MPP 901 Dissertation

2024

Rethinking Sustainable Urban Mobility for RAS Al Khaimah

by

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This dissertation report is submitted in partial fulfillment

Of the award of Master of Public Policy

Declaration

I, the undersigned, ***Read H. H. Abounaga***, declare that this Dissertation is my original work, that all material presented to Mohammed Bin Rashid School of Government is my own, and has not been previously submitted to any other university for a higher degree. I also declare that the publications cited in this work have been personally consulted. I understand that if at any time it is shown that I have significantly misrepresented material presented to the Mohammed Bin Rashid School of Government, any degree or credits awarded to me based on that material may be revoked.

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Word Count: 16,892

Abstract

The transportation sector in urban areas plays a crucial role in society's well-being, yet it simultaneously presents challenges that impede progress. This research addresses the lacuna in the literature by examining the application of sustainable transportation principles, focusing on stakeholders such as transportation planners. The primary objective is to harmonize transportation interventions and transform them into catalysts for development, environmental preservation, and meeting societal needs.

The study conducts a comprehensive review of existing literature and data analysis to assess the preparedness of rapidly urbanizing regions like Ras Al Khaimah (RAK) in the United Arab Emirates (UAE) for sustainable urban growth. Emphasizing the integration of various modes of transport, the assessment explores the environmental consequences of improving mobility infrastructure, highlighting benefits such as congestion reduction, emissions mitigation, and enhanced accessibility.

Drawing from global approaches, the research provides suggestions and a strategic plan for RAK to fortify its urban transportation system, aiming to balance growth with preservation and enhance the quality of life. The evaluation of RAK's current transportation system underscores its limitations, particularly in pedestrian accessibility and micro-mobility services. Recognizing RAK's ambitious goal of achieving a 30-40% public transport mode share by 2030, the study proposes realistic targets considering growth rates in neighbouring cities: 3-5% by 2030, 15% by 2040, and 25% by 2050.

In conclusion, the thesis underscores the opportunity for RAK to strengthen its transportation policies and infrastructure, fostering smoother operations and coordination among systems. Strategic recommendations involve proposed projects, including improved transit frequency, passenger infrastructure, and active transportation corridors. Enabling policies focus on promoting public transport use, walkability, and private sector participation.

The proposed initiatives aim to meet sustainability goals and position RAK as a pioneer in creating a resilient and forward-thinking transportation ecosystem. Aligned with global

best practices, these projects and policies ensure compliance and accelerate the transition to sustainable mobility by 2030.

Keywords: *Urban Mobility, Active Transportation, Sustainable Modes of Transportation, Multimodal Transportation, Transportation Integration, Mobility Infrastructure.*

ملخص البحث

يلعب قطاع النقل في المناطق الحضرية دورًا حاسمًا في رفاهية المجتمع، وفي الوقت نفسه يطرح تحديات تعيق التقدم. يتناول هذا البحث الفجوة في الأدبيات من خلال فحص تطبيق مبادئ النقل المستدام، مع التركيز على الفاعلين مثل مخططي النقل. الهدف الرئيسي هو موائمة التدخلات في مجال النقل وتحويلها إلى عوامل دافعة للتنمية وحفظ البيئة وتلبية احتياجات المجتمع.

يقوم البحث بإجراء استعراض شامل للأدبيات وتحليل البيانات لتقييم استعداد المناطق الحضرية السريعة التكامل مثل رأس الخيمة في الإمارات العربية المتحدة للنمو الحضري المستدام. من خلال التأكيد على تكامل مختلف وسائل النقل، يتناول التقييم العواقب البيئية لتحسين بنية التنقل، مع التركيز على فوائد مثل تقليل الازدحام وتقليل انبعاثات الغازات الضارة وتعزيز إمكانية الوصول.

وبالاستناد إلى الأساليب العالمية، يقدم البحث اقتراحات وخطة استراتيجية لرأس الخيمة لتعزيز نظام النقل الحضري، بهدف تحقيق التوازن بين النمو والحفاظ على البيئة وتحسين نوعية الحياة. يؤكد تقييم نظام النقل الحالي في رأس الخيمة على القيود التي يواجهها، لا سيما في مجال إمكانية وصول المشاة وخدمات التنقل الصغيرة. مع الأخذ بالإعتبار طموح رأس الخيمة لتحقيق حصة نمط النقل العام بنسبة 30-40% بحلول عام 2030، يقترح البحث أهدافًا واقعية تأخذ في اعتبارها معدلات النمو في المدن المجاورة: 3-5% بحلول عام 2030، 15% بحلول عام 2040، و25% بحلول عام 2050.

في الختام، توضح الأطروحة الفرصة التي تتاح لرأس الخيمة لتعزيز سياساتها وبنيتها التحتية للنقل، وتعزيز تنسيق العمليات والتكامل بين الأنظمة. تتضمن التوصيات الاستراتيجية مشاريع مقترحة، بما في ذلك تحسين ترابط وسائط النقل، والبنية التحتية للنقل، وممرات النقل النشطة. تتركز السياسات التمكينية على تعزيز استخدام وسائل النقل العامة، وسهولة المشي، ومشاركة القطاع الخاص.

المبادرات المقترحة في الإطروحة لا تحقق أهداف الاستدامة فحسب، بل أيضًا تعزيز مكانة رأس الخيمة كمدينة رائدة في إنشاء نظام نقل متين ومستقبلي ومستدام. وتضمن هذه المشاريع والسياسات، وفقًا لأفضل الممارسات العالمية، الامتثال وتسريع الانتقال إلى التنقل المستدام بحلول عام 2030.

الكلمات المفتاحية: *التنقل الحضري، النقل النشط، وسائل النقل المستدامة، النقل متعدد الوسائط، تكامل النقل، البنية التحتية للتنقل.*

Acknowledgments

I want to thank several individuals and organizations who have played pivotal roles in my academic and personal journey.

First and foremost, I want to express my sincere appreciation to Dr. Scott Fargher. His mentorship, guidance, and unwavering support have shaped my academic and professional growth. Dr. Fargher's expertise and insights have been a constant source of inspiration, and I am deeply thankful for the time and wisdom he has generously shared.

I would also like to acknowledge the MBRSG College and all the esteemed teams contributing to my education and training. Your collective knowledge and dedication to pursuing excellence have enriched my academic experience and broadened my horizons.

Additionally, I thank the RAK Transport Authority for their cooperation and assistance throughout my academic and research endeavors. Their collaboration has been invaluable, and I am grateful for their commitment to fostering research and innovation.

Last but certainly not least, I want to express my heartfelt appreciation to my family. Their unwavering support, love, and encouragement have been the cornerstone of my success. Their belief in me has been a constant source of motivation, and I am truly blessed to have them by my side.

To all these individuals and organizations, I offer my deepest thanks. Your contributions have been integral to my journey, and I am profoundly grateful for your support and guidance.

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Abbreviations

ICT…… Information and Communication Technology

IEA…… International Energy Agency

ITC.....Integrated Transport Centre – Abu Dhabi

IUCN.....International Union for Conservation of Nature

Maas.....Mobility-as-a-Service

MENA .....Middle East and North Africa

NACTO .....National Association of City Transportation Officials

PT modes.....Public Transport Model

RAKTA.....RAK Transport Authority

RAK .....RAS Al Khaimah

RTA .....Road and Transport Authority - Dubai

SDGs .....Sustainable Development Goals

TfL…… Transport for London

UN .....United Nations

UMII…… Urban Mobility Innovation Index

UAE .....United Arab Emirates

UITP .....International Association of Public Transport

WCED.....World Commission on Environment and Development

WHO…… World Health Organization…

Chapter 1: Introduction

Sustainability is a multifaceted concept commonly associated with the interconnectedness of three pillars: environment, society, and economy. These pillars, though distinct, must be integrated to fulfill the purpose of sustainable development, defined as the capacity to meet current needs without compromising the needs of future generations (Giddings et al., 2002).

