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# AMMAN 2050: PATHWAYS TO SUSTAINABLE URBANIZATION AND CLIMATE ACTION THROUGH SDG 11 AND 13 INTEGRATION

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## ABSTRACT

Cities are growing faster than ever, bringing both opportunities and challenges that affect our economies, societies, and environment. In the Arab world, this swift urban expansion makes problems like water shortages, energy dependence, and climate change even more pressing. Amman, Jordan, is a vivid illustration: it's a city expanding quickly, dealing with limited resources, welcoming many refugees, and facing inequalities across neighborhoods, all while aiming for ambitious sustainability goals. This research looks at how Amman is working toward becoming a more sustainable and climate-friendly city. It focuses on how the goals for sustainable cities (SDG 11) and climate action (SDG 13) come together in Amman's journey. The study uses a mix of data comparison and policy review to see how Amman stacks up against other cities in the region like Dubai, Tunis, and Rabat. The analysis demonstrates significant policy commitments through initiatives like Bus Rapid Transit and increased solar power, as well as tools like the Climate Action Plan and the Green Growth National Action Plan. However, there is room for improvement in recycling, equitable green spaces, and accessible public transportation. In contrast to Dubai's technology and Rabat's excellent public transportation, Amman finds it difficult to translate policy objectives into equitable practice. In conclusion, for Amman to take the lead in adaptable and inclusive urban change in the region, reforms in operations, equitable planning, and the application of a circular economy are essential. This study explores how Amman is navigating the challenges of sustainable urban development and climate resilience by examining the interaction between Sustainable Development Goal 11 (Sustainable Cities and Communities) and Sustainable Development Goal 13 (Climate Action). A qualitative and comparative policy analysis is employed, drawing on official municipal documents, national strategies, and international sustainability frameworks. Amman's urban and climate policies are examined in relation to selected cities in the MENA region, including Dubai, Tunis, and Rabat, to highlight similarities and contextual differences. The analysis shows that Amman has taken meaningful steps toward sustainability, particularly through public transport reforms, renewable energy initiatives, and the development of climate-focused planning instruments. Despite these advances, implementation challenges persist, especially in waste management practices, access to green spaces, and the inclusiveness of public transportation systems. The study finds that while Amman's policy framework aligns well with the objectives of SDG 11 and SDG 13, practical outcomes on the ground remain uneven. Addressing institutional coordination and implementation capacity is critical for achieving more equitable and resilient urban development. The findings offer practical insights for urban planners and policymakers seeking to strengthen sustainable urban governance, enhance climate resilience, and adapt global sustainability goals to local urban contexts within Amman and comparable cities.

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**Keywords:** Amman; Sustainable Cities; Climate Action; Urban Resilience; Circular Economy.

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## 1. INTRODUCTION

One of the most significant spatial and demographic shifts of the twenty-first century is urbanization. According to UN estimates, by 2050, about 68% of people will reside in cities (1). Globally, the rate of urbanization varies; in the Arab world, it is increasing at a rate of 2.4% annually, higher than the average of 1.8% (2). This expansion creates opportunities as well as challenges by altering economies, societies, and landscapes. In addition to generating over 80% of the world's GDP and driving economic growth, modern cities also consume 60% of resources and are responsible for 70% of greenhouse gas emissions (3). In terms of the integrated implementation of SDG 11 (Sustainable Cities and Communities) and SDG 13 (Climate Action), this duality places urban areas as crucial testing grounds for the implementation of the 2030 Agenda for Sustainable Development. The convergence of these objectives represents a crucial synergy in which sustainable urban design serves as the primary mechanism for both climate mitigation and adaptive strategies (4,5).

