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Urban Mobility and Sustainable Transportation in the MENA Region: Trends and Perspectives

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Abstract

Due to the rapid urbanization, economic growth, and the related environmental and other externalities, pivotal challenges can be detected related to sustainable transport systems within the Middle East and North Africa (MENA) territory. The main aim of the study is to identify and present the characteristics of the current sustainable transport environment in the MENA region. Based on the available relevant information in the selected cities of the MENA countries, it analyzes the main trends, the key challenges and also the related opportunities considering sustainable mobility. The sustainable mobility landscape covers, among other themes, sustainable transport, including urban mobility, public transport developments also considering the integration of new technologies. The study highlights the MENA region's commitment to the transition towards a sustainable transport sector, supported by strategic plans and policy reforms, while also addressing the main obstacles to responding to the challenges in the region. Finally, it focuses on policy recommendations to be able to foster the practical implementation of a more resilient and greener transport sector in the examined region.

Keywords

sustainable transport, MENA region, urban mobility, indicator-based assessment, policy framework

1 Introduction

The global urban and rural populations reached equal levels for the first time in human history in 2007 (Kundu and Pandey, 2020). Since then, urbanization has accelerated, transforming economies, societies, and mobility patterns across the world. According to United Nations projections, by 2030, 60% of the global population will reside in urban areas. However, this growth is uneven. (United Nations Population Fund, 2023) While high-income countries are urbanizing at a slower pace, low- and middle-income nations are experiencing rapid urban expansion, significantly reshaping the global urban landscape.

Urbanization trends also reveal marked regional disparities. In 1950, Europe and Northern America accounted for a combined 54% of the world's urban population, 38% and 20%, respectively. By 2050, these shares are projected to drop to just 10% and 8%. In contrast, 85% of the global urban population will be concentrated in Asia, Sub Saharan Africa, and the Middle East and North Africa (MENA) (United Nations, 2018). These regions are undergoing significant population growth, increasing urban density, and a surge in demand for mobility solutions capable of supporting rapidly expanding cities.

The MENA region is undergoing unprecedented demographic and economic transformations, driving a surge in transport demand. Rapid urbanization, increasing car ownership, and the expansion of e-commerce are placing immense pressure on existing transport infrastructure, exacerbating traffic congestion, air pollution, and greenhouse gas emissions. These trends raise an important question: Can a transport system be sustainable if the city itself is not? Or conversely, can a city develop sustainably while its transport system remains unsustainable? (Tóth-Szabó and Várhelyi, 2012).

Historically, MENA cities have followed a car-centric mobility model, where private cars dominate urban streets, supported by government policies that favor vehicle ownership. This preference for individualized travel has led to high motorization rates, extensive urban sprawl, and a declining modal share of public transport. The resulting traffic congestion and pollution

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levels are unsustainable and require urgent intervention (UITP, 2021).

Within the region, the Gulf Cooperation Council (GCC) states, UAE, Saudi Arabia, Kuwait, Oman, Bahrain, and Qatar differ significantly in their urban mobility infrastructure (HSBC, 2023). These high-income countries boast modern transport networks, yet car ownership remains deeply ingrained in social norms. However, since 2009, when Dubai launched the region's first metro system, other cities such as Doha and Riyadh have followed suit. This trend is expected to continue, especially with ambitious giga-projects such as NEOM in Saudi Arabia, which aims to implement a zero-carbon mobility system (UITP, 2025). By contrast, North African and Levant cities face persistent challenges due to aging infrastructure, limited transport investment, and a high dependence on informal transport modes. In cities like Tehran, Cairo, and Istanbul, informal transport plays a major role, operating alongside but not fully integrated with formal public transport services. This raises concerns regarding safety, efficiency, and sustainability (Mostofi et al., 2020). The region's fragmented transport governance and insufficient investment in public transport have made sustainable mobility difficult to achieve (UITP, 2025).

However, technological advancements and policy reforms offer opportunities for transformation. Many MENA cities are investing in metro systems, electric mobility, and digital transport solutions to enhance efficiency and sustainability considering urban mobility. For example, the rise of Mobility as a Service (MaaS) platforms and AI-driven traffic management is reshaping urban mobility in cities like Dubai and Riyadh (Sulaiman, 2025). At the same time, there is an increasing need for behavioral changes among both individual commuters and policymakers to ensure a shift towards sustainable urban mobility solutions (Knoflacher, 2007).

Given these dynamics, it is essential to rethink urban mobility strategies to support the sustainable growth of MENA cities. The following sections will explore different interpretations of sustainable transport, assess the current state of MENA's transport sector, and identify opportunities and policy recommendations to enhance sustainability, efficiency, and resilience in the examined region's transport systems.

2 Definition of sustainable transportation

Understanding sustainable transportation is the foundation for identifying key challenges, barriers, and intervention points in urban mobility systems (Łuczyszyn, 2024). However, as Zegras (2006) emphasized, the concept is multidimensional and interdependent with urban development, sustainability, and transport. The scope of sustainable transport varies depending on whether the focus is on transportation systems in general or their urban-specific impacts. This variation has led to the absence of a universally accepted definition, with studies emphasizing different aspects, including environmental, economic, and social dimensions (Buzási and Csete, 2015).

A widely recognized definition was provided by the European Council of Ministers of Transport, as cited by Shiau and Liu (2013), which defines sustainable transport based on three dimensions, social (ensures basic accessibility for individuals and businesses, connecting present and future generations), economic (enhances regional development through affordable and efficient transport systems) and environmental (promotes renewable resources while limiting emissions and waste within the Earth's absorption capacity to mitigate future negative impacts).

However, Zegras (2006) argues that accessibility should be the primary characteristic of sustainable transport, rather than merely focusing on environmental or economic aspects. Despite this, many studies continue to emphasize environmental impacts, often neglecting economic and social sustainability (Török, 2014). Tóth-Szabó and Várhelyi also found that sustainable transport studies are often biased toward environmental concerns, leading to policies that may be ecologically beneficial but economically inefficient (Tóth-Szabó and Várhelyi, 2012).