Mobility is similarly intricate, influencing the environment, society, and economy. Mobility facilitates access to education, work, services, and leisure activities, impacting economic growth and job creation. However, inefficient mobility systems contribute to environmental degradation and compromise public health, diminishing the quality of life in urban areas (WHO, 2018).

According to the European Environment Agency (2019), road transport significantly contributes to nitrogen dioxide emissions, accounting for 39% in 2019, posing threats to public health. Alarming statistics from the Health Effects Institute (2020) reveal that air pollution led to 6.67 million deaths globally last year. Moreover, the onset of the COVID-19 pandemic has shifted perceptions of public transportation, with more than a 50% drop in usage reported. This has led to a surge in private vehicle usage, posing a challenge to environmental conservation efforts.

Encouragingly, research has delved into promoting sustainable mobility, recognizing the need to understand consumer behavior, motivations, and external inhibiting factors (Yin et al., 2018; Keyson et al., 2017). The evolving landscape of mobility models, including sharing services, has shown promise in reducing CO2 emissions and fostering economic and ecological consumption (Shaheen et al., 2010; Bardhi & Eckhardt, 2012).

The United Nations 1992 underscored the pivotal role of transportation in social and service activities, designating it as one of the ten priority areas for the century. However, regions such as Ras Al Khaimah RAK in the United Arab Emirates (UAE) face challenges in their transportation sectors, often prioritizing immediate needs over long-term environmental, economic, and societal consequences (UN, 1992).

Despite its potential, RAK grapples with traffic congestion, noise pollution, and insufficient infrastructure. Addressing these challenges necessitates a shift towards sustainable transportation systems (UN,1992). These challenges extend beyond local issues, contributing to global concerns such as traffic congestion, greenhouse gas emissions, and associated economic costs (Texas A&M Transportation Institute, 2021; IEA, 2019; World Economic Forum, 2019).

In developed nations, escalating traffic and congestion in 2019 incurred significant economic losses, with the United States alone facing a cost of $166 billion (Texas A&M Transportation Institute, 2021). Greenhouse gas emissions from the transportation sector further underscore the imperative for environmentally friendly solutions (IEA, 2019). Similarly, developing countries encounter challenges related to accessibility, affordability, and safety, with over 90% of road crash fatalities occurring in these regions (UN, 2016).

However, within these challenges lie opportunities for inclusive mobility. The 2030 Agenda for Development outlines Sustainable Development Goals (SDGs) that emphasize the interconnected nature of transportation, linking objectives such as reducing greenhouse gas emissions with ensuring food security and healthcare access (UN, 2016). Sustainable transport, thus, plays a crucial role in achieving these SDGs with a focus on safety, equal access, and environmental friendliness (UN, 2016).

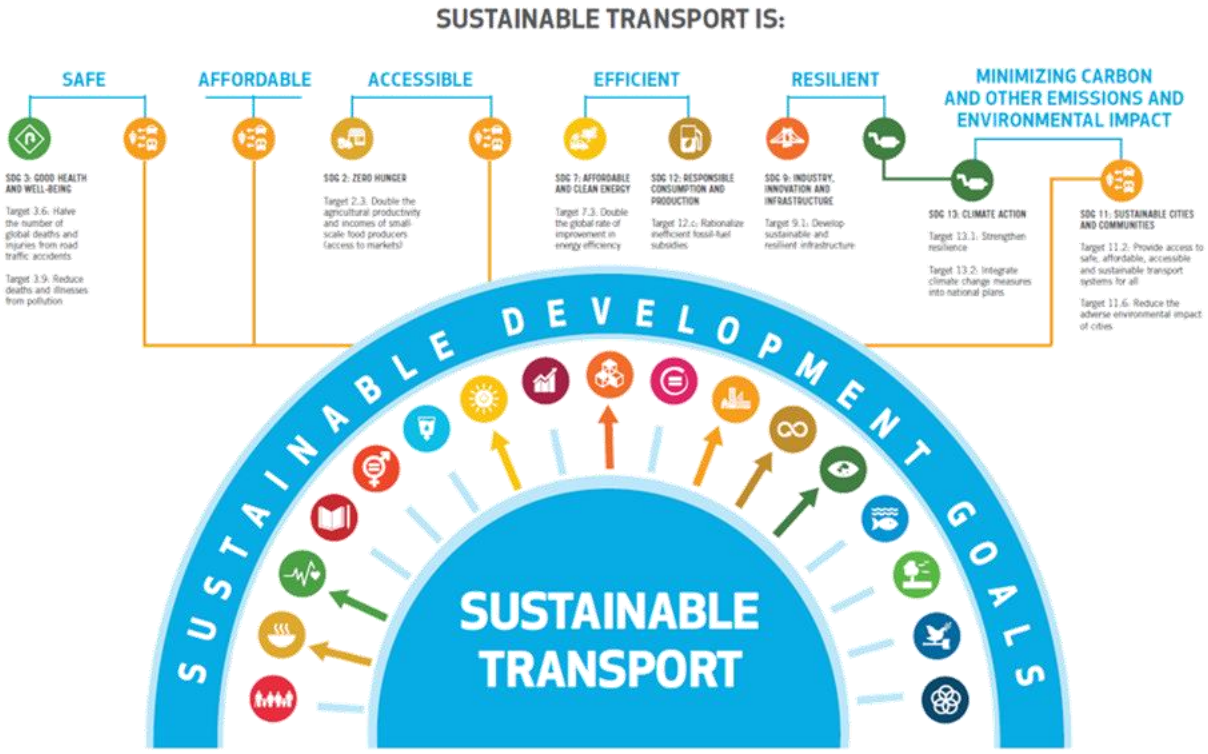
The 21st century has witnessed rapid urbanization, placing cities under immense pressure to develop transportation solutions that accommodate growing populations while promoting sustainability and ensuring access for all (UN, 2019). This study addresses these challenges and opportunities by examining global case studies to formulate a mobility model tailored for RAK. By integrating economic factors into the framework, the study aims to provide insights into transforming RAK's transportation system (Rodrigue & Notteboom, 2020).

Situated within the SDGs framework, this study aligns with Goal 11, which focuses on "Cities and Communities." Goal 11 emphasizes the importance of sustainability in the face of global urban expansion, advocating for environmentally responsible, socially inclusive, and economically vibrant cities. The study contributes to Goal 11 by exploring

the readiness of cities to transition to sustainable transportation practices, comparing them to global best practices, and offering a model for urbanizing cities.

Importantly, this study acknowledges the interconnectedness of the SDGs, recognizing the relevance of Goal 7 (clean and affordable energy) and Goal 13 (climate action). It emphasizes the need for an integrated approach to address the complex challenges urban areas face today. By aligning with global sustainability priorities and specifically emphasizing Goal 11, this research seeks to make a meaningful contribution toward advancing sustainable and resilient cities worldwide. Figure 1 shows the impact of sustainable transport on achieving the SDGs.