### 1.1. The Context of the Arab Region

The Arab region is currently facing a complex sustainability crisis, marked by extreme aridity, significant water scarcity, a pervasive reliance on fossil fuels, and heightened susceptibility to temperature increases that surpass the global average (6). Climate projections indicate that the Middle East and North Africa (MENA) region is anticipated to endure some of the most severe repercussions of global warming. This situation has direct implications for urban livability, energy consumption, and the security of water resources. Cities within the Arab world, such as Amman, grapple with these pervasive challenges, which are exacerbated by regional factors, including political instability, substantial refugee influxes, economic fluctuations, and rapid, often unregulated urban expansion (7). Jordan ranks among the nations with the highest per capita refugee ratios globally, with approximately 750,000 registered refugees predominantly residing in urban areas. This demographic reality imposes considerable pressure on housing, infrastructure, and community services (6). Consequently, Amman emerges as a pivotal and intricate case for the examination of the practical application of integrated Sustainable Development Goals (SDG) frameworks in contexts that are constrained by resources and sensitive to geopolitical dynamics.

### 1.2. Amman's Historical Development

Amman's urban progression illustrates a notable

strategic transformation. Historically, the city was characterized by reactive, automobile-dependent expansion following the displacements of 1948 and 1967, which precipitated waves of population influx and the establishment of informal settlements (7). This growth encroached upon agricultural land and natural pathways, culminating in a disjointed urban fabric marked by socio-spatial disparities. The city's reliance on private automobiles has exacerbated challenges related to congestion, air pollution, and inefficient land use (8). Nevertheless, in recent years, Amman has begun to implement forward-thinking planning methodologies. The Amman Climate Action Plan (ACAP, 2024) aspires to achieve net-zero emissions by 2050 (9), while Jordan's Green Growth National Action Plan (GGNAP, 2021–2025) represents a coherent policy shift towards low-carbon, resource-efficient urban development (10). Concurrently, infrastructural initiatives such as the expanding Bus Rapid Transit (BRT) system (11) and national investments have positioned Jordan as a regional frontrunner in solar photovoltaic (PV) integration, comprising approximately 29% of the electricity generation mix (12,13). These initiatives indicate a burgeoning recognition that Amman's sustainability challenges cannot be addressed through isolated interventions but necessitate a holistic transformation.

### 1.3. Theoretical Foundations

This analysis is predicated on three interrelated theoretical frameworks that illuminate Amman's sustainability trajectory and contribute analytical rigor to empirical observations: Urban Political Ecology (UPE), Just Transition Theory, and Critical Smart City Studies. Collectively, these paradigms underscore that sustainability transcends mere technical considerations and is fundamentally rooted in political, social, and institutional processes.

**Urban Political Ecology (UPE).** Urban Political Ecology investigates how socio-environmental transformations arise from the interplay of political and economic power relations. In Amman, patterns of urban sprawl, inequitable distribution of green spaces, and the siting of waste management facilities in proximity to low-income communities exemplify the uneven distribution of environmental benefits and burdens. Contemporary scholarship reveals that Arab cities often perpetuate inequalities through planning decisions that favor affluent areas while marginalizing vulnerable populations (14). Employing UPE facilitates a critical assessment of whether sustainability initiatives—such as the Bus Rapid Transit and solarization projects—are genuinely equitable and inclusive (15).

**Just Transition Theory.** While historically grounded in labor advocacy, has evolved into a comprehensive framework advocating for equitable and inclusive climate action. It functions as a vital analytical framework for ensuring that climate adaptation and mitigation strategies advance social equity and generate quality livelihoods. This theoretical approach offers an essential metric for evaluating climate interventions in Arab cities, specifically by asking whether they reduce or inadvertently intensify existing socio-spatial divides affecting refugees and economically vulnerable residents. Current research insists that effective just transitions are not generic but must be locally grounded, prioritizing both equitable outcomes and inclusive decision-making processes within environmental policy (4,16). For a city like Amman, this framework demands a scrutiny of flagship sustainability projects—from scaling up renewable energy to expanding Bus Rapid Transit (BRT) systems and developing waste-to-energy facilities—to assess if their design explicitly centers the needs of marginalized communities or risks compounding their disadvantage (17).

**Critical Smart City Studies.** Interrogate the dominant narratives of technological urbanism. In contrast to promotional discourses that prioritize innovation, this scholarly lens scrutinizes whether smart city interventions engage with the underlying socio-political drivers of unsustainability or simply digitize entrenched spatial inequities (5,18,19). For Amman, initiatives such as integrating Bus Rapid Transit (BRT) data with public platforms and expanding solar photovoltaic (PV) capacity signify notable technological progress. However, critical analysis posits that without parallel reforms in governance and deliberate social innovation, such technical upgrades risk automating existing inefficiencies and reinforcing, rather than resolving, patterns of exclusion (5,18).

