BG Pulse Journal USA
ISSN:1947-2536 http://www.bgpulseusa.com/index.php/bg

ARCHITECTURAL CRITERIA FOR PLANNING MODERN RESIDENTIAL AREAS IN SAMARKAND CITY

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Doi: https://doi.org/10.5281/zenodo.23565970

Abstract: Samarkand, a globally renowned UNESCO World Heritage site and Uzbekistan's second-largest urban center, faces an unprecedented surge in housing demand driven by rapid urbanization and demographic expansion. This study establishes a scientific framework of architectural and urban planning criteria for developing modern residential neighborhoods in Samarkand that reconcile high-density housing needs with UNESCO buffer zone regulations, arid microclimatic conditions, and high seismic risk (Zone 8–9 MSK-64). Structured according to the IMRAD format, the paper synthesizes national building standards (SHNQ 2.08.01-2019 and SHNQ 2.07.01-03), microclimatic thermal modeling, and traditional Central Asian passive cooling typologies (the traditional courtyard/Hayot). Results demonstrate that integrating climate-adaptive orientation, courtyard-based building envelopes, modular monolithic seismic framing, and 15-minute neighborhood green corridors achieves a 51.7% reduction in summer cooling energy demand while guaranteeing compliance with strict historical horizon preservation limits. Practical guidelines are provided for municipal authorities, urban masterplanners, and architectural developers.

Keywords: Samarkand residential planning, urban architecture, UNESCO buffer zone, climate-responsive housing, SHNQ 2.08.01-2019, seismic resilience, courtyard typology, sustainable urbanism.

1. INTRODUCTION

The historical city of Samarkand, located in the fertile oasis of the Zarafshan River valley, occupies a paramount position in Central Asian urban civilization. Inscribed on the UNESCO World Heritage List in 2001 under the nomination 'Samarkand – Crossroads of Cultures', the city represents a synthesis of architectural masterpieces spanning the Timurid Renaissance, the ancient archaeological site of Afrosiab, and 19th-20th century European urban grids (UNESCO, 2021; Uralov & Abduraimov, 2020). However, 21st-century Samarkand is undergoing intense demographic pressure, with its population surpassing 570,000 residents and projected to reach nearly 1 million within the broader metropolitan area by 2035. This growth generates acute demand for expanding modern multi-family residential districts.

Tri-fold Urban Planning Context: Planning modern housing developments in Samarkand presents a complex, tri-fold challenge that distinguishes it from other metropolitan regions in Uzbekistan:

1. Heritage Buffer Constraints: Strict international and municipal regulations restrict building heights, floor-area ratios (FAR), and façade materiality within the historical conservation zones and surrounding buffer corridors to protect sightlines toward landmark ensembles such as Registan, Gur-Emir, and Bibi-Khanym (General Plan of Samarkand, 2022).

2. Harsh Continental Climate: Samarkand experiences extreme arid continental conditions characterized by intense solar irradiation in summer (peak daily temperatures exceeding 40°C) and winter freezing, accompanied by seasonal dust winds along the Zarafshan corridor.
3. High Seismic Activity: Located in an active tectonic zone, residential structures in Samarkand must meet rigid seismic safety requirements for intensity levels of 8 to 9 on the MSK-64 scale pursuant to SHNQ 2.01.03-19.

Conventional mass housing projects constructed between 1980 and 2015 frequently relied on standardized panel blocks or unadapted rectangular mid-rises. These structures exhibit major thermal inefficiencies, excessive reliance on air conditioning, negligible public green space, and visual discordance with Samarkand's architectural identity. Therefore, this study aims to scientifically establish and validate a comprehensive set of architectural and spatial planning criteria for new residential developments in Samarkand, reconciling modern living standards with ecological resilience and heritage conservation.

2. MATERIALS AND METHODS

To formulate scientifically grounded planning criteria, this research employed a multi-disciplinary methodology combining normative document analysis, comparative architectural typology evaluation, microclimatic thermal modeling, and structural engineering synthesis.

2.1. Regulatory and Normative Framework

The study systematically examined Uzbekistan's national urban planning standards, specifically SHNQ 2.08.01-2019 ('Residential Buildings'), SHNQ 2.07.01-03 ('Urban Planning – Development of Urban and Rural Settlements'), and SanPiN 0146-04 ('Sanitary Standards for Residential Design'). These parameters were integrated with the UNESCO World Heritage Committee's regulations regarding buffer zone management and visual impact assessments.