Figure 1 The Sustainable transport impact on achieving the SDGs



Source: UN Report (2021)

In the following sections, we will explore the challenges and opportunities in mobility. We will discuss the significance of transportation, the impacts of investments in transport infrastructure, and the role of transportation in markets. Additionally, we will focus on

assessing RAK's transport infrastructure state and evaluate its readiness for mobility using an "Urban Mobility Readiness" framework (Eltayeb et al., 2016). Through this study, we aim to contribute to a future characterized by inclusive and efficient transportation systems.

1.1. Problem Statement

(RAK), one of the Emirates in the UAE faces the challenge of developing its urban areas amidst population growth and economic expansion. The current transportation system in RAK is fragmented and heavily reliant on vehicles, lacking integration. This has led to traffic congestion, air pollution, limited accessibility, and inadequate infrastructure for pedestrians and cyclists. These challenges impact residents' quality of life and impede RAK's progress in meeting Sustainable Development Goal 11, emphasizing the importance of sustainable cities and communities. To effectively address these issues, it is crucial to establish a comprehensive and integrated urban mobility framework that caters to multiple modes of transportation. This dissertation aims to bridge this knowledge gap by analyzing metropolitan mobility readiness in RAK, focusing on integrating numerous transportation options. By understanding the root causes of these mobility challenges and proposing solutions, this research seeks to facilitate RAK's transition towards a sustainable, efficient, and equitable urban mobility system aligned with the SDGs and broader goals for sustainable urban development.

1.2. Aim and Objective of the Study

The main objective of this dissertation is to investigate how mobility impacts sustainability efforts and broader policy discussions in RAK. The study encompasses goals.

1. Emphasize the importance of mobility in promoting friendly, socially inclusive, and economically viable urban development within RAK. This highlights the significance of mobility in the context of sustainability.

2. Provide evidence-based insights to assist policymakers and urban planners in RAK. By providing a basis for decision-making and resource allocation, the study supports developing strategies to improve city mobility.

3. Focus on addressing challenges to RAKs context and offer tailored recommendations to address urban mobility issues. This research directly benefits the city's pursuit of an environment.

4. Recognize that this study has relevance beyond RAK, serving as a model for regions facing urbanization challenges and striving for development.

5. Align with Development Goal 11 by emphasizing the value of establishing inclusive and resilient cities. Demonstrate how these global objectives can be implemented at a community level, contributing to efforts towards urban development.

1.3. Research Questions

This study delves into the critical role of mobility within the context of RAK, emphasizing its alignment with Sustainable Development Goal 11, which advocates for sustainable, inclusive, and resilient cities. Urban mobility is pivotal in achieving these objectives by addressing traffic congestion, air pollution, and limited accessibility. Considering this, the primary question at the heart of this research emerges: *What is the optimal urban development policy to help achieve sustainability in RAK?*

To answer this question, several sub-questions have been developed:

RQ1: *What is the current state of transportation in RAK?*

With this first question, we assess the current state of transportation in RAK and its impact on issues like traffic congestion, air quality, and accessibility. Hence:

RQ2: *What are the key benefits and challenges facing sustainable transportation in RAK?*

In addressing this question, we draw on a systematic literature review and relevant data to identify the key benefits and challenges that hinder establishing a sustainable urban transportation system in the region.

RQ3: *What is the most viable sustainable transport option for RAK?*

Again, drawing on a systematic literature review, this question explores the current best practices of sustainable urban transport and investigates their relevance to RAK.

The next chapter presents a comprehensive literature review; this provides an overview of key developments in urban mobility, explores sustainability and mobility, and explains the definitions used in the thesis. In the third chapter, I will explain the research methodology. In the fourth chapter, I will conduct a comprehensive discussion and standard comparisons with best practices in sustainable transportation according to two main models, the UMII Framework and the Urban Mobility Index. Finally, I will present the most prominent results and recommendations in the fifth chapter.

Chapter 2: Literature Review

The scientific literature extensively explores the subject of urban mobility. Subsequently, this text offers a comprehensive overview of sustainable mobility based on the most prominent and pertinent literature.

2.1. Definitions

This section will present a scientific overview and narration of scientific definitions related to the research topic to deepen understanding of these terms, including definitions of sustainable development, sustainable mobility, smart mobility, and multimodal transport. Transportation integration.

2.1.1 sustainable development

Sustainable development is defined as ensuring that our current actions do not compromise the ability of generations to meet their needs (WCED, 1987).

The United Nations (UN) describes development as an approach that considers economic, social, and environmental aspects while meeting present needs and safeguarding future generations' needs (UN, 2015).

According to the World Bank, sustainable development is defined as a path that generates benefits in these dimensions without causing harm to the systems supporting life on Earth (World Bank, 2020).

Regarding the standpoint adhered to in this dissertation, it is crucial to acknowledge that sustainable development is a concept that is not fixed and depends on the circumstances. It encompasses aspects such as preserving the environment, promoting fairness, and ensuring economic prosperity. The precise definition of development may differ based on the situation and objectives. It is a progressive concept that aims to balance future generations' needs and welfare by considering numerous factors in each scenario.

2.1.2 Sustainable Mobility

Sustainable mobility is a diverse concept lacking an agreed-upon definition. It generally encompasses the movement of people and goods within areas focusing on transportation methods, infrastructure, and policies that promote efficient, safe, and sustainable transportation options.

It generally encompasses the movement of people and goods within areas focusing on transportation methods, infrastructure, and policies that promote efficient, safe, and sustainable transportation options (WHO, 2017).

According to the International Association of Public Transport (UITP), urban mobility encompasses a system of private transportation options available in urban areas. These include buses, trams, subways, bicycles, walking paths as car sharing and ridesharing services. The aim is to provide sustainable mobility solutions (UITP, 2019).

Moreover, Sustainable transportation is often associated with reducing CO2 emissions and promoting forms of movement that do not rely on motor vehicles. The mobility paradigm sets sustainable mobility apart from conventional approaches. While traditional travel planning focuses on considering travel because of demand and minimizing costs in terms of time and money, sustainable mobility prioritizes travel. It emphasizes making travel accessible and actively involves people planning transportation to gain acceptance for policy changes (Banister,2007).

The literature on mobility categorizes its characteristics into three pillars: environmental, social, and economic aspects of urban development. The ecological dimension addresses how urban mobility affects the environment on a scale, emphasizing cities' responsibility to reduce their transportation systems' impact on the environment. Goals within this pillar include promoting modes of transport, reducing traffic congestion, and minimizing air pollution, noise levels, and visual disturbances caused by transportation activities (Banister, 2007). It highlights the approach to mobility by advocating for actions that “reduce the need for travel (trips), encourage changing modes of transport, shorten trip distances, and promote greater efficiency in the transportation system.”

The dimensions of quality-of-life individuals and their needs consider factors like health and affordability. Social sustainability aims to provide reliable mobility for everyone with zero traffic accidents and affordable transportation systems. Ensuring opportunities for transportation is a focus involving important stakeholders and communities in decision-making processes.

To summarize, sustainable mobility aims to reduce the impact caused by transportation, improve the efficiency of resources in infrastructures and modes of transport, and ensure equitable access to public transportation. It emphasizes reducing reliance on cars. The characteristics of mobility involve an interconnected relationship between dimensions of sustainable development, striving for harmony among people, the planet, and profit.