Synthesized, these three theoretical anchors—Urban Political Ecology, Just Transition, and Critical Smart City Studies—establish a foundational premise: sustainability in cities cannot be divorced from the political economies that shape them. This integrated framework yields three core propositions for this investigation:

- Urban Political Ecology posits that environmental conditions are co-produced by power relations and material social processes.
- Just Transition Theory asserts that legitimate climate action must be fundamentally redistributive and inclusive, centering

historically marginalized communities.

- Critical Smart City Studies maintain that technological systems attain transformative potential only when subordinated to robust democratic governance and social agency.

To operationalize this critical stance, the analysis is structured by synthesizing the Sustainable Development Goals (SDGs), urban resilience theory, and governance paradigms. The indicators presented in Table 1 are explicitly mapped to pertinent SDG targets, ensuring the benchmarking exercise contributes to this global framework. Urban resilience theory provides the conceptual lens for interpreting the capacity embodied in the selected domains—renewable energy, public transport, green space, recycling, and air quality—across environmental, social, and institutional dimensions. Concurrently, governance theory clarifies that outcomes in these areas are fundamentally contingent on institutional clarity, cross-sectoral collaboration, and meaningful civic engagement. Finally, the methodology of comparative urbanism frames the cross-city analysis not as a search for a universal ranking, but as a disciplined inquiry into divergent developmental pathways and contextually transferable insights, thereby situating Amman's specific challenges and strategies within a broader regional discourse on urban futures.

#### 1.4. Knowledge Gaps

Despite growing attention to Arab urban sustainability, substantial critical knowledge deficiencies remain. Firstly, comprehensive, indicator-based evaluations benchmarking Amman's integrated progress on SDG 11 and SDG 13 against comparable Arab cities are notably scarce (2). Secondly, existing analyses frequently prioritize technical or policy dimensions, overlooking the fundamental role of socio-cultural factors, community agency, and civic-academic collaborations in shaping urban transitions (20). Thirdly, the practical governance challenges associated with intersectoral integration—moving beyond fragmented projects to achieve systemic transformation—necessitate more profound empirical exploration (21). Addressing these deficiencies is imperative for formulating actionable pathways that harmonize Amman's sustainability aspirations with empirical realities.

#### 1.5. Amman as a Regional Exemplar

Amman's developmental trajectory provides instructive insights for Arab cities confronting

analogous constraints. Dubai epitomizes a high-resource, technology-centric model of urban sustainability with articulated net-zero aspirations; however, its elevated per capita consumption engenders questions regarding replicability (11). Tunis serves as a representative mid-income North African city characterized by a historical urban fabric and disparate governance structures, while Rabat exemplifies integrated planning with robust public transport and alignment with national climate policies (22). A comparative analysis of Amman with these counterparts reveals variations in economic capacity, governance frameworks, and geographic contexts while retaining regional significance. Amman's experience illustrates how middle-income, resource-constrained cities can pursue ambitious sustainability agendas despite geopolitical and economic impediments.

### 1.6. Research Questions

This investigation seeks to address these deficiencies through a comprehensive evaluation of Amman's sustainable urbanization trajectory. We assert that Amman's success is contingent upon the operationalization of the dynamic triad of policy, technology, and society. Our primary research inquiries are:

- How does Amman's performance on essential SDG 11 and SDG 13 indicators compare with those of regional counterparts (Dubai, Tunis, Rabat)?
- What principal synergies and critical trade-offs become evident in practice when integrating climate action (SDG 13) with urban sustainability (SDG 11)?
- What governance and societal innovations can effectively bridge the implementation gap between strategic vision and empirical reality in resource-constrained settings?

