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ARCHITECTURAL AND PLANNING ADAPTATIONS OF HISTORICAL URBAN LANDSCAPES: FROM TRADITIONAL MEDINAS TO SUSTAINABLE STREETS IN HOT CLIMATES

Abstract: This article explores the architectural and planning adaptations of historical urban landscapes, focusing on the transformation of traditional medinas into modern sustainable environments in hot climates. Urban features such as compact street layouts, housing designs, gardens, fountains, walls, and arches have undergone significant evolution, reflecting a balance between cultural heritage preservation and the demands of contemporary urban life. This study highlights how historical patterns, designed for passive cooling, social interaction, and environmental harmony, are reinterpreted using modern materials, technologies, and planning approaches. By integrating ecological strategies, cultural identity, and innovative techniques, these urban adaptations aim to enhance functionality, thermal comfort, and resilience while addressing challenges posed by rapid urbanization and climate change.

Case studies from North Africa, particularly Morocco, demonstrate how traditional urban forms are adapted to incorporate green infrastructure, energy-efficient systems, and sustainable water management. Visual comparisons illustrate how handcrafted architectural elements, intricate layouts, and symbolic gardens are transformed into functional yet culturally significant modern urban spaces. The study emphasizes the multidimensional benefits of these transformations, including pollution reduction, energy efficiency, biodiversity promotion, and improvements in physical and mental health. These outcomes underline the critical role of cultural heritage in achieving urban sustainability and resilience in hot climates.

This research concludes with actionable recommendations for urban planners and policymakers on leveraging historical patterns as a framework for addressing the challenges of modern urbanization. By combining traditional knowledge with innovative solutions, the study contributes to creating adaptive, livable, and sustainable cities that honor their cultural legacy while meeting future demands.

Keywords: architectural planning; historical urban landscapes; medinas; sustainable urban streets; hot climates; urban adaptation; ecological strategies; green

infrastructure; passive cooling; urban sustainability; climate-responsive design; thermal comfort; water-sensitive urban design.

Formulation of the problem. The challenges of hot climates, including extreme heat, water scarcity, and rapid urbanization, create significant obstacles for sustainable urban development. Traditional architectural and urban planning methods, while effective in addressing these issues historically, require adaptation to meet contemporary urban demands. The integration of these vernacular approaches with modern sustainability practices remains underexplored.

Analysis of research and publications. A wealth of research underscores the importance of integrating vernacular knowledge with contemporary urban planning to address challenges in hot climates. Notable contributions include Hassan Fathy's seminal work, Natural Energy and Vernacular Architecture (1986), which emphasizes passive cooling techniques and the use of locally available materials for thermal comfort in arid regions. Fathy's studies highlight the effectiveness of traditional architectural elements, such as thick walls, small windows, and courtyards, in mitigating extreme heat without reliance on modern mechanical systems.

Silva's Urban Planning in North Africa (2016) examines the impact of urbanization on traditional city forms, focusing on how sustainability can be embedded within modern urban development. This work provides valuable insights into the integration of green infrastructure and resource-efficient designs that align with cultural and environmental contexts in North African cities. Similarly, Roaf's Ecohouse: A Design Guide (2001) and Oliver's Encyclopedia of Vernacular Architecture of the World (1997) provide foundational frameworks for energy-efficient design rooted in traditional practices.

Recent studies extend these principles by addressing the intersection of traditional techniques and modern innovations. For example, Fuentes Pardo (2023) explores the adaptation of vernacular architecture in a globalized world, emphasizing its relevance for sustainable urban design. Santos et al. (2023) investigate low-carbon construction techniques, focusing on the integration of traditional materials and passive design elements with contemporary technologies.

Attia's (2009) experimental study on the adaptation of windcatchers demonstrates how traditional cooling systems can be modernized to meet the demands of contemporary urban environments. His research provides practical examples of how vernacular design elements can be adapted for resource efficiency, reduced carbon footprints, and enhanced thermal comfort.

Collectively, these studies highlight the value of blending historical architectural wisdom with cutting-edge technologies to create sustainable, resilient, and culturally rooted urban environments. While much attention has been given to traditional

architectural elements, there remains a gap in research on their large-scale adaptation to modern urban planning frameworks. This study contributes to filling this gap by analyzing how historical urban landscapes can be reimagined as sustainable, livable, and culturally significant spaces, offering actionable recommendations for urban planners and policymakers.

The objective of the article. The aim of this article is to analyze the adaptation of historical urban landscapes, focusing on traditional medinas, into sustainable urban streets that address the environmental, cultural, and socio-economic challenges of hot climates. It explores the integration of historical urban design principles with modern technologies and ecological strategies, providing a novel framework for sustainable urban development in hot climates. It emphasizes the dual benefits of preserving cultural heritage while achieving environmental resilience and socio-economic functionality.