Litman (2010) warns that a one-dimensional focus on sustainability indicators can result in trade-offs, where environmental gains come at the cost of economic inefficiencies, or vice versa.

This ongoing debate demonstrates that sustainable transport is a dynamic concept. Some scholars, such as Zito and Salvo (2011), argue that true sustainability in mobility can only be achieved by:

- Reducing the demand for transport services;
- Encouraging modal shifts toward low-carbon and shared mobility;
- Decreasing trip lengths through better urban planning;
- Enhancing transport efficiency through technological innovations and infrastructure investments.

From a broader perspective, sustainable transport can be defined as "satisfying current transportation and mobility needs without compromising the ability of future generations to meet their own needs" (Zito and Salvo, 2011). This definition is derived from the Brundtland Commission's

(World Commission on Environment and Development, 1987) general sustainability principle and incorporates economic, environmental, social, and institutional dimensions.

Not to forget that the traditional three-pillar model (economic, environmental, and social sustainability) has been widely accepted, but recent studies suggest that an institutional dimension should be integrated. Buzási and Csete (2015) highlight that the effectiveness of sustainable transport depends not only on technological solutions but also on governance, policy coordination, and data transparency. This aligns with Sulaiman (2025), who found that in the MENA region, lack of climate governance and transparency hinders sustainable transport planning.

In addition, the 7th Edition of the MENA Transport Report (UITP, 2025) emphasizes that policy fragmentation, lack of inter-agency coordination, and outdated environmental laws create barriers to implementing sustainable transport solutions (UITP, 2025). Without strong governance frameworks, even well-designed sustainability policies may fail in execution resulting in less effective sustainable transport planning initiatives.

A crucial, yet often overlooked, aspect of sustainable mobility is data availability and transparency. Sulaiman (2025) argues that many MENA countries lack reliable transport data, making sustainability assessments difficult. World Economic Forum (2015) further highlights that insufficient climate reporting and fragmented information ecosystems prevent effective decision-making.

The inversion of the transport pyramid, as discussed in Sustainable Mobility (Bejjani et al., 2021), suggests that a true transition toward sustainable mobility requires reducing private car dependency, prioritizing public and active transport, and leveraging real-time data for adaptive policy making.

Given the complexity of defining sustainable transport, an enhanced definition should integrate accessibility, economic efficiency, environmental impact, governance, and data transparency. Building upon previous definitions, we propose the following expanded concept: sustainable transport refers to a mobility system that ensures equitable accessibility, economic efficiency, and environmental responsibility, while integrating institutional frameworks, management aspects and data transparency to support long-term adaptation to urban and regional challenges.

This definition emphasizes the multi-dimensionality of sustainable transport, ensuring that policies and planning strategies address not only environmental concerns but also governance, equity, and long-term resilience.

3 Literature review

The assessment of sustainable transport systems requires structured frameworks using key indicators that evaluate environmental, economic, and social dimensions (Buzási and Csete, 2015). Transport sustainability assessment is particularly challenging in MENA due to high car dependency, rapid urbanization, and limited data availability (Chaudhry et al., 2023). Given these challenges, a multi-indicator approach is necessary to support policy decisions and urban planning strategies (Litman, 2010).

The selection of relevant transport indicators is fundamental for evaluating sustainability progress (Buzási and Csete, 2015). Zito and Salvo (2011) emphasized the lack of a standardized framework for evaluating transport sustainability globally, making it difficult to compare cities across different regions. Mostofi et al. (2020) highlighted that this lack of standardization particularly affects cities in emerging economies, where urbanization rates outpace transport infrastructure development.

The MENA region, however, faces additional challenges, particularly in data transparency and institutional barriers (Sulaiman, 2025). Unlike European cities, where comprehensive transport databases exist, MENA's transport statistics are fragmented, outdated, or unavailable, making sustainability assessments difficult and inconsistent (World Economic Forum, 2015). Haghshenas and Vaziri (2012) identified that the lack of reliable transport databases is a significant barrier to effective decision-making in urban mobility planning. Similarly, Saber et al. (2024) found that in Egypt and Lebanon, inconsistent transport data hinders the ability to implement data-driven policy reforms.

Several studies have identified key indicators that are critical for transport sustainability assessments. These include:

- Environmental indicators: CO_2 emissions, air pollution levels, and energy consumption from transport (Joumard et al., 2011). Mostofi et al. (2020) further explored the role of alternative fuels in reducing urban transport emissions, particularly in cities like Tehran and Cairo.
- Economic indicators: Transport affordability, logistics efficiency, and infrastructure investment (Gudmundsson, 2003). Recent findings by Saber et al. (2024) emphasize that ride-hailing services have reshaped urban transport economics in MENA, creating affordability concerns for lower-income commuters.
- Social indicators: Accessibility, safety, public transport coverage, and digital integration of transport services

(Mostofi et al., 2020). Saber et al. (2024) examined the increasing reliance on smartphone-based mobility services in MENA and their impact on accessibility.

According to Buzási and Csete (2015), indicators should be:

- Easily measurable and quantifiable;
- Reflect various dimensions of transport sustainability;
- Sensitive to changes over time;
- Comparable across cities and countries.

Incorporating these criteria-based indicators in MENA's transport sector remains challenging due to limited inter-agency cooperation, bureaucratic hurdles, and outdated policies (Sulaiman, 2025). Mostofi et al. (2020) argue that governance fragmentation across municipal and national levels further complicates sustainable transport planning.

Another important aspect to notice is that transport systems in MENA cities are overwhelmingly car-centric, with low public transit ridership compared to global standards (Chaudhry et al., 2023). Mostofi et al. (2020) found that in Tehran and Cairo, the expansion of ride-hailing services (e.g., Uber, Careem) has influenced public transport usage, since in Cairo, ride hailing complements public transit, improving last-mile connectivity, and in Tehran, ride-hailing reduces transit ridership, leading to increased car dependency. This aligns with findings from Saber et al. (2024), who identified gender disparities in mobility choices, with women in MENA cities preferring ride-hailing services over traditional public transport due to safety concerns.