### 1.7. Contribution

By placing Amman within the larger framework of Arab urban developments, this research adds value to both theoretical and practical domains. It empirically examines the interconnections of SDG 11–13 within a less explored regional setting, highlights the importance of integrating governance rather than relying solely on technological solutions, and utilizes just transition theory in Arab urban environments, uncovering the conflicts between green growth initiatives and equity objectives. Ultimately, the trajectory of Amman towards 2050 reflects the overarching challenge faced by Arab cities: the need to reconcile swift urban expansion

with limited resources in the context of climate vulnerability. The measure of success will not be confined to the number of megawatts generated or the kilometers of Bus Rapid Transit (BRT) constructed, but rather the city's capacity to cultivate a green, resilient, and equitable urban environment for all its residents.

## 2. METHODOLOGY

This study employs an integrated mixed-methods approach, combining quantitative benchmarking with qualitative policy analysis. Urban sustainability cannot be fully understood through statistics alone, nor through narrative accounts in isolation. By weaving these two forms of evidence together, the research achieves a dual purpose: it situates Amman's performance within a measurable regional context while interrogating the governance structures and social dynamics that shape those outcomes.

### 2.1. The Investigation Unfolds in Three Complementary Phases

**Phase 1: Establishing Context and Theoretical Lens** This foundational phase profiles Amman's unique urban context—its history of expansion, demographic pressures, and policy landscape. The profile is examined through the critical frameworks of Urban Political Ecology, Just Transition Theory, and Critical Smart City Studies, which together focus the inquiry on equity, power, and technological governance.

**Phase 2: Quantitative Benchmarking** The second phase conducts a comparative analysis using five core sustainability indicators: renewable energy share, public transport accessibility, green space per capita, municipal recycling rates, and annual mean air quality (PM<sub>2.5</sub>). These indicators, aligned with SDG 11 (Sustainable Cities) and SDG 13 (Climate Action), are benchmarked across Amman and three regional counterparts—Dubai, Tunis, and Rabat. Data are rigorously sourced from municipal reports, national statistical offices, and verified international databases to ensure validity and comparability.

**Phase 3: Qualitative Policy and Discourse Synthesis** The final phase engages in a deep analysis of the plans and discourses guiding action. Through a systematic review of key policy documents—including the Amman Climate Action Plan and Jordan's Green Growth strategy—and relevant academic literature, this phase identifies prevailing priorities, implementation challenges, and gaps between stated ambitions and on-the-ground realities.

This triangulated methodology ensures findings that are both empirically robust and contextually rich, offering a nuanced portrait of the opportunities and obstacles on Amman's sustainability pathway (4,9,10,23,24).

The focus of this research is the Greater Amman Municipality (GAM), Jordan's national core. As the country's political center, primary economic engine, and cultural hub, Amman is home to more than 4.5 million residents—nearly half of Jordan's population. Decades of rapid, radial urban expansion have transformed agricultural peripheries and natural corridors into built-up areas (24). This growth carries a substantial environmental cost, with annual carbon dioxide emissions estimated at 7.8 million tonnes, largely driven by energy use in buildings and a growing transportation sector (23). This context of demographic pressure and environmental impact frames the urgency for effective sustainability transitions.

To construct a robust analysis, data were gathered from multiple complementary streams, ensuring breadth and cross-verification:

- Policy & Planning Documents: Foundational strategies including the Amman Climate Action Plan (2024) (9), Jordan's Green Growth National Action Plan (2021–2025) (10), and Vision Amman 2050 (25).
- Quantitative Performance Data: Metrics for the five indicators sourced from Jordan's Department of Statistics (24), the International Renewable Energy Agency (IRENA) (12), and World Bank urban sustainability datasets.
- Academic Literature: A systematic review of scholarly work via Scopus and Web of Science, focusing on Arab urbanism, SDG localization, and urban resilience (7,26).
- Regional Benchmarking Data: Equivalent datasets for Dubai, Tunis, and Rabat collected from municipal and national statistical agencies.

The analytical process employed NVivo 14 software to manage and thematically code qualitative data from policies and literature. Quantitative data were assessed using a tailored benchmarking framework developed for this study. In addition, a stakeholder mapping exercise identified the key actors within Amman's sustainability governance network. This mapping, informed by document analysis and contextual knowledge, outlines a diverse ecosystem that includes municipal departments, national ministries,

academic institutions, civil society organizations, and international development partners.