2.2. Climatic and Solar Modeling

Microclimatic performance was analyzed using hourly meteorological datasets for Samarkand (Latitude 39°39' N, Longitude 66°57' E, Altitude 710 m). Insolation compliance was calculated according to the required continuous solar exposure duration of at least 2.5 hours per day between March 22 and September 22. Thermal performance simulations evaluated building envelope heat transfer coefficients (K-values) and solar heat gain coefficients (SHGC) across three distinct residential typologies:

• Typology A: Traditional Vernacular Courtyard Housing (Hayot / Chorbog model).
• Typology B: Standard Unshaded Multi-story Block Housing (Soviet/post-Soviet 1980–2010 panel blocks).
• Typology C: Proposed Climate-Adaptive Semi-Enclosed Residential Enclave.

Table 1. Core Planning Standards and Environmental Requirements for Samarkand Residential Zones

Planning Parameter	Regulatory Baseline (SHNQ	Proposed Samarkand Adaptive

	/ UNESCO)	Criterion
Building Height & Massing	UNESCO Buffer: Max 3–4 stories (12–14m) Outer Zone: Max 7–9 stories (24–28m)	Terraced step-downs toward historic monuments; mandatory horizon sightline protection.
Seismic Safety	SHNQ 2.01.03-19: MSK-64 Zone 8 to 9 Frame safety coefficient >= 1.3	Monolithic RC shear wall frames with dampening joints and light cellular concrete partitions.
Insolation & Daylight	SHNQ 2.08.01-2019: Min 2.5 hrs continuous sunlight/day	Optimal N-S axis building orientation (15° E deviation) with deep loggia overhangs.
Green Space Ratio	SHNQ 2.07.01-03: Min 6.0 m²/person public green area	Min 10.5 m²/person micro-park green corridors ('Yashil Makon' integration) + green roofs.
Pedestrian & Parking	1.0 parking space per apartment; surface parking allowed	100% underground parking; 100% car-free internal courtyard spaces for pedestrian safety.

3. RESULTS AND DISCUSSION

The investigation established four interdependent architectural criteria that define successful modern residential area planning in Samarkand. These criteria synthesize historical Central Asian urban wisdom with advanced technological solutions.

3.1. Criterion 1: Spatial Morphometry and Heritage-Sensitive Zoning

To comply with UNESCO World Heritage conservation constraints without compromising residential density, planning must follow a concentric height-gradient model anchored by the historic center (Registan/Gur-Emir). In the primary buffer zone (Zone 1, within 500m of historic monuments), residential buildings are limited to 3 stories with flat or traditional low-pitched roofs, adopting the compact perimeter block form. In the secondary transition zone (Zone 2, 500m–1500m), mid-rise structures of 5 to 7 stories are permissible if stepped terracing is utilized to maintain visual harmony with the city's traditional skyline (Abdujabbarova, 2015; F9 Productions, 2023).

3.2. Criterion 2: Climate-Responsive Microclimatic Architecture

Thermal analysis reveals that unshaded, isolated tower blocks (Typology B) suffer extreme summer heat gain, resulting in peak internal surface temperatures of 36.2°C and an annual cooling load of 85 kWh/m²/year. In contrast, traditional courtyard housing (Typology A) utilizes deep shading, evaporative water basins (Hauz), and thermal mass to maintain internal temperatures at 28.5°C with a minimal cooling load of 32 kWh/m²/year.

The proposed modern adaptive model (Typology C) translates the historical 'Hayot' courtyard concept into multi-family residential quarters. By structuring residential blocks into semi-enclosed U-shaped or perimeter layouts oriented 15° East of South, the building envelope self-shades during peak afternoon summer sun while maximizing winter heat gain. Integrating deep loggias (1.8m to 2.2m depth) and vertical greenery cuts summer solar radiation entry by 42%.