Main part. The findings reveal that traditional urban designs offer a rich repository of principles that remain relevant in modern architectural practices. In North Africa, historical urban landscapes were meticulously crafted to respond to environmental conditions, enhance resource efficiency, and foster social cohesion. The transition to contemporary urban designs demonstrates how these historical elements have been reinterpreted using modern technologies and techniques to meet current sustainability and aesthetic standards.

Sustainability through Urban Form and Function. Traditional medinas, with their compact layouts and shaded courtyards, served as effective solutions for mitigating harsh climatic conditions. These elements reduced solar heat gain and facilitated passive cooling, as highlighted by Fathy and Givoni [2, 3]. Modern urban designs have adopted these principles through ecological strategies, such as integrating vertical gardens and green roofs, which offer comparable thermal benefits while aligning with contemporary urban aesthetics. For exam. Fig.1 compares historical street layouts to modern adaptations, showcasing how traditional narrow alleys and shared communal spaces have influenced the design of pedestrian-friendly streets and urban plazas in contemporary cities.

Cultural Identity and Material Transformation. A striking aspect of traditional North African architecture is the use of zellij (intricate mosaic tilework) and geometric plaster carvings. These elements not only served decorative purposes but also carried deep cultural and symbolic meanings, reflecting the mathematical and artistic ingenuity of Islamic art. Historically, these designs were handcrafted by skilled artisans, often trained through generations of apprenticeship. The labor-intensive process of creating zellij involved meticulously cutting small tiles of varying shapes and colors, which were then assembled into elaborate geometric patterns. Similarly, plaster decorations were carefully carved into wet plaster using simple tools, resulting in intricate reliefs

that adorned walls, ceilings, and arches. These works represented not only the artistic expression of their creators but also the cultural identity and sophistication of their communities [8].

In modern designs, while zellij and plaster decorations remain iconic, their production methods have significantly evolved. Machine-made zellij tiles and prefabricated plaster panels are now widely used to meet the economic and logistical demands of urban expansion. As Beckers and Berardi [4] observe, this shift has allowed these decorative elements to remain a defining feature of North African architecture while making them more accessible for large-scale projects. However, the transition to machine production often results in a loss of the nuanced imperfections and unique variability inherent in handcrafted works, which added to their charm and authenticity.

Historically, the materials used for these architectural elements were sourced locally, such as carved stone, clay, and hand-molded adobe. These materials were not only abundant but also provided excellent thermal insulation, effectively regulating indoor temperatures in hot climates. Intricate carvings and textured surfaces added depth and complexity to facades, while also diffusing light and creating dynamic visual effects. This harmony between form, function, and environment underscored the ingenuity of traditional designs.

In modern applications, locally sourced materials have often been replaced by prefabricated panels, lightweight composites, and high-performance coatings. These materials are designed to mimic traditional patterns and textures while offering enhanced durability, energy efficiency, and resistance to environmental degradation. For example, modern zellij panels are often made from ceramic or polymer composites that are lightweight and easier to install, making them suitable for high-rise structures and expansive facades. Similarly, prefabricated plaster panels now incorporate insulation layers and are treated to withstand humidity and wear, ensuring long-term performance without compromising the aesthetic integrity of the design [1, 2 and 16].

Despite these advancements, the essence of traditional craftsmanship remains central to the design philosophy of many modern North African projects. Architectural features such as arches, domes, and latticed screens (mashrabiya) continue to draw from traditional design principles while adapting to the requirements of contemporary urban environments. For instance, laser-cut metal panels are often used to recreate the intricate latticework of mashrabiya, providing shading and ventilation while catering to modern standards of precision and scalability. This blending of tradition and innovation reflects the dynamic evolution of architectural practices in North Africa. While modern technologies and materials have streamlined construction processes and expanded the possibilities of design, they also challenge architects to retain the authenticity and cultural significance of historical elements. The careful

reinterpretation of traditional zellij, plaster carvings, and facade patterns in modern architecture ensures that these timeless features remain an integral part of the region's evolving identity, bridging the past and the future.

Fig. 1. Historical Urban Patterns and Contemporary Adaptations: Before-and-after visualizations of street layouts or housing designs adapted over time

Integration of Traditional Techniques in Modern Contexts. The adaptation of traditional design elements extends beyond aesthetics to functional aspects. Historical geometric patterns on walls and windows were often strategically placed to control

light and airflow, contributing to the interior's comfort and ambiance. Modern designs incorporate these principles using advanced materials, such as high-performance glazing, to achieve similar effects with added energy efficiency [17].