### 3. RESULTS

The comparative assessment of Amman, Dubai, Tunis, and Rabat reveals how sustainability frameworks differ according to institutional capacity, investment priorities, and the degree of governance integration. Amman stands out for its ambitious policy agenda and growing operational maturity, though uneven systemic implementation continues to pose challenges. Within the city, strategic planning has been consolidated into municipal structures that set medium-term priorities for 2022–2026 across transportation, energy, waste management, and data governance. This consolidation signals a clear commitment to align operations with resilience goals and to coordinate responsibilities across departments. It also marks a departure from earlier project-driven approaches, laying the foundation for integrated action even if execution remains inconsistent across sectors (27).

At the national level, sectoral visions reinforce this trajectory. The Ministry of Transport, for example, has emphasized sustainability and adaptability, positioning transportation as a driver of growth and promoting coherence across different modes. Such strategies strengthen metropolitan integration and justify corridor-based planning that links Amman with surrounding urban areas (26).

Table 1 highlights Amman's comparative strengths in renewable energy adoption (~29%), while also drawing attention to persistent weaknesses in recycling (<10%) and public transport usage (~12–14%). Rabat presents a more balanced profile, with higher public transport utilization (~35%) and greater availability of green space (~12–15 m<sup>2</sup> per capita). Dubai demonstrates technological progress but struggles with air quality (~30 µg/m<sup>3</sup> PM<sub>2.5</sub>) and high per capita consumption. Tunis, by contrast, excels in social inclusion but suffers from critically limited green space (~3–5 m<sup>2</sup> per capita). These contrasts underscore Amman's central challenge: translating strong policy frameworks into consistent implementation and ensuring equitable distribution of benefits across neighborhoods(22).

This challenge points to immediate priorities, including the establishment of a Mayor's Office for SDG Integration and the introduction of mandatory SDG impact assessments (19). Both measures are intended to ensure that institutional clarity translates into measurable outcomes.

Weak recycling performance further highlights the need to develop a circular economy industrial

park at Al Ghabawi, converting waste into resource recovery(28–30). Similarly, the low share of public transport use underscores the urgency of completing Phase 2 of the Bus Rapid Transit system and integrating bike lanes to expand multimodal options

(11). Meanwhile, Amman’s relatively high renewable energy penetration (~29%) provides a strong foundation for scaling municipal solar and storage facilities, with the long-term goal of achieving a 50% renewable share in operations by 2050 (16,31).

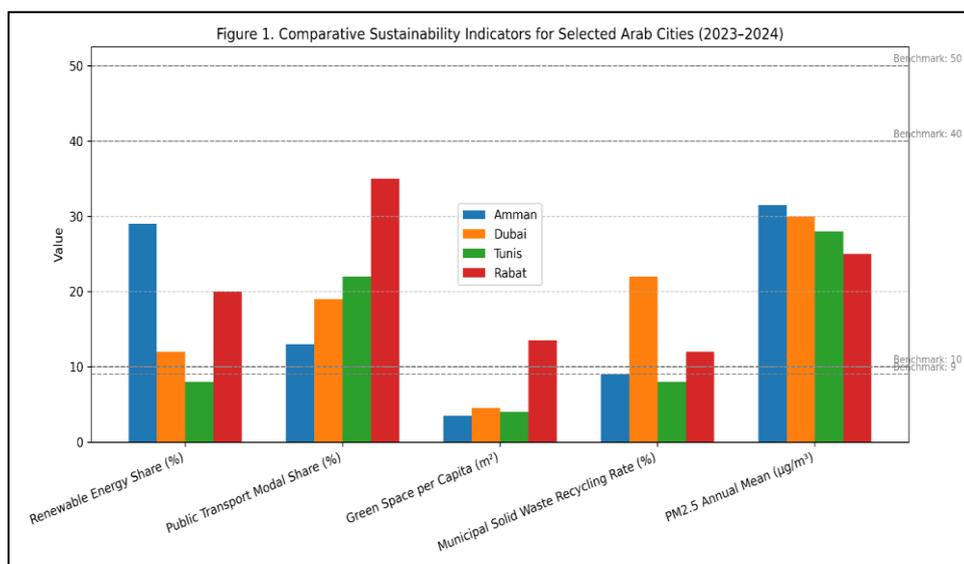
**Table 1: Comparative Sustainability Indicators for Selected Arab Cities (2023–2024).**