Similar trends exist in GCC states (e.g., UAE, Saudi Arabia), where car ownership remains a cultural status symbol (Saber et al., 2024). However, metro investments in Dubai, Riyadh, and Doha suggest a potential shift toward transit-oriented mobility. Alotaibi and Potoglou (2017) studied the effect of metro expansion in Dubai, indicating that while car ownership remains prevalent, metro usage is rising among daily commuters.

Another important aspect to highlight is the investments in metro systems, public transport integration remains weak across most MENA cities (UITP, 2025). Saber et al. (2024) examined ride-hailing trends in Egypt and Lebanon, finding that younger demographics prefer app-based mobility due to convenience and safety concerns, and women in MENA cities are more likely to use ride-hailing than public transit due to safety risks. Adding that regulatory challenges hinder the integration of shared mobility services into formal transport networks. Mostofi et al. (2020) further emphasized that without regulatory oversight, ride-hailing may lead to increased congestion rather than a reduction in private car dependency.

These findings align with Gudmundsson (2003), who identified social barriers and institutional fragmentation as key obstacles in achieving sustainable urban mobility.

On the scale of data, we should highlight that there are limitations in MENA Transport Research, hence, transport planning in MENA is severely constrained by data availability issues (Sulaiman, 2025). Key challenges include:

- Limited access to government transport data;
- Lack of transparency in sustainability reports;
- Inconsistent CO_2 emissions tracking;
- Informal transport services (e.g., minibuses, shared taxis) lacking official documentation.

The World Economic Forum (2015) noted that MENA's data transparency levels are among the lowest globally, affecting urban sustainability research. According to Sulaiman (2025), poor data governance and political instability further hinder access to reliable transport data. Mostofi et al. (2020) suggest that leveraging mobile data analytics could offer alternative methods for assessing transport flows in data-scarce environments.

Mentioning all of the above, it is vital to highlight that Climate governance in MENA transport policies remains weak, with limited inter-agency coordination (Sulaiman, 2025). Key findings indicate that climate policies in MENA cities are outdated and poorly enforced, besides the lack of coordination between urban planners and environmental agencies, and last but not least, investment in data collection and transparency remains insufficient. Saber et al. (2024) suggest that enhancing climate resilience in transport policies requires stronger integration of renewable energy sources into public transport systems.

To overcome these challenges, Sulaiman (2025) suggests adopting international climate data transparency standards and strengthening public-private partnerships for sustainable mobility planning.

Despite extensive research on sustainable mobility, a critical gap remains in understanding its implementation in the cities of the MENA. Existing studies tend to focus on European and North American models, often overlooking MENA's unique socio-economic and institutional challenges. For instance, studies such as Iannacci et al. (2025) investigate the complex interdependencies between infrastructure, governance, and behavior in achieving sustainable urban mobility, yet their insights are largely drawn

from Western contexts, limiting their applicability to MENA cities. This study bridges these gaps by providing an indicator-based assessment, addressing governance constraints, improving data transparency, promoting modal shifts to public transport, and exploring the role of emerging mobility technologies in enhancing sustainability.

4 Current state of transport in the MENA region

The 7th MENA Transport Report highlights that rapid urban expansion, particularly in cities like Cairo (22.6 million), Riyadh (8.6 million), and Dubai (3.6 million), has placed immense pressure on transportation networks (UITP, 2025).

One of the most pressing challenges in achieving sustainable urban mobility is the high level of car dependency, which is reflected in the elevated vehicle ownership rates across major cities in the MENA region. For instance, Dubai records a car ownership rate of 622 passenger cars per 1,000 population, followed by Abu Dhabi with 519, Amman with 393, and Riyadh with 156. This dependence on private cars contributes to chronic congestion, leading to significant economic losses and environmental degradation (Chaudhry et al., 2023). For example, Cairo loses over $8 billion annually due to traffic congestion, which accounts for 4% of its GDP (UITP, 2025). Riyadh's congestion index has risen by 35% over the past decade, increasing fuel consumption and emissions (Bejjani et al., 2021).

In addition to congestion, transport inclusivity remains a major issue. Women, youth, and lower-income groups often struggle with access to safe, affordable, and reliable mobility options (Sulaiman, 2025). Informal transport systems, such as shared taxis and minibuses, are widely used but lack proper regulation and safety standards. Despite these challenges, public transport fares vary significantly across the region:

- Dubai: $53.85/month (PPP-adjusted fares);
- Cairo: $55.56/month (PPP-adjusted fares);
- Riyadh: $73.68/month (PPP-adjusted fares).

Without a modal shift towards public transport, congestion, air pollution, and urban transport inefficiencies will continue to worsen, affecting economic productivity and urban livability (Buzási and Csete, 2015).

4.1 Public transport development

4.1.1 Metro and rail investments

MENA cities have invested heavily in metro, tram, and LRT networks, yet low ridership and financial sustainability remain challenges (UITP, 2025).

- Dubai: 89.6 km (645 vehicles) one of the most advanced metro networks in the region, yet public transport modal share is below 20% (UITP, 2025).
- Cairo: 10 km (831 vehicles) the region's oldest metro system, suffering from severe overcrowding and maintenance backlogs (Mostofi et al., 2020).
- Riyadh: 176 km (448 vehicles) a major expansion project, yet ridership remains below projections (Saber et al., 2024).

4.1.2 Light rail & tramway development

- Dubai LRT: 10.6 km well-integrated with the metro system.
- Algiers LRT: 23.2 km relatively small but an important alternative to road congestion.

4.1.3 Bus & BRT networks

- Bus networks remain unreliable due to low service frequency, lack of integration, and aging fleets (Sulaiman, 2025).
- BRT expansion remains limited, except for pilot projects in Amman and Casablanca (Bejjani et al., 2021).
- Public Transport Investment (Million $): Data gaps persist, reflecting a transparency issue in transport financing (Sulaiman, 2025).

