appropriate for women.

Challenges Faced;

Despite their contributions, women at the Bauhaus often encountered gender discrimination. They were frequently relegated to less prestigious roles and faced challenges in being recognized as equals to their male counterparts.

Impact on Modern Design;

The work of women at the Bauhaus had a lasting impact on modern design, influencing fields such as textile design, furniture design, and architecture. Their legacy continues to inspire contemporary designers.

Cultural Context;

The Bauhaus coincided with significant social changes in the early 20th century, including movements for women's rights. While the school aimed for equality and innovation, the realities of sexism in the early 20th century often limited the recognition and opportunities for women.

The contributions of women to the Bauhaus were significant and helped to shape modern design, despite the challenges they faced. The evolving narrative

around their roles continues to inspire discussions about gender equality in art and design today.

In conclusion, while the Bauhaus provided a platform for women to express their creativity and challenge societal norms, it also reflected the gender biases of its time. The legacies of women at the Bauhaus remind us of the ongoing struggle for equality in the arts and design, highlighting both their achievements and the need for greater inclusivity in creative fields. Their contributions continue to inspire future generations, emphasizing the importance of diverse voices in shaping the narrative of design history.

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Chapter 3

An Example of a Virtual Space Experience in a Real Environment: Süleyman Demirel University Metaverse Venture Studio

Gamze AKYOL[1]

Abstract

This study investigates the architectural, educational, and technological significance of Metaverse Studios by focusing on the Süleyman Demirel University (SDÜ) Metaverse Venture Studio—a fully realized and constructed interior design project. As immersive technologies such as virtual reality (VR), augmented reality (AR), and mixed reality (MR) gain traction in educational and professional domains, the emergence of Metaverse Studios presents new challenges and opportunities for architects and educators alike. This paper examines how the spatial organization, material selection, and pedagogical programming of such studios converge to support creative production, digital literacy, and interdisciplinary collaboration. Drawing on a comprehensive case study of Turkey's first pre-incubation center focused on Metaverse education, the research outlines the studio's architectural features—such as modular furniture systems, zones for VR interaction and green screen content creation, and ergonomically designed study areas—all tailored to foster digital innovation in a higher education context. The SDÜ Metaverse Venture Studio was designed not merely as a conceptual prototype, but as a physically constructed, user-centered environment that aligns with broader national and regional innovation strategies. In addition to interior analysis, the paper situates the project within a global discourse on immersive design education, highlighting the studio's role in bridging physical and virtual learning spaces. By facilitating engagement with technologies, the studio supports student development, entrepreneurship, and community outreach.

Keywords:Metaverse Studio, Immersive Learning Environments, Interior Design, Architectural Pedagogy, Educational Innovation

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1. Introduction

The evolution of the Metaverse, an expansive digital universe enabled by virtual reality (VR) and augmented reality (AR) technologies, has given rise to the development of specialized facilities known as Metaverse studios. These studios serve as hubs of innovation, where virtual worlds are conceptualized, developed, and tested. This paper explores the concept of Metaverse studios, examining examples from both Turkey and the global context. Additionally, it delves into the architectural and material considerations critical to designing these cutting-edge spaces, with a particular focus on the Süleyman Demirel University (SDÜ) Metaverse Venture Studio. By analyzing the interplay between form, function, and materiality, this study provides insights into the design principles that underpin the creation of environments conducive to digital innovation and their role in supporting student development.

The design of metaverse studios represents a significant evolution in architectural and educational practices, driven primarily by advancements in virtual reality (VR), augmented reality (AR), and immersive technologies. The metaverse is envisioned as a three-dimensional, immersive virtual environment where collaboration, creativity, and architectural design can flourish beyond physical constraints. As noted by Schumacher, architects are poised to play a pivotal role in this transformation, utilizing unique design competencies to shape virtual spaces that reflect societal needs and experiences (Schumacher, 2022). With the increasing prevalence of VR tools, designers can explore and create within these digital realms, transcending traditional methodologies and fostering extensive interactive possibilities.

A comprehensive understanding of the architecture underlying the metaverse is crucial for design studios aiming to leverage its capabilities. Rawat and Alami highlight various requirements and standards essential for developing a robust metaverse infrastructure, emphasizing the architecture's role in enabling immersive experiences and collaborative innovation (Rawat & El Alami, 2023). This structural foundation is further enriched by the insights from Izani et al., who argue that the metaverse has long been anticipated in the realm of digital gaming and virtual interaction, with contemporary discussions redefining its applicability within society (Izani vd., 2023). The architectural discourse around the metaverse also includes considerations of inclusivity and accessibility, ensuring that all users, regardless of their backgrounds or abilities, can engage with these innovative environments (Radanliev vd., 2023).