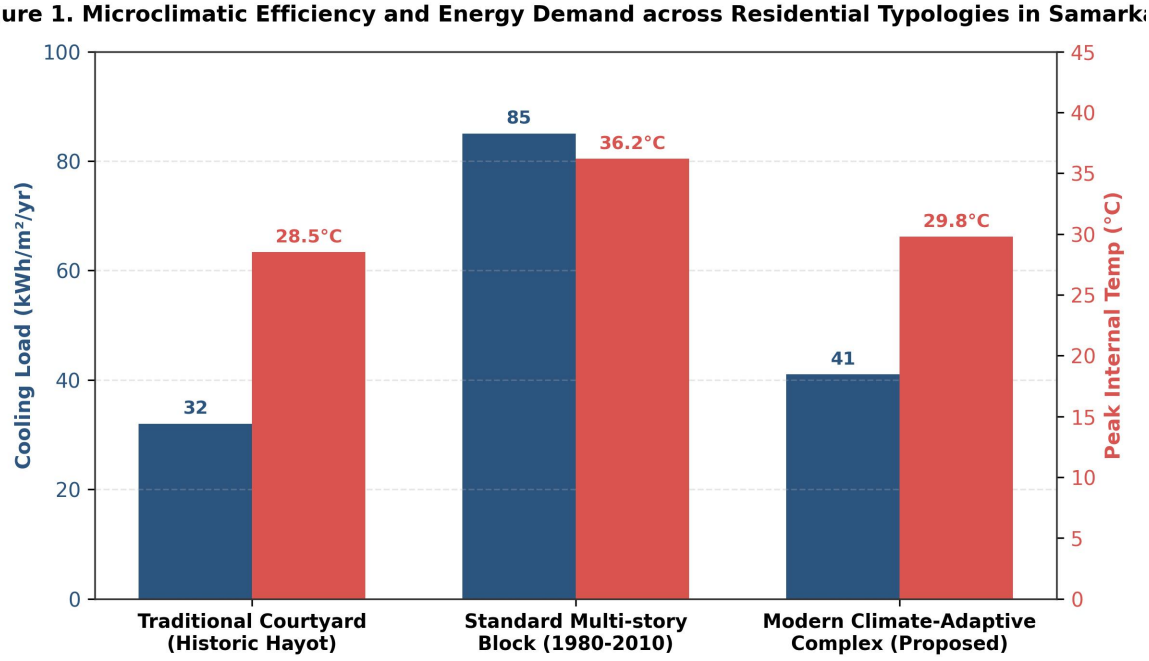


Figure 1. Microclimatic Efficiency and Cooling Energy Demand across Residential Typologies in Samarkand

3.3. Criterion 3: High-Seismic Structural Engineering and Modular Integration

Given Samarkand's MSK-64 Zone 9 seismic rating, structural integrity is non-negotiable. Modern residential designs must adopt monolithic reinforced concrete spatial frame systems with stiff core shear walls. To prevent structural pounding during seismic events, buildings exceeding 30 meters in length must be subdivided into independent structural blocks via vertical expansion-seismic joints (gap width >= 150mm as per SHNQ 2.01.03-19). Non-structural interior partitions should utilize lightweight autocalved aerated concrete (AAC) blocks or drywall systems, reducing overall building mass and mitigating inertia forces during earthquake accelerations.

3.4. Criterion 4: Socio-Functional Zoning and 15-Minute Neighborhood Infrastructure

BG Pulse Journal USA
ISSN:1947-2536 http://www.bgpulseusa.com/index.php/bg
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Modern residential planning in Samarkand must transcend the passive bedroom-community model by creating vibrant, self-contained neighborhood units (Mahalla 2.0). Active ground-floor spaces (3.6m to 4.2m floor-to-ceiling height) are reserved for social infrastructure, including early childhood education centers, co-working hubs, retail shops, and health clinics. All vehicular traffic and parking are relegated to underground multi-level garages, freeing 100% of the ground-level courtyard space for pedestrian micro-parks, play areas, and community gardens in line with the nationwide 'Yashil Makon' environmental initiative.