2.1.3. Smart Mobility

According to Lyons (2018), Smart Mobility can be described as the goal of creating attractive and sustainable connectivity in towns and cities. It is a concept driven by the sharing of data. It aims to improve connectivity, efficiency, and sustainability in transportation. The incorporation of ICT into transport infrastructure plays a role in driving advancements in Smart Mobility.

The Smart City concept focuses on improving the quality of life for citizens; an essential aspect of achieving this is addressing mobility within a city. Traditional transportation methods often lead to outcomes like pollution, traffic congestion, long commutes, and high public transportation costs. On the other hand, Smart Mobility aims to tackle these challenges and enhance the well-being of populations (Benevolo et al., 2016).

According to Papa & Lauwers (2015), Smart Mobility can be divided into two dimensions: a technology-driven approach emphasizing infrastructure and a user-centered approach focusing on meeting individual needs. The technology-driven aspect gives prominence to ICT as a tool for establishing mobility to maximize efficiency.

In contrast, the user-centered approach recognizes the importance of involvement. Aims to meet individual requirements. In this perspective, innovative infrastructure, vehicles, and service technologies are seen as facilitators for end users. Consequently,

applications based on user-centered Smart Mobility strive to optimize individuals' mobility patterns through ICT integration (Papa & Lauwers, 2015).

2.1.4. Multimodal Transportation Integration

The concept of multimodal transportation integration is central to improving urban mobility Readiness. Multimodal transportation integrates modes, such as public transit, cycling, walking, and car-sharing, to provide efficient, convenient, and sustainable mobility options (Litman, 2019). This approach reduces congestion and emissions while enhancing accessibility (Tirachini & Hensher, 2018).

Multimodal transportation integration initiatives have been successful in various urban settings. For example, Singapore's comprehensive transportation system incorporates efficient public transit, cycling infrastructure, and congestion pricing measures to promote sustainable urban mobility (Lee et al., 2018). Such case studies offer valuable insights into Ras Al Khaimah's aspirations to enhance its transportation system.

2.2. Mobility types of consumption:

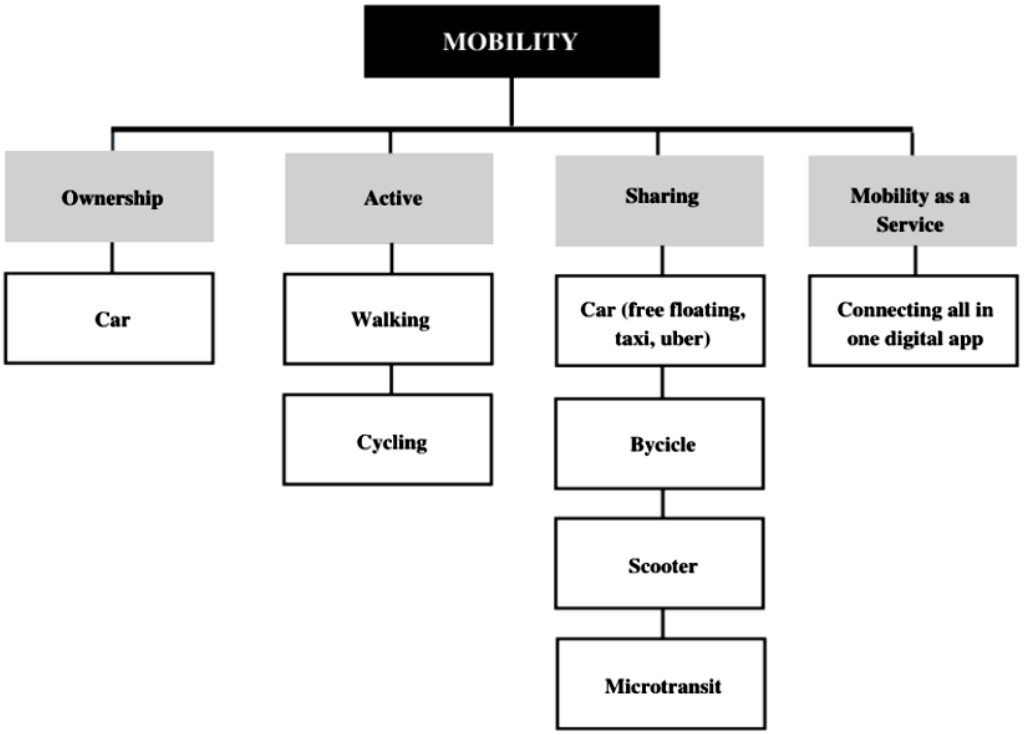
Climate change has led to a surge in green marketing and a rise in sustainable offerings, with mobility being no exception. A crucial element in addressing climate change involves minimizing emissions from the transportation sector. This sector contributes to 23% of global energy-related CO2 emissions, many of which originate from road transport, particularly passenger cars and light-duty trucks (Iyanna et al., 2019).

Traditional modes of commuting, such as walking and cycling, remain under scrutiny in mobility research as a practical means of reducing carbon emissions (Biehl et al., 2019). Additionally, sharing platforms are gaining prominence, transforming consumers' engagement with various transportation options (Sands et al., 2020).

Moreover, the proliferation of emerging mobility alternatives has given rise to Mobility as a Service, designed to cater to customer needs by integrating various transportation modes into a single interface. The objective is to encourage multimodality and public transport usage while combating emissions and traffic congestion (Hoerler et al., 2020).

In summary, mobility can be experienced through ownership, active modes of transportation, sharing, or as a service. Each mode possesses distinct characteristics, and different transportation options may align with specific modes. Figure 2 provides an overview of the mobility consumption in this dissertation.

Figure 2 Types of Mobility Consumption



To obtain a more in-depth understanding of the current advancements in the various methods of engaging with mobility outlined earlier, the following four sections in this literature review will delve into the specific characteristics of each approach.

2.2.1 Car ownership

More than practical considerations drive car ownership, it encompasses emotions and sentiments, as evident in car commercials that often target feelings of independence, power, thrill, social status, high self-esteem, and enjoyment (Steg, 2005). The literature distinguishes between affective and functional motives, with affective motives more associated with men and young drivers. Those emphasizing affective motives find it

challenging to shift to alternative modes of transportation, often changing destinations instead of commuting methods (Zhou & Wang, 2019).

While attitude changes have a limited influence on car use frequency (Kalter et al., 2020), expressing car pride correlates with more frequent use (Moody & Zhao, 2020). Intentions to reduce car usage hinge on perceived behavior control, with those believing they can alter their commuting routine expressing stronger intentions to reduce car usage (Semenescu & Gavreliuc, 2019). The positive effects of car ownership include a sense of ownership, comfort, and independence, while negatives encompass cost, stress, traffic, and responsibility (Burlando et al., 2019). Notably, the cost, often limited to fuel by car owners, contributes to mobility inequalities, favoring privileged groups (Carmo et al., 2017). Urgent investment in public transport is suggested to decrease inequality and position cars as a complementary commuting mode (Carmo et al., 2017).

Car reliance is significantly influenced by social surroundings, including co-workers, family expectations, peer comparisons, and the perception of lower stress with car usage (Steg, 2005). Increased social interactions and activities, the presence of children, and residences farther from the city center contribute to heightened car usage (Arroyo et al., 2020). Geographic location, family organization, and work are critical factors influencing commuting choices, with a high-quality experience with public transport and early exposure decreasing the likelihood of car ownership (Smart & Klein, 2017).