As a summary, metro expansion has not yet significantly reduced congestion, and bus/BRT infrastructure remains underdeveloped. Integrated multimodal transport strategies are urgently needed (UITP, 2025).

4.1.4 Freight logistics and trade barriers

The rise of e-commerce and regional trade has significantly increased freight transport demand, exacerbating urban congestion and environmental impact (Bejjani et al., 2021; David, 2024).

- Key Freight Hubs:
  - Dubai, Jeddah, and Casablanca are emerging as regional logistics centers, but cross-border inefficiencies persist (World Economic Forum, 2015).
- Last-Mile Delivery Challenges:
  - Urban freight congestion due to poor planning and lack of dedicated corridors (Sulaiman, 2025).
- Cross-Border Trade Barriers:
  - Customs delays and inconsistent regulations continue to hinder trade efficiency in MENA economic corridors (UITP, 2025).

Freight congestion significantly contributes to emissions and transport inefficiencies, requiring better logistics planning and policy interventions. In Table 1 the overview of the existence public transport modes in MENA cities can be seen.

4.2 Environmental impact

The transport sector accounts for a major share of CO_2 emissions in MENA. Poor air quality in cities like Cairo, Tehran, and Riyadh is directly linked to vehicle emissions.

- Private Vehicle Emissions:
  - Petrol and diesel still dominate urban transport, increasing urban air pollution (Sulaiman, 2025).
  - EV adoption remains slow, except in Doha, Dubai and Saudi Arabia, where government incentives are growing (Bejjani et al., 2021).
- Limited Public Transport Electrification:
  - Dubai leads in electric bus deployment, while Cairo, Algiers, and Beirut still rely on diesel-powered fleets (Mostofi et al., 2020).

MENA lags behind in green mobility adoption. There is a pressing need for policy incentives in electric public transport (Bejjani et al., 2021).

4.3 Technological advancements & smart mobility

4.3.1 Intelligent transport systems (ITS) & AI integration

- Doha, Dubai and Riyadh are implementing AI-powered traffic management systems (UITP, 2025).
- Cairo is piloting real-time public transport tracking but faces infrastructure limitations (Sulaiman, 2025).

4.4 Connected & autonomous vehicles (CAVs)

- UAE and Saudi Arabia are testing self-driving vehicles, but regulatory barriers slow down the adoption (UITP, 2025).

4.5 Mobility as a service (MaaS) & ride-hailing

- Uber, Careem, and Hala dominate MENA's ride-sharing market, but public transport integration remains weak (Mostofi et al., 2020).

From all of above we noticed that technology adoption is growing, but policy frameworks lag behind, hindering implementation.

5 Indicator-based assessment of sustainable transport in MENA

We conducted indicator-based comparative assessment of sustainable transport in MENA cities, integrating data from the UITP (2025) and other sources applying statistical normalization methods and a weighted scoring system to rank cities based on their transport sustainability performance; keeping in mind that the findings will help identify best practices and policy interventions to promote sustainable urban mobility in the region.

To assess the sustainability of transport systems across MENA cities, three key dimensions of transport sustainability indicators were considered as highlighted in Table 2.

Each of these indicators plays pivotal role in determining how sustainable, accessible, and efficient urban transport systems are in MENA cities.

Table 1 Public transport modes in the examined MENA cities

City	BUS	BRT	Tram/LRT	Monorail	Metro	Suburban rail	Waterborne	Cable car
Dubai	✓		✓	✓	✓		✓	
Cairo	✓				✓	✓	✓	
Riyadh	✓				✓			
Beirut	✓							
Algiers	✓		✓		✓	✓	✓	✓
Amman	✓	✓						
Bahrain	✓							
Tehran	✓	✓			✓			
Baghdad	✓						✓	
Kuwait	✓							
Rabat	✓		✓					
Muscat	✓							
Doha	✓				✓			
Tunis	✓		✓		✓	✓	✓	
Abu Dhabi	✓						✓	

Source: own compilation based on UITP (2025)

Table 2 Selected sustainable transport indicators in the MENA region

Environmental indicators	Economic indicators	Social indicators
Transport CO_2 emissions per capita	Minimum public transport fares (adjusted for PPP)	Share of population with convenient access to public transport
Carbon footprint of transport as a share of global emissions	Monthly pass costs relative to average income	Availability of e-ticketing & trip planners (digital accessibility)
Adoption rate of alternative fuels & e-mobility (electric buses, trams, renewable energy-powered transport)	Fleet size per million inhabitants	Development of smart transport systems (use of AI, IoT, digital platforms for traffic optimization)
Adoption rate of new zero-emissions buses	Network length per million inhabitants	Share of people supporting political action on climate change
Availability of electric bike and scooter-sharing	Public transport ridership per capita	
	Presence of ride-hailing & car-sharing services	
Total number: 5	Total number: 6	Total number: 4
Total indicator number	15	

5.1 Data collection

The data for this study was gathered from multiple sources:

- UITP (2025);
- World Bank Urban Mobility Indicators;
- Government Transport Reports (where available);
- Academic Literature on Sustainable Transport in MENA (Chaudhry et al., 2023; Mostofi et al., 2020).

Data were collected for major MENA cities, including Dubai, Riyadh, Cairo, Algiers, Beirut, and others, to ensure a representative sample of urban mobility challenges and opportunities in the region.

To compare transport sustainability across cities, data were normalized using two statistical methods.

5.2 Min-max normalization

This method rescaled indicator values to a common range of 0 to 1:

$$X_{\text{norm}} = \left(X - X_{\min}\right) / X_{\max} - X_{\min} \,. \tag{1}$$

Where:

- X_{norm} = normalized value,
- X = original value,
- $X_{\max} - X_{\min}$ = maximum and minimum values of the indicator.