Indicator	SDG Alignment	Amman	Dubai	Tunis	Rabat	Benchmark/Target
Renewable Energy Share in Electricity Mix	SDG 7.2, 13.2	~29%	~12%	~8%	~20%	40% (Arab region aspirational)
Public Transport Modal Share	SDG 11.2	~12–14%	~18–20%	~22%	~35%	40% (UITP standard)
Green Space per Capita (m <sup>2</sup> )	SDG 11.7	3–4	4–5	3–5	12–15	9 (WHO minimum)
Municipal Solid Waste Recycling Rate	SDG 11.6, 12.5		~22%	~8%	~12%	50% (EU 2030 target)
PM2.5 Annual Mean (µg/m <sup>3</sup> )	SDG 11.6	~31–32	~30	~28	~25	10 (WHO guideline)

- EcoMENA. Progress of solar PV sector in Jordan. 2024. Available from: <https://www.ecomena.org>
- International Renewable Energy Agency (IRENA). United Arab Emirates energy profile. Abu Dhabi: IRENA; 2023.
- Morocco World News. Morocco produces 42.38 TWh of electricity in 2023, renewable energy up 22.7%. 2023 Dec. Available from: <https://www.moroccoworldnews.com>
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As depicted in Figure 1, the comparative visualization improves Table 1 by highlighting Amman's strengths in renewable energy while also pointing out its weaknesses in recycling and public transportation. Consequently, this reinforces the theoretical framework that links sustainability indicators to governance and resilience theory.



In the realm of public transportation, Amman’s Bus Rapid Transit (BRT) has moved beyond its initial operational phase and is now part of a broader integration effort that emphasizes both efficiency and accessibility. Recent improvements in digital services and operational frameworks—such as embedding

transit information into widely used platforms and harmonizing service plans—are designed to strengthen connections between trunk routes and feeder services. These steps have undeniably improved user experience and transparency, aligning with the ambitions of smart city initiatives.

Yet, the transformative potential envisioned by transit-oriented development remains contingent on closer coordination with land-use policies, the provision of affordable housing near stations, and a multimodal design that genuinely incorporates walking and cycling. Such elements are still unevenly applied across corridors (11).

This situation reflects a wider reality: Amman's progress in smart city rankings (32), and the critiques of similar trajectories across the Arab region (33), highlight advances in data integration, service digitization, and performance monitoring. However, these gains alone cannot deliver structural change unless reinforced by urban design, regulatory reform, and financing mechanisms that embed innovation into everyday urban practice. In this regard, governance tools such as land value capture become essential to fund transit expansion and guarantee equitable access (8,34).

Turning to energy, Jordan's national development path demonstrates a sharp rise in renewable capacity, with official projections exceeding 2,840 MW by 2024 (31). Regional interconnection projects with neighboring countries are expected to enhance grid flexibility and resilience (18). These achievements create fertile ground for municipal transformations in Amman, including the spread of distributed solar installations across public facilities and the exploration of storage technologies to stabilize local systems and curb peak-time emissions. Still, the structure of tariffs and the grid framework remain decisive in enabling adoption by households and private firms. The momentum also underscores the importance of smart water metering and tariff reform to promote conservation and efficiency (12,13,25). Equally critical is the water-energy nexus: sustainable energy transitions must be accompanied by stronger water infrastructure management to guard against scarcity and ensure fair access in urban settings.

Waste management has likewise advanced beyond incremental steps. The Greater Amman Municipality has introduced engagement frameworks for solid waste governance, particularly at the Al Ghabawi site, clarifying stakeholder roles, regulatory responsibilities, and institutional duties. These measures are vital for complex projects such as landfill gas capture and energy recovery (35). Embedding equity requires participatory neighborhood resilience planning (36) and reimagining schools as sustainability hubs that combine education, energy efficiency, and community involvement (37,38).

Regional comparisons sharpen Amman's profile:

Rabat's integration of transport and urban design consistently delivers operational benefits; Dubai's technological drive reveals the trade-offs between capacity and consumption; Tunis's emphasis on social inclusion contrasts with slower technological uptake. Together, these cases highlight Amman's central challenge—translating strong planning and policy frameworks into cohesive, equitable implementation across diverse sectors and neighborhoods (22). Meeting this challenge is fundamental to the city's sustainability transition.