2.2.2 Mobility as a Service (Maas)

The increasing adoption of Mobility as a Service (Maas) in areas is primarily driven by the desire to reduce the impact caused by private cars. However, relying on Maas might not fully achieve this goal because there are transportation options like taxis and car sharing that are not environmentally friendly. This can lead to consequences as individuals who typically prefer eco-mode transportation may switch to less sustainable alternatives (Jang et al., 2020).

The general perception among citizens is that Maas offers an alternative transportation option. Public transport users are more open to embracing Maas than those relying on

cars (Hoerler et al., 2020). This challenges Maas's expectation, which aims to decrease private vehicle ownership (Jang et al., 2020). The study suggests that people would be willing to give up their cars if provided with adaptable alternatives, particularly for leisure activities, where factors like cost, availability, independence, and storage space influence their transportation choices (Hoerler et al., 2020).

When developing MaaS systems, it is crucial to consider user attitudes towards these services as essential aspects, such as service features and pricing, to succeed. The importance of Maas is highlighted by its focus on meeting customer needs and incorporating data on consumer behavior and perceptions into its concept (Hoerler et al., 2020). Furthermore, acknowledging that Maas could be seen as a competitor to transportation, it is suggested that the private and public sectors collaborate. This collaboration would establish frameworks determining pricing structures and setting guidelines for government involvement in ticketing, data sharing, and risk communication (Wilson & Mason, 2020).

2.2.3 Shared mobility

Sharing is an aspect of consumer behaviors beyond barriers related to materialism and possessions. This trend, driven by awareness of justice, environmentalism, and consumer well-being, aligns with the sharing economy concept, which impacts the quality of life and economic transactions (Belk, 2010). The sharing economy has experienced growth thanks to platforms, peer-to-peer transactions, access-based models, and the utilization of underused resources (Huynh et al., 2020).

Shared mobility plays a role in addressing challenges like congestion and limited parking space by promoting shared use of vehicles such as bicycles, scooters, and cars, as well as ridesharing services (Puzio, 2020).

Users perceive shared mobility as sustainable since it contributes to reducing tendencies. Technological advancements have significantly improved user experiences in floating car-sharing systems, leading to their adoption (Becker et al., 2017). The emphasis is placed on shared responsibility for consumption, which motivates users to engage in

shared mobility (Yin et al., 2018). Notably, mobility platforms witness levels of user involvement, with around 74% of users having already utilized shared mobility services in the United States (Sands et al., 2020). However, as people's preferences in the sharing economy in terms of transportation become more critical, there is still an understanding across various categories (Sands et al., 2020).

Factors including quality, trust, perceived usefulness, social value, and environmental impact influence users' satisfaction with shared mobility. Social value plays a role in ridesharing. Emphasizes the importance of building social connections (Arteaga Sánchez et al., 2018). There are conflicting findings about the impact of factors on satisfaction and repeated use of platforms. Some studies suggest that it has an influence (Mohlmann, 2015), while others highlight a motivation for sharing based on environmental concerns (Sands et al., 2020). Some see Shared mobility as a catalyst for bringing about change. It continues to be a complex and evolving aspect of the sharing economy (Burghard & Dutschke, 2019).

2.2.4 Active Mobility

Active forms of transportation, including walking and cycling, are recognized as solutions to address urban issues such as noise and air pollution, traffic congestion, and accidents (Ferretto et al., 2021). These modes of commuting do not improve the well-being of city dwellers. It also creates job opportunities for cycling in urban and surrounding areas (Scotini et al., 2017). Moreover, walking and cycling contribute to enhanced interactions, indicating that investments in pedestrian-cyclist-friendly spaces improve the overall quality of urban life (van den Berg et al., 2017). Existing research supports transportation's impact on physical and mental health (Hess et al., 2017). However, promoting active mobility effectively poses challenges due to varying initiatives at scales influenced by landscapes (Hackl et al., 2019).

Implementing mobility requires behavior change, which entails providing information, services, and incentives, especially for individuals who own private cars, which often hinder active commuting (Markvica et al., 2020). The diverse perceptions among consumers further emphasize the importance of targeted approaches. While some people

see cycling as humanly enhancing their routine, others see it as a hindrance due to the physical effort involved (McKenzie, 2020).

Research shows that there are reasons why people choose not to cycle to work, such as inconvenience and concerns over road safety and weather conditions. On the other hand, factors related to health benefits, cost savings, and time efficiency motivate individuals to choose cycling (Claudy & Peterson, 2014). It is worth noting that young adults often find walking more convenient for distances. Therefore, when promoting mobility among this group, it is essential to highlight the affordability, flexibility, social aspects, and cycling speed (Simons et al., 2014).

2.3. Impact of values on mobility choices

Many authors highlight the effects of Mobility as a Service (Maas) models on transportation. The main arguments supporting this idea revolve around its sustainability benefits, such as reducing traffic congestion and greenhouse gas emissions, improving accessibility, and creating opportunities through innovative business approaches (Sarasini et al., 2017). The definition of Maas itself, described as "a one-stop shop principle that integrates planning and payment for multimodal and sustainable transportation services," emphasizes its commitment to incorporating sustainability considerations (Karlsson et al., 2017, page number). As a result, this section aims to address the question of how Maas can contribute to achieving mobility.

(Karlsson et al. 2017) They categorized the advantages of Maas into three impact areas: social, economic, and environmental impacts, which refer to changes in the environment caused by an organization’s activities, whether negative, such as effects on air quality or land use. Social impacts encompass the effects on people’s economic well-being, often influenced by their experience as users of Maas services.

Economic impacts, in essence, pertain to the consequences of activity within a specific region (Karlsson et al., 2017).

2.3.1 Environmental Impact:

Air Pollution: Urban mobility, mainly using fossil fuel-powered vehicles, contributes significantly to air pollution. This includes emissions of pollutants like nitrogen oxides (NOx) and particulate matter (PM), which have adverse health effects (WHO, 2021).

Transportation plays a role in the emission of greenhouse gases, carbon dioxide (CO2). These emissions impact climate change and its consequences (IPCC, 2018).

2.3.2 Economic Impact:

Traffic congestion in cities leads to losses as it causes travel times and higher fuel consumption. In 2019, congestion costs in the United States were estimated to be around $166 billion (TTI, 2020).

Building and maintaining urban transportation infrastructure requires significant funds (ITF, 2017).

2.3.3 Public Health Impact

Engaging in activities such as walking and cycling within areas can positively impact individuals' health by promoting regular exercise and decreasing the chances of developing chronic illnesses (Sallis et al., 2016).

Conversely, the prevalence of transportation in cities can contribute to a rise in traffic accidents, resulting in injuries and even fatalities (WHO, 2021).

2.3.4 Social Equity Impact:

Lack of dependable transportation can restrict people’s access to employment, education, and healthcare, particularly impacting those with incomes (Litman, 2021). Unequal distribution of the advantages and disadvantages associated with transportation systems can worsen existing inequalities (Noland, 2019).

2.3.5 Urban Planning and Land Use Impact:

Urban sprawl occurs when urban areas heavily rely on cars for transportation, leading to the use of land, longer commute distances, and higher costs for infrastructure (Ewing et al., 2016).

To address this issue and improve mobility while reducing dependence on automobiles, investing in transit and encouraging transit-oriented communities is beneficial (Cervero & Murakami, 2010).

2.3.6 Technological Impact:

The landscape of mobility and transportation systems is transforming due to the progress made in various technologies, like electric vehicles, self-driving cars, and ridesharing platforms (Gwilliam & Vanourek, 2021).