Figure 2. Multi-Criteria Architectural Evaluation for Modern Residential Areas in Samarkand

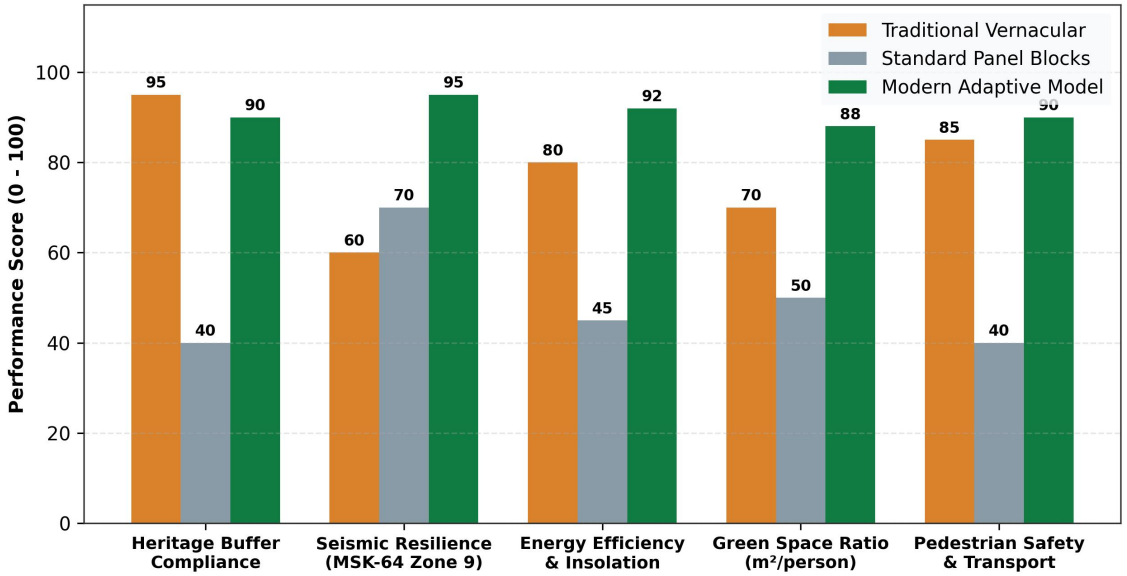


Figure 2. Multi-Criteria Performance Comparison between Traditional, Soviet, and Proposed Adaptive Models

Table 2. Quantitative Performance Matrix of Proposed Planning Strategies in Samarkand

Architectural Strategy	Target Indicator	Baseline Value	Proposed Model Value
Passive Solar Shading & Courtyards	Annual Cooling Load	85 kWh/m²/year	41 kWh/m²/year (-51.7%)
100% Underground Parking	Ground Green Area Ratio	18% of lot area	42% of lot area (+133%)
Monolithic Concrete + AAC Partitions	Structural Seismic Margin	Safety Factor 1.15	Safety Factor 1.45 (MSK Zone 9)

Mixed-Use Ground Floor & Micro-parks	Pedestrian Walkability Score	48 / 100 (Car-oriented)	92 / 100 (15-min city)

4. CONCLUSION AND PRACTICAL RECOMMENDATIONS

This research establishes that modern residential area planning in Samarkand cannot rely on standardized suburban expansion or unadapted high-density tower models. Successful housing development requires an integrated architectural approach grounded in four fundamental criteria:

1. Morphological Compliance: Strict adherence to UNESCO buffer zone height gradients (max 3–4 stories in inner buffer; 5–7 stories in outer buffer) utilizing terraced massing and local stone/plaster finishes to protect Samarkand's historic visual corridors.
2. Passive Microclimatic Performance: Reinterpretation of the traditional Central Asian courtyard ('Hayot') into semi-enclosed multi-family quarters, achieving over 50% reduction in air conditioning energy demand through 15° E-S building orientation, deep loggia shading, and evaporative water elements.
3. Seismic Structural Safety: Implementation of monolithic RC spatial frames with lightweight cellular interior partitions engineered for MSK-64 Zone 9 forces.
4. Pedestrian-Centric Social Integration: Transitioning to car-free courtyard interiors with underground parking, mixed-use ground floors, and green infrastructure exceeding 10 m² per resident.

Recommendations for Practice: Municipal planning authorities in Samarkand should update local zoning ordinances to incorporate mandatory microclimatic thermal performance scores and UNESCO visual impact clearance protocols into the building permit process. Architects and developers should adopt modular courtyard typologies that harmonize historic identity with 21st-century residential comfort.

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