In terms of educational applications, the metaverse provides unique opportunities for design education, especially in the context of architectural design studios. Studies indicate that virtual design studios can replicate and

enhance traditional studio practices by allowing real-time collaboration and project critiques in immersive settings (Al-Ghaili vd., 2022; Sidhu vd., 2024). Current pedagogical frameworks emphasize the importance of engaging students through hands-on experience within these virtual environments, combining traditional design practices with new digital tools (Komarzyńska-Świeściak vd., 2021). For instance, Jin and Tiejun point out that using a metaverse platform in art and design education significantly enhances student engagement and learning outcomes due to its immersive nature and reduced barriers to accessing studio resources (Jin & Tiejun, 2023). This shift underscores the necessity for educators to adapt their methods and explore new technologies that support active learning and creative expression.

Moreover, the challenges of transitioning to metaverse-based design studios cannot be overlooked. As discussed by Ham and Schnabel, there are significant considerations regarding socio-technical dynamics in virtual environments, including the necessity for equitable access to technology and the potential for motion sickness associated with VR use (Ham & Schnabel, 2012; Lin vd., 2023). The effectiveness of virtual studios hinges on a well-designed user experience that mitigates these issues while maintaining high levels of student interaction and learning efficacy (Ceylan vd., 2020).

Educational institutions have started to adopt Metaverse Studios, utilizing their capabilities to recreate physical learning environments disrupted by events like the COVID-19 pandemic. These environments provide students with interactive learning experiences that mirror face-to-face engagements, bolstering cognitive and emotional educational outcomes (Frydenberg & Ohri, 2023; Rahman vd., 2023). Furthermore, with the emergence of AI technologies within these platforms, adaptive learning systems can be implemented, personalizing educational approaches and responding dynamically to student needs, thereby enhancing engagement. The fusion of rigorous design with educational pedagogy within Metaverse Studios holds the potential to redefine how learning environments are conceptualized and experienced (Rahman vd., 2023; Sidhu vd., 2024).

The architectural properties of Metaverse Studios reflect a convergence of cutting-edge technologies and creative design principles intended to foster immersive environments. The concept of the Metaverse encapsulates a virtual reality space where users interact with a computer-generated environment and with each other in real-time. This sophisticated interplay is primarily underpinned by advancements in mixed reality (MR), augmented reality (AR), and virtual reality (VR), which are pivotal in projects aiming to create hyper-

connected, immersive spaces that replicate or even enhance the sensory experiences of the physical world (Guan vd., 2022).

One such example is the Metaverse Venture Studio at Süleyman Demirel University (SDÜ), which exemplifies how architectural and pedagogical integration can empower regional transformation. Designed with distinct architectural features, the studio includes modular and transparent interior elements that foster adaptability and collaboration. It functions not only as a space for digital experimentation but also as a project-based learning environment. The studio was developed under the coordination of Professor Pınar Göktaş and designed by Dr. Gamze Akyol, a member of project team, with financial support from the Western Mediterranean Development Agency (BAKA) through its 2022 Financial Support Program (Ref No: TR61/22/GEG/0007). The initiative addresses the limited investment potential and infrastructural deficiencies in Isparta's entrepreneurial ecosystem, aiming to enhance the region's competitiveness through strategic digital development.

The overarching goal of the SDÜ Metaverse Studio is to raise awareness of the Metaverse, promote youth entrepreneurship in this domain, and create mechanisms for easier access to funding and infrastructure necessary for developing technological products. This effort aligns with broader national and regional strategies such as the TÜBİTAK Vision 2023 Plan, the Eleventh Development Plan (2019–2023), the National Strategy for Regional Development (2014–2023), and the European Union Digital Action Plan (2021–2027). Each of these policy frameworks emphasizes the cultivation of qualified human resources, the establishment of physical and legal infrastructures for emerging technologies like blockchain and artificial intelligence, and the importance of creating digital innovation hubs. Thus, the SDÜ Metaverse Venture Studio emerges as a pioneering initiative within Turkey's digital transformation agenda, serving as the country's first pre-incubation center focused on Metaverse education. The studio aims to foster a community of digital entrepreneurs by offering them a physical space to develop and implement ideas while equipping them with the necessary skills to thrive in the digital economy.