2.3.7 Quality of Life Impact:

Excessive noise caused by traffic can impact the well-being of urban dwellers, as studies have shown (Basner et al., 2014). On the other hand, when urban mobility systems are carefully designed and implemented, they can significantly improve the city's quality of life. This includes reducing traffic congestion, enhancing accessibility, and fostering the creation of areas (ITF, 2017).

2.4. Urban Mobility and Sustainable Urban Development

Urbanization is characterized by expanding cities and urban areas, which brings about several challenges related to transportation, infrastructure, and sustainability (UN, 2018). When it comes to development, the role of urban mobility is crucial. Sustainable urban development, as outlined in the United Nations SDGs Goals, focuses on creating resilient cities (UN, 2015). Addressing the challenges associated with mobility is essential to achieve this objective effectively.

In recent years, attention has been given to urban mobility readiness. This concept encompasses the efficiency and sustainability of transportation systems within cities. It is a basis for advancing sustainable urban development (Munoz et al., 2018).

Sustainable transportation planning has become increasingly important, emphasizing promoting vehicles and creating eco-friendly alternatives. Looking at cities like Amsterdam, which are renowned for their transport strategies, can offer lessons (Harmsen & Slinger, 2016).

2.5. SDG 11 Conceptual Framework

SDG 11 aims to make cities and human settlements inclusive, safe, resilient, and sustainable. Achieving this goal requires addressing various challenges related to urbanization, transportation, and environmental impact. Integrating sustainable mobility, smart mobility, and multimodal transit can play a crucial role in advancing SDG 11; the following shows how sustainable transportation can help achieve SDG 11.

2.6.1. Sustainable Mobility

Sustainable mobility focuses on providing transport solutions that minimize environmental impact, reduce congestion, and enhance accessibility. Transitioning to low-emission vehicles, such as electric cars and bikes, and promoting public transportation are vital. According to the (IEA), sustainable mobility reduces greenhouse gas emissions and air pollution (IEA, 2018).

2.6.2. Smart Mobility

Innovative mobility leverages technology to enhance the efficiency and effectiveness of transportation systems. This involves data, connectivity, and automation to optimize traffic flow, reduce travel time, and improve safety. Innovative mobility solutions, such as intelligent traffic management and real-time transportation information, contribute to more sustainable and resilient cities (UN DESA, 2019).

2.6.3. Multimodal Transportation Integration

Multimodal transportation integrates various modes of transport (e.g., walking, cycling, public transit) to create a seamless and efficient network. This approach encourages people to use multiple modes of transportation for their journeys. The World Bank emphasizes that multimodal transportation can enhance accessibility, reduce congestion, and improve urban mobility (World Bank, 2018).

2.6.4. Reducing Environmental Impact

Sustainable and intelligent mobility solutions contribute to reducing the environmental impact of transportation. Electric vehicles, for instance, decrease air pollution and reliance on fossil fuels. The Global Commission on the Economy and Climate highlights the importance of sustainable transportation in achieving both environmental and economic benefits (GCEC, 2018).

2.6.5. Enhancing Accessibility and Social Inclusion

Integrating multimodal transportation enhances accessibility for all members of society, including people with disabilities. This aligns with the inclusive nature of SDG 11. The United Nations Human Settlements Program (UN-Habitat) emphasizes the role of accessible transportation in promoting social inclusion and reducing inequality (UN-Habitat, 2020).

2.7. Chapter Summary

Different organizations have interpretations of development. The World Commission on Environment and Development (WCED, 1987) defines it as ensuring that our current actions do not compromise the needs of generations. The United Nations emphasizes integrating social and environmental aspects to meet needs while safeguarding the future (UN, 2015). The World Bank focuses on development as a path that brings benefits across dimensions without harming Earth's life-supporting systems (World Bank, 2020). On the other hand, the IUCN sees development as enhancing human life while respecting ecosystem capacity (IUCN, 2021).

Mobility involves eco-friendly transportation options that address environmental, social, and economic concerns (WHO, 2017). Scholars divide mobility into pillars highlighting responsibility, social inclusivity, and economic prosperity (Banister, 2007). In the context of mobility (Lyons, 2018) defines it as creating connectivity through data sharing driven by information and communication technology.

To ensure urban mobility readiness in cities, integrating modes of transportation such as transit, cycling, walking, and car sharing has become a key strategy (Litman, 2019).

Different mobility options, influenced by climate change concerns, can range from methods to alternatives like Mobility as a Service (Maas) (Iyanna et al., 2019). The decision to own a car is often influenced by emotional reasons, financial considerations, and individual preferences (Steg, 2005).

Maas, shared mobility services, active mobility (such as walking and cycling), and car ownership represent approaches to transportation, each with its distinct features. Shared mobility addresses traffic congestion and limited parking space issues, while active mobility promotes health and enhances the quality of life. Both considerations and emotional factors drive car ownership, whereas Maas aims to reduce the impact of cars. Understanding these approaches is crucial for developing solutions for urban transportation.

When examining the influence of values on transportation choices, Maas stands out due to its sustainability benefits, which include reducing air pollution and traffic congestion while improving well-being (Karlsson et al., 2017). The impact of transportation encompasses aspects such as environmental effects, economic implications, public health outcomes, and social equity considerations in city planning processes along with technological advancements (WHO, 2021).

In creating cities, it is essential to consider transportation readiness. By focusing on transportation planning and infrastructure development, we can address the challenges associated with mobility effectively (UN, 2015).

In conclusion, sustainable development and urban mobility can be understood differently depending on one’s perspective. It is crucial to grasp the intricacies of mobility approaches, recognize how personal values influence transportation choices, and understand urban mobility's impacts on our cities. Can we develop comprehensive and successful solutions for achieving sustainable urban development?

Chapter 3: Research Methodology

Methodology

3.1. Conceptual Framework

This research is grounded in a qualitative methodology designed to explore the complex and multifaceted aspects of urban mobility, with a particular focus on Ras Al Khaimah. The primary research question guiding this study is: "What is the optimal urban development policy to achieve sustainability in Ras Al Khaimah?" To answer this question, the Urban Mobility Index Indicator (UMII) framework has been used as a conceptual foundation. The UMII framework, with its three pillars Readiness, Implementation, and Livability provides a comprehensive structure for evaluating urban mobility across various cities and contexts. Additionally, the Urban Mobility Report for the Middle East was used for comparison with urban mobility systems in the region.

The qualitative nature of this research is particularly well-suited to the exploratory and comparative goals of the study. By focusing on in-depth analysis of case studies, literature, and data from local and international sources, the study aims to generate insights that are both contextually relevant and theoretically grounded. The choice of a qualitative approach allows for a nuanced understanding of urban mobility in Ras Al Khaimah, considering both physical (infrastructure, systems) and non-physical (policies, public attitudes) aspects of sustainability.

3.2. Literature Review

The research builds on the comprehensive literature review, as reported on in chapter 2. It established the current state of knowledge relating to urban mobility. This included definitions, historical developments, purposes, and the core dimensions of urban mobility. The literature review also identified global best practices by analyzing cities around the world, providing a basis for comparison and contextual understanding.

3.3. Case Study Analysis

The study employs case studies of cities that have achieved high rankings in the Mobility Readiness Index, summarized below in figure 3, focusing on three levels:

- Local Level: Analysis of Dubai and Abu Dhabi to understand regional context and challenges.
- Regional Level: Study of Doha and Amman to compare Ras Al Khaimah with another Gulf and Arab city.
- International Level: Examination of Singapore and London as global models of urban mobility.