On the other hand, to ensure data comparability and account for distribution differences, *Z*-score normalization was also applied:

$$Z = X - \mu/\sigma \,. \tag{2}$$

Where:

- Z = standardized value,
- X = original value,
- μ = mean of the indicator,
- σ = standard deviation.

Z-score normalization is less sensitive to extreme values than Min-Max normalization, making it suitable for cross-city comparisons.

Each transport indicator was weighted based on its relevance to sustainable mobility. The following weighting scheme was applied as demonstrated in Table 3, an explanation behind designing it was explained in Appendix.

The final Sustainable Transport Score (*STS*) for each examined city in the MENA region was calculated as:

$$STS = \sum_i \left(Z_i \times W_i\right). \tag{3}$$

- Z_i = *Z*-score standardized value for indicator *i;*
- W_i = weight of indicator *i*.

6 Results

Considering the obstacles in collecting data related to the examined field, the following results can be highlighted according to the selected indicators. It is worth mentioning, that the indicators were selected based on the availability of data, the results can be demonstrated according to the pillars of sustainability. The analysis started with the environmental

Table 3 Selected sustainable transport indicator's weighting scheme considering the MENA region

Indicator	Weight
Metro fleet size (vehicles/1 mn inhabitants)	0.12
Metro network length (km)	0.12
Tramway/LRT fleet size (vehicles/1 mn inhabitants)	0.08
Tramway/LRT network length - network length	0.08
Bus fleet size (vehicles/1 mn inhabitants)	0.15
BRT network length (km)	0.1
Minimum public transport fare ($)	0.1
Share of populations with convenient access to public (transport, 2022 (Public Transport Modal Share (%))	0.1
Transport CO_2, emission per capita CO_2, emissions per capita (t), 2021	0.1
Carbon footprint of transport: its share in global emissions - CO_2 emissions per capita, 2021 (excluding LULUCF)	0.05

performance assessment as it's known that transport emissions remain a major sustainability challenge in MENA region, as urban areas are highly dependent on fossil-fueled private vehicles (Sulaiman, 2025). The transport CO_2 score was estimated using vehicle density per million inhabitants as a proxy for emissions, and the key findings were demonstrated in Table 4.

Despite government-led initiatives to promote electric vehicles (EVs) and renewable energy in transport, the adoption rate remains below global standards (UITP, 2025). The lack of integrated sustainability policies across some MENA cities further exacerbates carbon footprint disparities.

The second pillar is the economic performance, and infrastructure, affordability, and public transport investment were discussed within this category. It needs to be emphasized that economic sustainability in transport systems hinges on affordability, network efficiency, and accessibility. While some cities have made significant investments in metro and tramway networks, the cost of public transport and service availability vary considerably, the key findings were demonstrated in Table 5.

This analysis aligns with previous studies (UITP, 2025), which indicate that MENA transport investments alone do not always translate to affordability. Cities should focus on fare optimization, multimodal integration, and targeted subsidies to enhance economic accessibility.

Table 4 MENA cities' environmental performance

City	Country code	Metro fleet size (vehicles per million)	Congestion impact on carbon footprint	Alternative fuel adoption
Doha	QAT	278	Severe	Limited adoption
Dubai	ARE	177	High	Leading in EV & e-mobility
Riyadh	SAU	52	Severe	Leading in EV & e-mobility
Cairo	EGY	37	N/A	Limited adoption
Algiers	DZA	N/A	N/A	Relies on diesel fleets
Amman	JOR	N/A	Low	Limited adoption
Tunis	TUN	N/A	Low	Limited adoption
Beirut	LBN	N/A	Moderate	Relies on diesel fleets
Kuwait	KWT	N/A	High	Relies on diesel fleets
Rabat	MAR	N/A	Low	Limited adoption
Muscat	OMN	N/A	Moderate	Limited adoption
Bahrain	BHR	N/A	N/A	Relies on diesel fleets

Last but not least, the third pillar is social and digital accessibility in which the focus is on smart mobility and public transport integration.

Even though the integration of digital mobility solutions such as real-time trip planning, e-ticketing, and AI-based traffic management is crucial for increasing public transport adoption (UITP, 2021), digital accessibility levels vary significantly across MENA cities as demonstrated in Table 6.

Empirical analysis indicates that digitalization enhances transport efficiency and should be a priority for cities looking to improve ridership and reduce congestion.

The scope of the performance assessment was focused exclusively on Dubai, Doha, Riyadh, Cairo, and Algiers due to the availability and consistency of relevant data. In other MENA cities, data availability was extremely limited, often restricted to one or two indicators at most, or entirely absent making comprehensive evaluation across the full set of sustainability pillars unfeasible.

The final sustainable transport ranking is demonstrated in Table 7.

It's essential to highlight that even though Cairo comes 9th as ranking but they have made tremendous advancement in the three pillars with providing reliable data.

To complement the indicators based analysis insights, it is essential to reflect on the overall distribution of sustainable transport performance across the region. Based on the results in Table 7, the average Sustainable Transport Score (STS) for the evaluated MENA cities is approximately 0.234.

Out of the twelve assessed cities, three cities scored above the average—Doha (0.596), Dubai (0.459), and Riyadh (0.391). These cities are primarily located in high-income countries or have shown strong policy commitment toward sustainable transport, supported by modern infrastructure and digital integration. For instance, Doha and Dubai significantly benefit from their investments in metro systems, AI-based traffic management, and bus fleet expansion, while Riyadh's recent efforts in metro development and smart mobility are beginning to yield results.