2. Süleyman Demirel University Metaverse Venture Studio

The Süleyman Demirel University Metaverse Venture Studio features an open-plan layout that is designed to facilitate collaboration and communication. The space is divided into different zones, each dedicated to specific stages of the development process, from conceptualization and design to coding and testing. The open-plan design allows for easy movement and interaction between these zones, fostering a sense of community and shared purpose (Figure 1).

Fig.1. 3D Render - Top View of Metaverse Studio

At the entrance of the studio, there is a stepped seating area in the form of an amphitheater has been designed to enable students to clearly view the projection wall located deeper within the space. Adjacent to this, the general study area functions as a flexible workspace that supports both individual study and coworking activities. It also accommodates educational programs and seminars by providing accessible and comfortable seating for participants. On the left side of the entrance, a coffee corner is located, offering a designated space for users to take breaks during work sessions. Directly across from the entrance, the manager/meeting room is positioned to allow the studio manager to oversee and coordinate activities within the studio effectively. Adjacent to this room is the green box room, the entrance of which is deliberately situated behind a partitioned area to avoid disrupting those working in the general study zone.

The general study area is further divided into two sections by an elevated platform. This upper level includes circular tables intended for group work, while individual workstations are positioned along the windows, providing users with natural light and views of the surrounding landscape. On the exterior wall of the green box room, which is clearly visible from the general study area, a white projection screen is installed. In front of this screen is a designated virtual reality (VR) experience area, characterized by a floor with varied textures to support immersive interaction.

2.1. Entrance and Coffee Corner

At the entrance of the studio, a stepped seating area in the form of an amphitheater has been designed to enable students to clearly view the projection

wall located deeper within the space. The seating platforms are constructed from maple-veneered MDF panels, supported by a steel skeleton structure engineered to bear both the weight of the material and user occupancy. Electrical outlets are embedded into the steps to provide users with accessible power sources, facilitating a functional workspace for digital devices. The amphitheater consists of two distinct seating zones: one designed with three levels and the other with two, the latter intentionally kept lower in height to avoid obstructing natural light from the nearby window (Figure 2).

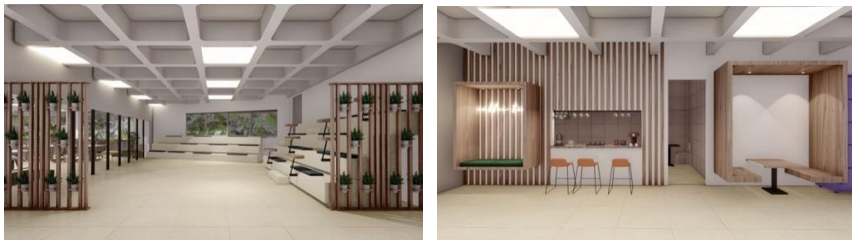

Fig.2. Renders- Entrance (Left), Coffee Corner (Right)

In the design of the coffee corner, material selection was a critical consideration, as the space is intended to function as a relaxation area during study breaks. It was essential to use materials that evoke a sense of calm and comfort. For this reason, wood was selected as the primary material, used for wall paneling, seating elements, and furniture to create a warm and inviting atmosphere. The use of wood helps to create a more inviting and human-centered environment, essential in spaces where creativity and collaboration are key. A service window was incorporated into the wall to establish a visual and functional connection between the kitchenette and the coffee corner, thereby facilitating efficient service. To the left of the service window, a rectangular seating unit was installed to provide users with a place to sit and unwind while enjoying their beverages. On the right side, a custom-designed piece of furniture integrates seating with table surfaces, allowing users to study and enjoy coffee simultaneously within a cohesive and comfortable setting (Figure3).

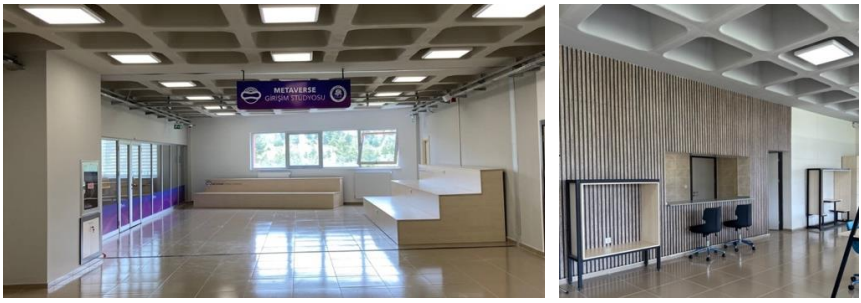

Fig.3. Photos- Entrance (Left), Coffee Corner (Right)