Comparative analysis is conducted using the UMII framework and the Urban Mobility Report for the MENA region published by the UITP. The UMII framework is used to systematically assess and compare Ras Al Khaimah (RAK) with the cities studied in the case analyses. This includes comparing urban mobility in Ras Al Khaimah with that in Abu Dhabi, Dubai, Amman, Doha, Singapore, and London, focusing on key components such as Readiness, Implementation, and Livability. The framework ensures consistency in comparisons, allowing for a structured analysis that moves from a broad perspective to a focused one.

At the regional level, the comparison process involved using the Urban Mobility Report for the Middle East and North Africa region published by UITP, which provides a macro-level analysis of the region's performance in public transport and new mobility services.

Subsequently, the research sought to find a global city comparable to Ras Al Khaimah for direct comparison and selected Boulder, Colorado, USA, due to similarities in geographic and demographic characteristics between Ras Al Khaimah and Boulder. The study and direct comparison between these two cities focused on six criteria: safety, equity, accessibility, reliability, technology, affordability, and effectiveness, as well as comparing mobility strategies. The primary goal of this comparison was to identify areas where Ras Al Khaimah could improve by learning from Boulder's experiences in urban mobility.

3.4. Key Findings and Recommendations

The study then analyzes the most significant findings and provided a comprehensive summary of the key points and comparison results, which is used to form the foundation for recommendations to develop the urban mobility system in Ras Al Khaimah. These recommendations include:

- Identifying proposed projects to enhance urban mobility in the emirate, consisting of three main projects.
- Proposing policies to be implemented to support sustainable mobility in Ras Al Khaimah.

3.5. Systematic Review and Scenario Planning

To identify the most feasible options for sustainable transportation in Ras Al Khaimah, a systematic review of international case studies and policy documents was conducted. The aim was to use the outcomes and findings to conduct scenario planning to model the potential outcomes of different sustainable transportation options in Ras Al Khaimah and generate contextually relevant and applicable insights and recommendations.

3.6. Data Collection and Evidence Methodology

This research primarily relies on evidence derived from multiple sources, including academic literature, government reports, case studies, and direct observations. The data collection process includes:

Validity: The use of the UMII framework and the Mobility Readiness Index provided a strong, widely recognized basis for comparison, enhancing the validity of the results.

Reliability: Consistency in applying the UMII framework across all levels of comparison (local, regional, international) ensured that the results were reliable and replicable by other researchers.

3.7. Ethical Considerations

Ethical considerations were integral to the research process. Potential issues related to data privacy, information accuracy, and case study representation were handled with care. The research adhered to ethical guidelines by ensuring the confidentiality of sensitive data, obtaining necessary permissions for data use, and providing accurate and unbiased interpretations of the results.

Conclusion

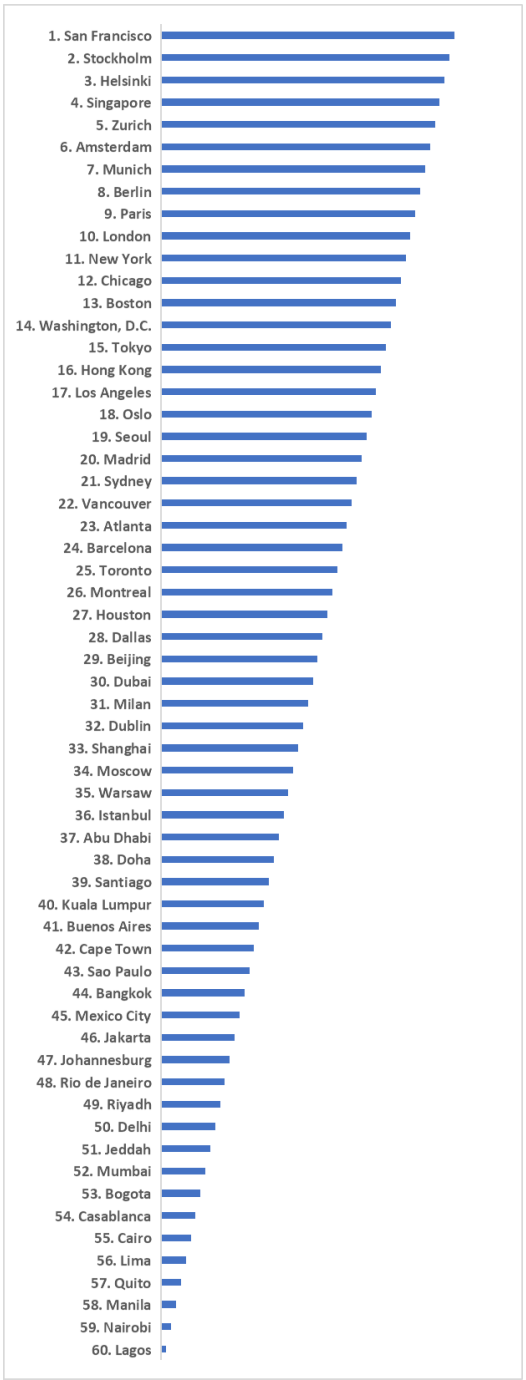
The selected methodology, supported by case studies, systematic review, and scenario planning, is well-suited to answer the research question. By systematically assessing urban mobility in Ras Al Khaimah against global and regional best practices, and directly comparing it with a similar city, the study provides a comprehensive and actionable set of recommendations for improving sustainable urban mobility in Ras Al Khaimah. The methodology not only addresses the research questions but also offers a model that can be replicated in future studies on urban mobility.

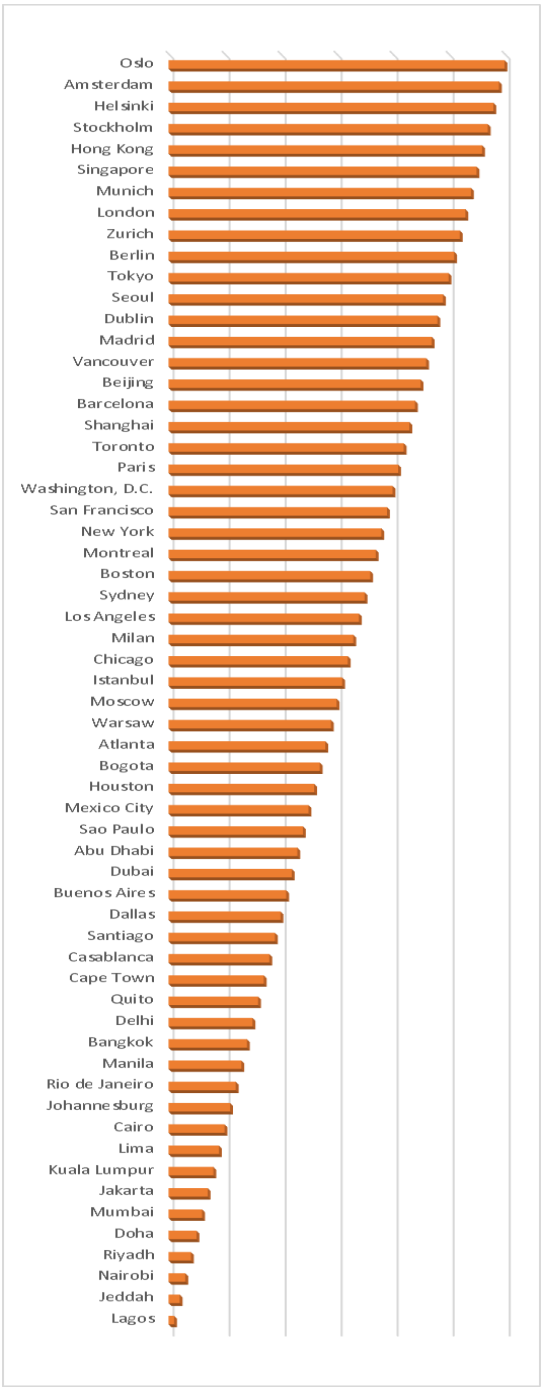
The comparative analysis also created an opportunity to develop a broader framework and perspective on best practices in urban mobility, which was crucial in addressing the primary research question: "What is the optimal urban development policy to achieve sustainability in Ras Al Khaimah?"