Finally, institutional fragmentation points to the need for a Mayor's Office for SDG Integration, a body that could unify initiatives and strengthen systemic coherence (39).

#### 4. DISCUSSION

Amman's journey toward sustainability illustrates how institutional collaboration, alignment with national policy, and the careful adoption of technology can generate meaningful progress. At the same time, it highlights the structural conditions required to achieve equity, respond to climate impacts, and advance systemic integration.

From a governance perspective, the municipality's strategic plan provides a strong framework for sector-specific initiatives. It signals a shift away from fragmented projects toward a more comprehensive vision of sustainability, where transport, energy, waste, and data are treated as interconnected levers (40). National transport policy reinforces this orientation by positioning sustainability as a central mission, stressing adaptability and readiness for future development. In practice, this strengthens the case for coordinated action across jurisdictions and more deliberate corridor planning (41).

Transportation offers a vivid example of both promise and constraint. The evolution of the Bus Rapid Transit (BRT) system demonstrates how digital integration—such as embedding service information into widely used platforms—can improve transparency, reduce barriers for passengers, and potentially boost demand. Yet, transit systems only become transformative when their physical, regulatory, and financial environments are reshaped to support them. This means rezoning to allow mixed-use density near stations, adopting inclusionary housing policies to prevent displacement, and redesigning streets to favor walking and cycling. Together, these measures expand catchment areas and reduce reliance on automobiles (11). Amman's digital and operational advances are commendable and reflected in its smart

city ranking, but deeper change will depend on merging urban design with land use and deploying strategies such as land value capture, parking reforms, and performance-based budgeting that prioritize emissions reduction and accessibility over throughput (41). Medium-term measures—like congestion pricing in the city center (42,43) and the rollout of smart water metering with tariff reform (25) - show how governance tools can simultaneously deliver equity and efficiency.

Energy and circularity add another dimension. Jordan's growing renewable capacity and regional interconnections create opportunities for Amman to decarbonize municipal assets and services. They also open the door to hybrid solutions that combine distributed generation with storage, demand management, and smart metering (44). Waste management at Al Ghabawi illustrates the governance foundations needed to scale complex interventions: stakeholder engagement, regulatory clarity, and clear institutional responsibilities. These are essential for moving from pilot projects to widespread energy recovery and grid integration. As such frameworks mature, landfill gas initiatives can evolve from compliance exercises into value-creating components of a circular economy, turning waste into energy and enabling industrial symbiosis when located near recovery and processing facilities (45).

Long-term strategies - such as achieving 50% renewable penetration in municipal operations (16,31) and establishing a circular economy industrial park at Al Ghabawi (28-30) - demonstrate how resilience can be embedded at the metropolitan scale.

Equity remains a defining measure of Amman's progress. Smart city rankings and capacity gains provide partial insight, but sustainability cannot be reduced to digitization or megawatts alone. Fair outcomes in access, exposure, and opportunity are the true benchmarks. Advancing justice requires moving from consultation to co-design with communities, channeling funds into pro-poor investments near transit and green infrastructure, and instituting safeguards that ensure vulnerable groups—including refugees and low-income families—share equitably in climate and urban benefits (46).

In practice, this involves formalizing participation throughout project lifecycles, restoring green spaces in neglected neighborhoods, and evaluating initiatives against equity metrics aligned with the Sustainable Development Goals (SDGs). These metrics track who benefits, who bears costs, and who risks displacement (47). Deepening this commitment calls for participatory neighborhood resilience strategies (36)

and transforming schools into sustainability hubs (37,38), ensuring that social innovation complements technical and governance reforms.

## 5. CONCLUSION

The comparative evaluation of Amman against Dubai, Tunis, and Rabat reveals a city marked by ambitious policy goals and growing institutional progress, though it faces challenges due to inconsistent implementation in sectors such as recycling, public transport, and equitable access to green spaces. These insights confirm that sustainability in Amman goes beyond simple technical challenges, embodying a socio-political initiative that requires governance reform and fair resource allocation.