Conversely, nine cities scored below the regional average, including Algiers (0.219), Amman (0.208), Tunis (0.206), Beirut (0.189), Kuwait (0.179), Cairo (0.126), Rabat (0.094), Muscat (0.078), and Bahrain (0.064). These cities often face persistent challenges such as aging infrastructure, governance fragmentation, low data transparency, and a high dependency on private vehicles or informal transport modes. In cities like Cairo, despite having the region's oldest metro system and highest ridership base, insufficient digital integration, underfunded

Table 5 MENA cities economic performance

City	Country code	Key strength	Key challenge	Monthly public transport cost (PPP-adjusted USD)	Metro network length (km)
Doha	QAT	Largest metro and tramway fleet per capita	N/A	$42.86	76 km
Dubai	ARE	Well-developed transit network	Affordability remains an issue	$53.85	89.6 km
Riyadh	SAU	Metro expansion securing strong performance	High transport costs limit accessibility	$73.68	176 km
Cairo	EGY	Largest ridership base in the region	Severe overcrowding, unreliable service	$55.56	10 km
Algiers	DZA	Developing metro system	NA	$28.69	18.8 Km
Amman	JOR	Growing interest in BRT systems	Lack of established rail infrastructure	$103.13	NA
Tunis	TUN	Extensive light rail network	Aging infrastructure and rolling stock	NA	21
Beirut	LBN	N/A	Absence of formal public transport system	NA	NA
Kuwait	KWT	Plans for metro development	Currently lacks mass transit options	$61.1	NA
Rabat	MAR	Successful tramway system	Expansion to meet growing demand	NA	NA
Muscat	OMN	Investments in bus services	No rail-based public transport	NA	NA
Bahrain	BHR	Initiatives for integrated transport network	Limited public transport usage	NA	NA

Table 6 MENA cities' social performance

City		Digital accessibility ranking	Key strength	Key challenge	Smart mobility integration
Dubai	ARE	1st	Advanced AI-driven transport management	N/A	Real-time trip planning, e-ticketing, MaaS integration
Doha	QAT	2nd	Strong digital infrastructure for transport	N/A	AI-powered transport platforms and congestion management
Riyadh	SAU	3rd	Investing in smart mobility platforms	Full integration still in progress	Smart mobility expansion in progress
Cairo	EGY	4th	N/A	Lack of modern e-ticketing and digital services	Limited digital transport integration
Algiers	DZA	5th	N/A	Outdated ticketing and accessibility issues	Limited digital transformation in public transport
Amman	JOR	6th	Initiatives for smart city development	Fragmented public transport system	Plans for integrated mobility solutions
Tunis	TUN	7th	Development of digital mobility strategies	Implementation challenges	Action plan for smart mobility in progress
Beirut	LBN	8th	Emerging smart mobility initiatives	Reliance on informal transport systems	Efforts to introduce digital transport solutions
Kuwait	KWT	9th	Adoption of intelligent traffic control systems	Need for comprehensive smart mobility framework	Integration of blockchain in transport systems
Rabat	MAR	10th	Implementation of smart mobility projects	Coordination among various stakeholders	Initiatives to promote digitalization in transport
Muscat	OMN	11th	Deployment of intelligent transport solutions	Early stages of smart mobility adoption	Introduction of smart parking and EV charging systems
Bahrain	BHR	12th	Integration of smart meters in public transport	Enhancing public transport utilization	Real-time passenger information systems implemented

Table 7 Sustainable transport ranking in the MENA region

City	Sustainable transport score (STS)	Rank
Doha	0.596	1st
Dubai	0.459	2nd
Riyadh	0.391	3rd
Algiers	0.219	4th
Amman	0.208	5th
Tunis	0.206	6th
Beirut	0.189	7th
Kuwait	0.179	8th
Cairo	0.126	9th
Rabat	0.094	10th
Muscat	0.078	11th
Bahrain	0.064	12th

public services, and service reliability issues have hindered performance across all sustainability pillars.

This disparity illustrates a clear divide between cities with proactive policy frameworks and those still constrained by structural and institutional limitations. It emphasizes the importance of not only investing in physical infrastructure but also strengthening governance coordination, affordability measures, digital solutions, and behavioral change strategies to unlock the full potential of sustainable transport systems across the MENA region.

7 Policy recommendations for the sustainable transport sector in the MENA region

The findings of this study highlight the urgent need for policy reforms to create a more sustainable, efficient, and accessible transport system in the MENA region. The following recommendations focus on infrastructure development, affordability, governance, digital transformation, and behavioral change to ensure long-term mobility sustainability.

1. Invest in public transport infrastructure and integration
   MENA cities should expand and integrate public transport networks to reduce congestion and car dependency. Metro and BRT systems should be scaled up in high-density cities, while feeder bus networks and micro-mobility options (e-scooters, bike-sharing) should improve last-mile connectivity. Public-private partnerships (PPPs) can help fund these expansions while reducing the financial burden on governments.
2. Make public transport more affordable and accessible
   Affordability remains a barrier in many cities, with Riyadh's transport costs ($73.68/month) among the highest. Governments should subsidize fares for low-income groups, introduce smart fare systems, and ensure pricing policies match income levels. Special policies should support women, the elderly, and disabled individuals to improve transport inclusivity.
3. Enhance governance and policy coordination
   Fragmented decision-making weakens transport planning across MENA. Cities need unified transport authorities to streamline operations, enforce sustainability regulations, and promote transparency. Climate governance in transport should be strengthened with emission reduction targets and congestion pricing mechanisms.
4. Promote low-carbon and electric mobility
   Despite efforts, EV adoption remains slow, with Dubai and Riyadh leading the transition. Governments should offer subsidies for electric public transport fleets and invest in charging infrastructure. Low-emission Zones (LEZs) should be introduced in major urban centers to restrict high-emission vehicle use.
5. Leverage digital innovation for smart mobility
   MENA cities should expand AI-driven traffic management systems to optimize urban mobility. Digital payment solutions, real-time trip planning, and Mobility as a Service (MaaS) platforms can improve commuter experiences. Cities like Dubai and Doha already leverage smart mobility solutions, while Cairo and Algiers still lack modern e-ticketing systems. Another important aspect is port sector, integrating automation and digital efficiency tools into transport systems can significantly reduce emissions while enhancing operational decision-making, underscoring the value of cross-sector sustainability strategies. (David et al., 2024)
6. Encourage behavioral change to reduce car dependency
   Sustainable transport policies should be combined with incentives and awareness campaigns to shift travel behavior. Congestion pricing, carpool lanes, and work-from-home incentives can reduce reliance on private cars. Employer-based mobility programs can offer transit benefits to encourage employees to choose public transport.
7. Improve freight and logistics sustainability
   Freight transport is a major contributor to urban congestion and emissions. To mitigate its impact, cities should develop freight consolidation centers, promote electric delivery vehicles, and integrate rail and maritime transport for goods movement.