2.2. Manager/ Meeting Room

This room, designed as a meeting or collaborative workspace within the studio, is characterized by its functional simplicity and clarity. A large window spans nearly the entire width of the exterior wall, allowing ample natural light to flood the space and offering expansive views of the surrounding landscape, which enhances both visual comfort and psychological well-being. Centrally located within the room is a circular wooden meeting table, surrounded by ergonomic swivel chairs, initially conceived in soft purple and pink tones to symbolically align with the visual language commonly associated with Metaverse technologies (Figure 4).

Fig.4. Renders- Manager/ Meeting Room

However, during implementation, the color palette was altered to red due to material constraints faced by the production company, which had limited availability of the originally intended upholstery materials (Figure 5).

Fig. 5. Photos- Manager/ Meeting Room

Along one wall, a series of modular storage units composed of alternating red and natural wood laminate panels provide both a vibrant visual element and practical storage. This use of bold color in combination with neutral tones offers a balanced aesthetic that energizes the space without overwhelming it. The flooring is composed of large-format ceramic tiles in a neutral beige tone, contributing to the room's clean and durable surface. The layout promotes flexibility, allowing the space to be used for formal meetings, collaborative work, or small seminars, while maintaining a degree of visual cohesion and spatial efficiency.

The room is separated from the general study area with a glass partition. Glass is a key material in the design of Metaverse studios, used extensively in partitions, walls, and facades. The transparency of glass promotes openness and communication, essential for fostering a collaborative work environment. Additionally, the use of glass allows natural light to penetrate deep into the interior spaces, reducing the reliance on artificial lighting and creating a more comfortable and sustainable workspace.

2.3. General Study Area

The general study area is designed as a multi-functional workspace that supports both collaborative and individual study activities. This section of the studio is visually and functionally divided by an elevated wooden platform, which creates two distinct zones within the open-plan layout. The elevated portion is positioned along the window façade to maximize natural daylight exposure and

external views, enhancing users' visual comfort and psychological well-being. This area features a combination of round tables for group discussions and linear workstations along the windows for individual study, all equipped with ergonomic chairs in varied colors such as mustard yellow and burgundy. The color differentiation not only aids in zone identification but also introduces a sense of vibrancy to the space (Figure 6).

Fig.6. Renders- General Study Area

On the main floor level, long communal tables supported by black metal frames and light wood surfaces offer additional workspaces. Each workstation is equipped with electrical outlets to accommodate digital devices, addressing the technological needs of users. Seating here is provided through green and blue ergonomic chairs with castor wheels to facilitate mobility. Centrally located within the space are custom-designed black steel-frame structures that act as both functional dividers and visual markers, originally envisioned as frames for hanging greenery and lighting fixtures. The flooring is a neutral-toned ceramic tile that transitions to wood-effect vinyl flooring on the raised platform, emphasizing material hierarchy and spatial function. The coffered concrete ceiling, consistent throughout the studio, reinforces a cohesive architectural identity while offering acoustic benefits and visual depth. Overall, the general study area integrates flexibility, comfort, and a stimulating environment, aligning with the pedagogical goals of the Metaverse Venture Studio.

Notably, some material and color selections were revised during production based on the availability of resources from the contracted suppliers. For example, while the visualizations included a diverse range of pastel and muted tones to evoke a more immersive, Metaverse-inspired atmosphere, the realized version

features a more limited color palette, dominated by readily available chair fabrics in red, green, blue, and yellow. Similarly, some of the more decorative elements—such as suspended greenery, fabric panels, or branding installations—were simplified or omitted to streamline the construction timeline. Despite these changes, the overall spatial logic, architectural structure, and programmatic function of the general study area have been successfully preserved. The final design still achieves a dynamic and inclusive learning environment that aligns with the educational goals of the Metaverse Venture Studio (Figure 7).

Fig. 7. Photos- General Study Area

2.4. VR Platform, Presentation Wall and Green Box Room

Adjacent to the general study area is a specialized zone that integrates three key functions within the Metaverse Venture Studio: the VR platform, the presentation wall, and the green box room. This area is designed to support both immersive digital experiences and content production, playing a central role in the technological ecosystem of the studio (Figure 8). The VR platform is distinguished from the surrounding floor by its use of a soft, hexagonal rubber flooring material—originally specified for safety and ergonomic comfort during extended virtual reality use. This specialized flooring not only delineates the interactive zone visually but also enhances physical comfort and user orientation during VR-based activities.