Grounded in Urban Political Ecology, Just Transition Theory, and critiques of Smart Cities, this analysis highlights the importance of institutional clarity being paired with equity-centered execution. Key strategies include establishing a Mayor's Office focused on SDG Integration (19,39), improving renewable energy and storage capabilities (16,31), and fostering circular economy infrastructure at Al Ghabawi (28-30).

In summary, the future direction of Amman will depend on the successful implementation of the dynamic interaction among policy, technology, and social agency. By strengthening governance reforms, promoting social innovation, and expanding technical solutions, Amman has the potential to position itself as a resilient Arab metropolis and a regional exemplar for the integration of Sustainable Development Goals 11 to 13.

### 5.1. Recommendations

The Greater Amman Municipality presently hosts specialized units such as the Sustainability and Resilience Unit, the Projects Sustainability Department, the Green City Action Plan (GCAP), and the Smart City Program. However, these initiatives often operate in isolation, which limits systemic integration. To address this issue, it is recommended to create a Mayor's Office for SDG Integration, which would act as a coordinating body to unify initiatives, enhance transparency, and promote community engagement. This office would accelerate the Climate Action Plan and ensure coherence across sectoral policies, making certain that all major projects are in alignment with the Sustainable Development Goals and the tenets of climate justice (19).

To actualize these recommendations, priority actions that encompass short, medium, and long-term perspectives are detailed in Table 2, which

combines governance reforms, technical interventions, and social innovations into a unified strategy for promoting the integration of SDG 11–13 in Amman.

**Table 2: Priority Actions for Accelerating SDG 11 13 Integration in Amman.**

Timeframe	Governance Actions	Technical Interventions	Social Innovations
Short-term (1-3 years)	Establish Mayor's Office for SDG Integration; Implement mandatory SDG impact assessments	Launch city-wide building retrofit program; Complete BRT Phase 2 with integrated bike lanes	Institutionalize community climate budgets in 3 pilot districts; Launch "Green Amman" citizen science program
Medium-term (3-7 years)	Formally link municipal planning with water/energy ministries; Implement congestion charging in city center	Develop 50 MW municipal solar + storage facility; Implement smart water metering with tariff reform	Scale urban agriculture to cover 5% of food needs; Establish SDG innovation fund for youth-led startups
Long-term (7-15 years)	Establish metropolitan governance for Amman-Zarqa corridor; Implement land value capture for transit financing	Achieve 50% renewable energy in municipal operations; Develop circular economy industrial park at Al Ghabawi	Achieve 100% of schools as sustainability hubs; Develop community-led resilience plans for all neighborhoods

## 5.2. Limitations and Future Directions

This study acknowledges several limitations. The temporal scope (2020–2024) provides only a brief overview, whereas longitudinal research extending over a decade would yield deeper insights into implementation trajectories.

Data availability remains limited, particularly at the neighborhood level in Amman and its comparative cities. The methodological rigor is constrained due to reliance on document analysis and expert consultations rather than comprehensive stakeholder interviews, which could enhance grassroots perspectives. While the SDG framework offers a comprehensive viewpoint, it may not fully capture the informal urbanisms and daily sustainability practices that characterize Amman's urban experience. Institutional and political factors, including shifts in municipal priorities and financial constraints, may also affect the applicability of the recommendations. Ultimately, the findings are context-specific, shaped by Jordan's influx of

refugees and water scarcity, which may limit direct applicability to other Arab cities facing unique challenges.

As a result, future research should focus on longitudinal studies spanning 5–10 years to track sustainability trajectories. Ethnographic investigations into how municipal departments interpret and implement policies in daily practice would provide valuable insights, while exploring household and business adoption of sustainable practices (such as water conservation, waste segregation, and public transport usage) would address the behavioral dimension. Analyzing financing mechanisms in middle-income Arab cities, including the effects of international climate finance, would enhance the economic perspective. Greater emphasis should also be placed on digital governance and participatory data platforms. Finally, comparative studies of cities like Cairo, Beirut, and Muscat could aid in developing typologies of Arab urban sustainability pathways, while new metrics for climate justice and regional collaboration would enrich the theoretical framework.

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