8 Conclusion

Sustainable transport in the MENA region is at a critical crossroads. While cities such as Dubai, Doha, and Riyadh have made significant strides in developing modern transit infrastructure, affordability, accessibility, and environmental impact remain key challenges. The findings of this study highlight the urgent need for comprehensive policy interventions to reduce car dependency, expand public transport networks, improve governance, and leverage smart mobility solutions.

The indicator-based assessment provided in this research underscores that infrastructure alone does not guarantee sustainability, a holistic approach integrating economic, social, and environmental dimensions is essential. Cities should go beyond metro and bus expansions and focus on multimodal integration, affordability, and technological advancements to ensure equitable and efficient mobility.

The key findings are:

- Doha ranks highest in sustainable transport, benefiting from strong public investment and modern metro infrastructure.
- Dubai excels in digital mobility but should address affordability concerns to enhance accessibility.
- Riyadh's ongoing metro expansion improves connectivity but requires pricing reforms to ensure transport remains accessible to all.
- Cairo faces severe congestion and infrastructure bottlenecks, demanding urgent investment in public transport electrification and service reliability.
- Algiers and other lower-ranked cities need greater policy coordination and investment in digital transport solutions and public transport networks.

Ultimately, sustainable transport in MENA requires a shift in both policy and public perception. Cities should prioritize integrated transport planning, climate-conscious policies, and behavioral incentives to encourage greater reliance on public and shared mobility. With targeted investments, better governance, and digital transformation, MENA cities can build resilient, low-carbon transport systems that enhance urban livability, economic competitiveness, and environmental sustainability.

The path forward is clear: act now, invest smartly, and create transport networks that serve both current and future generations.

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References

Alotaibi, O., Potoglou, D. (2017) "Perspectives of travel strategies in light of the new metro and bus networks in Riyadh City, Saudi Arabia", Transportation Planning and Technology, 40(1), pp. 4–27. https://doi.org/10.1080/03081060.2016.1238572

Bejjani, M., Elborai, S., Haddad, M. Cordahi, G. A. (2021) "Sustainable mobility: Inverting the transport pyramid", [pdf] Strategy&, Dubai, UAE. Available at: https://www.strategyand.pwc.com/m1/en/insights/2021/sustainable-mobility/sustainable-mobility.pdf [Accessed: 10 April 2025]

Buzási, A., Csete, M. (2015) "Sustainability Indicators in Assessing Urban Transport Systems", Periodica Polytechnica Transportation Engineering, 43(3), pp. 138–145. https://doi.org/10.3311/PPtr.7825

Chaudhry, A. G., Masoumi, H. Dienel, H. L. (2023) "A systematic literature review of mobility attitudes and mode choices: MENA and South Asian cities", Frontiers in Sustainable Cities, 4, 1085784. https://doi.org/10.3389/frsc.2022.1085784

David, A., Kļaviņš, A., Olei, A. B., Midan, A. A. (2024) "Sustainability of Maritime and Inland Ports", Cognitive Sustainability, 3(3), 119. https://doi.org/10.55343/cogsust.119

Gudmundsson, H. (2003) "Making concepts matter: sustainable mobility and indicator systems in transport policy", International Social Science Journal, 55(176), pp. 199–217. https://doi.org/10.1111/j.1468-2451.2003.05502003.x

Haghshenas, H., Vaziri, M. (2012) "Urban sustainable transportation indicators for global comparison", Ecological Indicators, 15(1), pp. 115–121. https://doi.org/10.1016/j.ecolind.2011.09.010

HSBC (2023) "Smart mobility transforms cities in the Middle East", [online] HSBC Business. Available at: https://www.business.hsbc.ae/en-gb/insights/growing-my-business/smart-mobility-transforms-cities-in-the-middle-east [Accessed: 10 April 2025]

Iannacci, F., Chari, S., Papagiannidis, S. (2025) "Investigating successful sustainable urban mobility in large cities: A contingency-based, fuzzy-set Qualitative Comparative Analysis", Technological Forecasting and Social Change, 212, 123963. https://doi.org/10.1016/j.techfore.2024.123963

Joumard, R., Gudmundsson, H., Folkeson, L. (2011) "Framework for Assessing Indicators of Environmental Impacts in the Transport Sector", Transportation Research Record: Journal of the Transportation Research Board, 2242(1), pp. 55–63. https://doi.org/10.3141/2242-07

Knoflacher, H. (2007) "Success and failures in urban transport planning in Europe – understanding the transport system", Sadhana, 32(4), pp. 293–307. https://doi.org/10.1007/s12046-007-0026-6

Kundu, D., Pandey, A. K. (2020) "World Urbanisation: Trends and Patterns", In: Developing National Urban Policies: Ways Forward to Green and Smart Cities, Springer, pp. 13–49. ISBN 978-981-15-3737-0 https://doi.org/10.1007/978-981-15-3738-7_2

Litman, T. A. (2010) "Sustainable Transportation Indicator Data Quality and Availability", [pdf] presented at Transportation Research Board 89th Annual Meeting, Washington, Dc, US, Jan 10–14 2010. Available at: https://trid.trb.org/View/910553 [Accessed: 10 April 2025]

Łuczyszyn, K. (2024) "Sustainable transport – development and goals", Cognitive Sustainability, 3(1), 92. https://doi.org/10.55343/cogsust.92

Mostofi, H., Masoumi, H., Dienel, H. L. (2020) "The Relationship Between Regular Use of Ridesourcing and Frequency of Public Transport Use in the MENA Region (Tehran and Cairo)", Sustainability, 12(19), 8134. https://doi.org/10.3390/su12198134