Lessons for Urban Development. The synthesis of traditional craftsmanship with modern manufacturing methods demonstrates a powerful approach to preserving cultural identity while addressing the challenges of urbanization, climate change, and resource constraints. By drawing on the principles of historical designs and adapting, those to contemporary needs, architects and urban planners can create environments that balance cultural preservation with modern functionality.

Traditional elements such as compact urban layouts, intricately carved facades, and decorative features like zellij and geometric plasterwork offer more than aesthetic value; they embody practical solutions for addressing environmental challenges. Historical practices in spatial organization promoted thermal comfort, social cohesion, and efficient resource use. As Alexander et al. highlight, urban patterns that prioritize human-scale interactions and environmental considerations foster livable communities [1, 18]. Modern adaptations of these principles integrate advanced materials and techniques, enabling scalability and functionality for larger and more complex urban development’s [2, 3].

The reinterpretation of traditional designs in urban renewal projects demonstrates the importance of preserving architectural authenticity while leveraging modern tools for improved efficiency and sustainability. Prefabricated materials, for example, replicate traditional patterns and textures while offering superior energy performance, durability, and ease of installation. As Fathy underscores, the use of local materials and climate-sensitive design ensures that even modern construction can respect the cultural and environmental context [2, 4]. Beckers and Berardi further emphasize how these approaches are being implemented in large-scale developments across Morocco, ensuring that cultural elements like zellij remain integral to contemporary urban identity.

Large-scale developments, particularly in arid climates, benefit from the integration of traditional and modern principles. Urban spaces that incorporate shaded courtyards, green infrastructure, and water-sensitive designs borrow from the ingenuity of historical methods while addressing current environmental concerns. This aligns with the findings of McHarg, who advocated for ecological integration in urban planning to enhance sustainability and livability [5, 3]. Givoni’s work on climate-responsive architecture also highlights how passive cooling techniques derived from traditional methods can mitigate the urban heat island effect in contemporary cities.

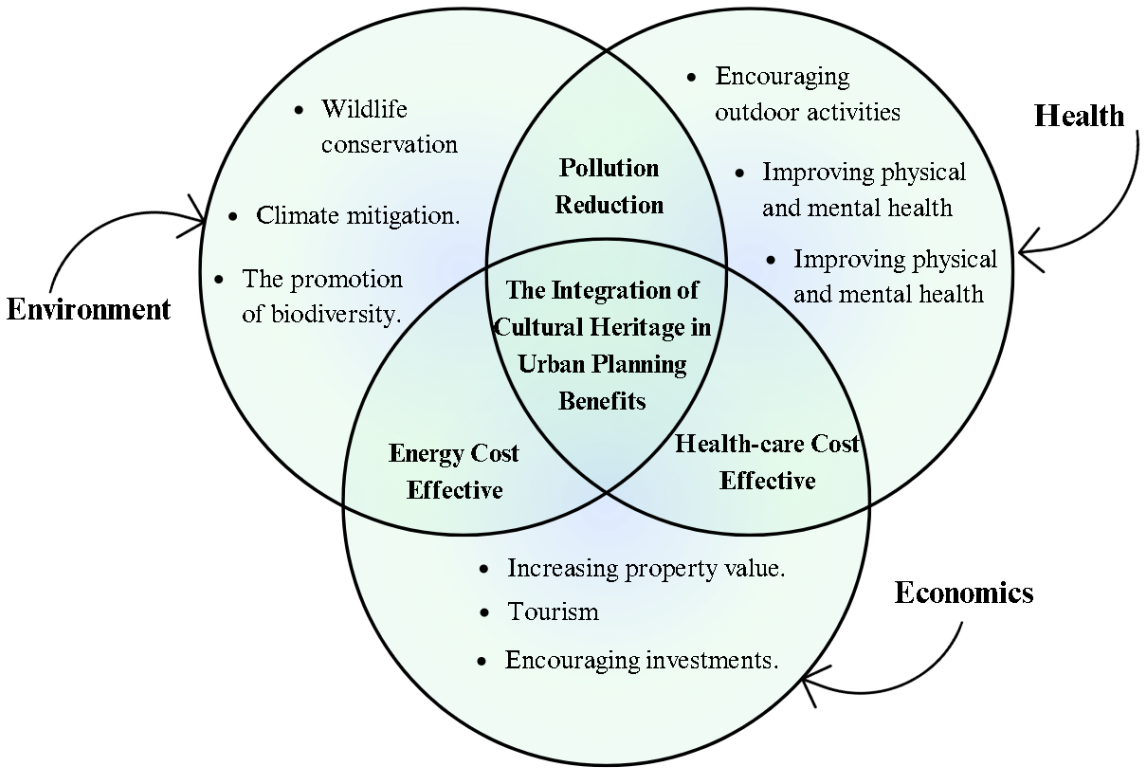

Fig. 2. The preservation of cultural heritage,
and its integration in sustainable urban planning