Fig. 8. Render - VR platform, the presentation wall, and the green box room

Positioned directly in front of the VR platform is a large white presentation wall, intended to serve as a multi-use display surface. In the design phase, this wall was conceived to support projection-based presentations, functioning as both a visual communication tool and a spatial anchor during workshops or events. In the built version, it also incorporates the institution's branding, reinforcing identity while maintaining a clean, neutral surface for projection (Figure 9).

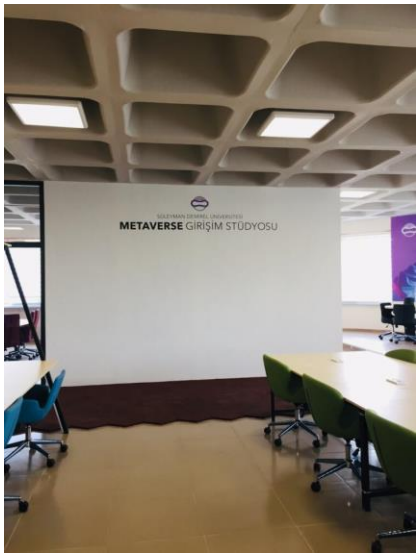

Fig. 9. Photos- VR platform and the presentation wall

Located behind this wall is the green box room, accessed via a sound-insulated acoustic door. This room was purposefully designed for digital content creation, particularly for video production and mixed reality recording. The acoustic treatment ensures minimal sound interference, which is critical for achieving high-quality audio-visual output. Although the core spatial relationships and architectural intentions were preserved in the transition from render to realization, some modifications—such as the simplification of lighting integration and material availability—were made during construction to accommodate feasibility and supply constraints. Nevertheless, the implemented configuration successfully supports its intended educational and creative functions, contributing to the immersive and media-rich character of the studio.

3. Conclusion

Süleyman Demirel University Metaverse Venture Studio stands as a significant model in the integration of architectural design and digital innovation within an academic context. As both a physical and conceptual space, the studio bridges the gap between emerging technologies—such as virtual reality, augmented reality, and digital content production—and the educational environment in which they are applied. Through careful spatial organization, the use of adaptive materials, and the incorporation of specialized zones such as VR platforms, green screen rooms, and flexible study areas, the studio supports a diverse range of activities including collaborative learning, individual study, prototyping, and immersive experience development.

As this study demonstrates, Metaverse Studios are not merely technologically equipped spaces but are also pedagogically and architecturally designed to support interdisciplinary collaboration, creativity, and experiential learning. The SDÜ Metaverse Studio offers zones for focused study, group work, content creation, and immersive experiences—each designed with spatial logic and user comfort in mind. While the built environment deviated in some ways from its initial renderings due to material availability and production constraints, the integrity of the architectural vision and its alignment with educational goals have been maintained.

While the initial design renderings proposed a highly dynamic and color-rich interior aligned with the visual language of the Metaverse, the realized version required several material and color adjustments due to production constraints. Nevertheless, the core design principles—such as modularity, ergonomic comfort, access to natural light, and acoustic optimization—have been successfully implemented. These considerations are not only architectural

decisions but also pedagogical tools, shaping how students and researchers interact with their environment.

Ultimately, SDÜ Metaverse Venture Studio illustrates how architectural design can serve as a catalyst for digital creativity and educational transformation. It functions as a hub for interdisciplinary collaboration, entrepreneurship, and experiential learning, aligning with national innovation strategies and responding to regional developmental needs. As a pioneering space in Turkey's academic landscape, the studio sets a precedent for how future educational facilities might respond to the evolving demands of hybrid and technology-integrated learning ecosystems.

To summarize, the metaverse represents a transformative arena for architectural design and education, where immersive virtual studios can thrive. This transition is facilitated by a more profound understanding of the metaverse's architecture and the integration of innovative pedagogical practices. Key considerations include ensuring accessibility, maintaining engagement, and leveraging technology to create enriching educational experiences. The future of design studios in the metaverse promises to redefine creative collaboration and architectural innovation.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

During the preparation of this work the author used Grammarly GO AI Writing Assistant and ChatGPT in order toimprove language and readability. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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