Saber, R. E., Dief-Allah, D. M., Ahmed, N. O., Khalifa, B. M., Masoumi, H. (2024) "The correlates of smartphone use for transportation purposes in Egypt and Lebanon", Frontiers in Sustainable Cities, 6, 1340372. https://doi.org/10.3389/frsc.2024.1340372

Shiau, T. A., Liu, J. S. (2013) "Developing an indicator system for local governments to evaluate transport sustainability strategies", Ecological Indicators, 34, pp. 361–371. https://doi.org/10.1016/j.ecolind.2013.06.001

Sulaiman, K. (2025) "Climate Information Transparency in the MENA Region", [online] Carnegie Endowment for International Peace, Washington, D.C., USA. Available at: https://carnegieendowment.org/research/2025/01/climate-information-transparency-in-the-mena-region [Accessed: 10 April 2025]

Török, Á. (2014) "Environmental comparism of road and railway transport: a case study in Hungary", International Journal for Traffic and Transport Engineering, 4(2), pp. 210–219. https://doi.org/10.7708/ijtte.2014.4(2).07

Tóth-Szabó, Z., Várhelyi, A. (2012) "Indicator Framework for Measuring Sustainability of Transport in the City", Procedia – Social and Behavioral Sciences, 48, pp. 2035–2047. https://doi.org/10.1016/j.sbspro.2012.06.1177

UITP (2021) "MENA Transport Report 2020/2021", [online] UITP, Brussels, Belgium. Available at: https://www.uitp.org/publications/mena-transport-report-2020-2021 [Accessed: 10 April 2025]

UITP (2025) "The 7th Edition of the MENA Transport Report: MENA on the Move – Public Transport and Urban Mobility Progress and Trends", [online] UITP, Brussels, Belgium. Available at: https://cms.uitp.org/wp/wp-content/uploads/2025/02/UITP_-_MTR24_26022025_Digital.pdf [Accessed: 10 April 2025]

United Nations Population Fund (2023) "Urbanization", [online] Available at: https://www.unfpa.org/urbanization [Accessed: 10 April 2025]

United Nations (2018) "World Urbanization Prospects: The 2018 Revision", [online] Population Division of the United Nations Department of Economic and Social Affairs (UN DESA), New York, USA. Available at: https://www.un.org/en/desa/2018-revision-world-urbanization-prospects [Accessed: 10 April 2025]

World Commission on Environment and Development (1987) "Transmits report of the World Commission on Environment and Development entitled: Our common future", [online] United Nations, New York, USA, A/42/427. Available at: https://digitallibrary.un.org/record/139811 [Accessed: 10 April 2025]

World Economic Forum (2015) "World Economic Forum Annual Meeting 2015: The New Global Context", [online] World Economic Forum, Geneva, Switzerland. Available at: https://www3.weforum.org/docs/WEF_AM15_Report.pdf [Accessed: 10 April 2025]

Zegras, C. (2006) "Sustainable Transport Indicators and Assessment Methodologies", [pdf] presented at Biannual Conference and Exhibit of the Clean Air Initiative for Latin American Cities: Sustainable Transport: Linkages to Mitigate Climate Change and Improve Air Quality, São Paulo, Brazil, July 25–27 2006. Available at: https://web.mit.edu/czegras/www/Zegras_LAC-CAI_Bkgd.pdf [Accessed: 10 April 2025]

Zito, P., Salvo, G. (2011) "Toward an urban transport sustainability index: an European comparison", European Transport Research Review, 3(4), pp.179–195. https://doi.org/10.1007/s12544-011-0059-0

Appendix

Note on the Selection of the Weighting Scheme for Sustainable Transport Indicators in the MENA Region

The weighting scheme used in this study was designed to reflect the contextual priorities and regional challenges of sustainable urban transport in the MENA region. Given the diversity in income levels, infrastructure maturity, and governance structures across the region, the weighting of indicators was informed by the following logic:

1. Emphasis on modal infrastructure (High weighting for metro and bus fleet size):
   Public transport infrastructure is at the core of sustainable mobility, particularly in car-dependent MENA cities. Indicators such as metro fleet size (0.12) and bus fleet size (0.15) received relatively higher weights due to their critical role in offering viable alternatives to private vehicle usage, especially in cities struggling with congestion and emissions.
2. Support for network reach and capacity (Weighting for metro and tramway lengths):
   Metro (0.12) and tram/LRT network length (0.08) were prioritized to capture the spatial coverage and accessibility potential of public transport systems. Network length influences ridership levels, last-mile connectivity, and modal shift behavior.
3. Inclusion of environmental considerations:
   Given that the transport sector is a major contributor to CO_2 emissions in MENA urban areas, indicators such as transport CO_2 emissions per capita (0.10) and transport's share in global emissions (0.05) were integrated with moderate weighting. These reflect environmental performance without overemphasizing it at the cost of other dimensions.
4. Affordability and accessibility as key economic & social dimensions:
   Public transport fare levels (0.10) and population with access to public transport (0.10) are central to equitable mobility. In many MENA cities, affordability is a barrier, particularly for vulnerable groups such as low-income populations and women. These indicators were thus assigned balanced importance.
5. Recognition of new and emerging mobility trends:
   To capture innovation and future-readiness, the scheme includes alternative fuel and zero emission bus adoption, ride-sharing presence, and digital transport systems (weighted across multiple social and environmental indicators), albeit with slightly lower weights due to data limitations and varying levels of implementation across cities.
6. Alignment with regional data availability and relevance:
   The weights were also influenced by data completeness across the cities analyzed. Indicators with more consistent and comparable data such as metro network length and public transport fares received higher weights to ensure robust comparative analysis. Conversely, indicators with lower availability or standardization, such as cable car systems or waterborne transport, were excluded or de-emphasized.
7. Balancing all pillars of sustainability:
   The final scheme maintains a balanced distribution across the three core pillars: environmental, economic, and social sustainability while also recognizing institutional and governance aspects through indicators like modal share and digital integration.