Moreover, the fusion of historical aesthetics and modern techniques serves as a replicable model for cities worldwide, particularly those in regions facing similar climatic and cultural challenges. Jacobs' perspective on human-scale design resonates with the adaptability of traditional North African layouts in modern contexts, where public spaces are designed to foster community interactions while promoting thermal comfort [6, 19]. These approaches, as illustrated in urban renewal efforts across North Africa, underscore the enduring value of traditional architectural wisdom in shaping future cities [7, 8].

This combination of tradition and innovation offers valuable lessons for urban planners and policymakers. By respecting and revitalizing historical principles, cities can foster a sense of continuity and identity while meeting the demands of modern urbanization. As Steele notes, preserving the essence of cultural heritage while adapting to contemporary needs ensures that urban development remains both sustainable and culturally rich [15, 20]. These strategies highlight the potential for sustainable urban environments that bridge the past and future.

Conclusion. This study underscores the invaluable insights offered by the integration of traditional architectural and planning principles with contemporary

sustainability practices in addressing the challenges of urbanization and climate change in hot climates. By examining the evolution of historical urban landscapes, particularly in the context of North Africa's medinas, this research highlights the enduring relevance of cultural heritage in fostering resilient, energy-efficient, and livable urban environments. The findings reveal how passive cooling strategies, compact layouts, and culturally significant architectural elements can be reinterpreted with modern technologies and materials to align with contemporary demands while preserving authenticity and identity.

The research emphasizes the multidimensional benefits of such adaptations, including environmental sustainability, thermal comfort, social cohesion, and cultural continuity. Furthermore, it presents actionable strategies for urban planners and policymakers to bridge historical wisdom with innovative solutions, offering replicable models for sustainable urban development in similar climatic and cultural contexts worldwide. By honoring the past and embracing innovation, these approaches pave the way for urban futures that are both sustainable and deeply rooted in cultural legacy.

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Анотація

Аль Еччейх Ель Алауї Дуаа, аспірантка кафедри архітектури будівель і споруд Одеської державної академії будівництва та архітектури.

Архітектурно-планувальні адаптації історичних міських ландшафтів: від традиційних медин до стійких вулиць у спекотному кліматі

У цій статті досліджуються архітектурні та планувальні адаптації історичних міських ландшафтів, зосереджуючись на перетворенні традиційних медин у сучасне стійке середовище в умовах спекотного клімату. Міські елементи, такі як компактні планування вулиць, дизайн житла, сади, фонтани, стіни та арки, зазнали значної еволюції, відображаючи баланс між збереженням культурної спадщини та вимогами сучасного міського життя. Це дослідження висвітлює те, як історичні моделі, призначені для пасивного охолодження, соціальної взаємодії та екологічної гармонії, переосмислюються за допомогою сучасних матеріалів, технологій та підходів до планування. Інтегруючи екологічні стратегії, культурну ідентичність та інноваційні методи, ці міські адаптації спрямовані на підвищення функціональності, теплового комфорту та стійкості, одночасно вирішуючи проблеми, пов'язані зі швидкою урбанізацією та зміною клімату.

Тематичні дослідження з Північної Африки, зокрема Марокко, демонструють, як традиційні міські форми адаптуються для включення зеленої інфраструктури, енергоефективних систем та сталого управління водними ресурсами. Візуальні порівняння ілюструють, як архітектурні елементи ручної роботи, складні планування та символічні сади перетворюються на функціональні, але культурно значущі сучасні міські простори. У дослідженні наголошується на багатовимірних перевагах цих перетворень, включаючи зменшення забруднення, енергоефективність, сприяння біорізноманіттю та покращення фізичного та психічного здоров'я. Ці результати підкреслюють критично важливу роль культурної спадщини у досягненні сталості та стійкості міст у спекотному кліматі.

Це дослідження завершується дієвими рекомендаціями для міських планувальників та політиків щодо використання історичних моделей як основи для вирішення проблем сучасної урбанізації. Поєднуючи традиційні знання з інноваційними рішеннями, дослідження сприяє створенню адаптивних, придатних для життя та сталих міст, які вшановують свою культурну спадщину, задовольняючи майбутні потреби.

Ключові слова: архітектурне планування; історичні міські ландшафти; медини; сталі міські вулиці; спекотний клімат; міська адаптація; екологічні стратегії; зелена інфраструктура; пасивне охолодження; міська стійкість; кліматично орієнтований дизайн; тепловий комфорт; міський дизайн.