The assessment of the current state of transportation in Ras Al Khaimah, and its comparison with those of similar cities in the Middle East and internationally, provided valuable insights into strengths and weaknesses, particularly in areas such as traffic congestion, air quality, and accessibility, which are critical for identifying areas that need improvement.

The research also addressed the key benefits and challenges of sustainable transportation in Ras Al Khaimah by studying academic literature, government reports, and case studies, revealing potential benefits such as reduced emissions and enhanced public health, while also considering challenges like high costs and infrastructure limitations.

Figure 3 The top cities score highly in a diverse set of metrics, underscoring the importance of a well-rounded playbook.





Source: The 2022 Urban Mobility Readiness Index, Oliver Wyman

Chapter 4: Discussion

In this chapter, I will examine and delineate an innovative transportation model utilizing three global indicators commonly employed by significant cities to distinguish themselves. The objective is to facilitate a comprehensive comparison, generating insights that address the research questions. Initially, the Urban Mobility Readiness Index 2022 by Oliver Wyman will serve as a primary reference. This index encompasses four dimensions (Connectivity, Public Transit, Electrification, and Automation).

Additionally, the Urban Mobility Innovation Index 2021 (UMII) Framework, which includes three dimensions: Readiness, Deployment, and Livability, will be employed. Insights from the UITP Urban Mobility Report 2020 will also be incorporated for international benchmarking. This entails evaluating transportation system indicators across selected cities worldwide, such as fleets, lengths, transportation modes, ridership, and fares. The goal is to spotlight regional progress and establish potential benchmarks. A comprehensive analysis will be undertaken, comparing RAK City with Boulder, Colorado, chosen for its similar geographical and population characteristics.

4.1. Introduction to the Emirate of RAS Al Khaimah:

Ras Al Khaimah, a region of the Arabian Peninsula overlooking the Arabian Gulf, became a part of the UAE on February 10, 1972. Its coastline stretches for 64 kilometers, and it is the emirate in terms of land area. RAK covers around 1,684 kilometers and 2.17% of the UAE's total land area. The population of this emirate is 400,000 residents. It has a strong GDP, reaching nearly USD 11 billion. This translates to a per capita GDP of USD 28,500. RAK is well known for its enduring social stability, which leads to policy-making and ambitious growth initiatives.

Located strategically within a four-hour flight from one-third of the world’s population, RAK attracts investment with its appealing features. It offers policies such as allowing 100% ownership, profit repatriation, zero income, and corporate taxation.

In addition to its strength, RAK is famous as the emirate in the UAE and is recognized for its diverse landscape, including beautiful beaches, deserts, and rugged mountains. With

a history of over 7,000 years, it boasts sites seeking UNESCO World Heritage recognition.

RAKs Jebel Jais Mountain is remarkable, offering attractions such as the world's most extensive zip line that stretches almost 3km. You will also find a restaurant in the UAE called 1484 by Puro. Interestingly, in 2021, it was named the Gulf Tourism Capital for the year and received safety certifications.

At the meeting point of Europe, Asia, and Africa, RAK is a hub for businesses aiming to expand their presence in the Middle East and Africa. The economy of RAK is characterized by diversification, with no single sector contributing more than 26% to its GDP. It consistently receives ratings from international agencies like Fitch and Standard & Poor's. Moreover, RAK boasts a community of over 38,000 businesses representing 100 countries across industries. The Emirate features free zones to attract foreign investments and offers an exceptional quality of life, competitive housing costs, and modern infrastructure. It boasts world-class healthcare services and educational institutions, including internationally renowned universities.

4.2. Introduction: Urban Mobility Readiness Index

The Urban Mobility Readiness Index report is a comprehensive evaluation of 60 global cities conducted by the Oliver Wyman Forum and the University of California, Berkeley. This index assesses cities' preparedness for the next phase in mobility, covering crucial dimensions such as Connectivity, Public Transit, Electrification, and Automation. The newly introduced Public Transit sub-index is of particular significance, gauging how effectively cities manage their public transit systems and how much commuters rely on them.

Public transit emerges as a pivotal aspect, being the most environmentally friendly means of facilitating large-scale movement and instrumental in attracting a workforce and sustaining vibrant city centers. The report delves into each city and region, providing insightful commentary on their strengths and challenges across these dimensions.

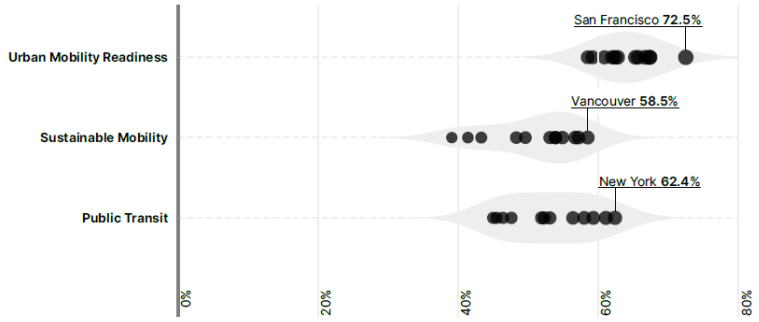
Furthermore, the report encompasses three key indices: the Urban Mobility Index, Sustainable Mobility Sub-Index, and Public Transit Sub-Index. These indices collectively represent the perspectives of businesses, consumers, and policymakers, outlining essential criteria for urban mobility success. The five critical dimensions—Social Impact, Infrastructure, Market Attractiveness, System Efficiency, and Innovation—are integral to fostering a robust and thriving mobility ecosystem. In navigating these dimensions, cities stand poised to shape a winning urban mobility landscape.

Within this section and in alignment with the findings of the Urban Mobility Readiness Index report for 2022, I will assess the preparedness for urban mobility across three regions. This analysis will draw comparisons based on insights from the report's examination. The regions I considered are North America, Europe, the Middle East, and Africa.

4.2.1. **North American cities**

Infrastructure and operational efficiency are the key drivers behind the success of North American cities. San Francisco leads the 2022 Urban Mobility Readiness Index by excelling in market attractiveness, a feat attributed to a robust network of academics and entrepreneurs embracing cutting-edge technology. Situated near Silicon Valley, Stanford University, the University of California at Berkeley, and the Lawrence Berkeley National Laboratory, the city has embraced emerging technologies, with a notable focus on autonomous driving systems. Figure 4 shows the distribution of scores for the three highest towns in North America: urban mobility readiness, sustainable mobility, and public transit.

Figure 4 Distribution of North American cities' scores in

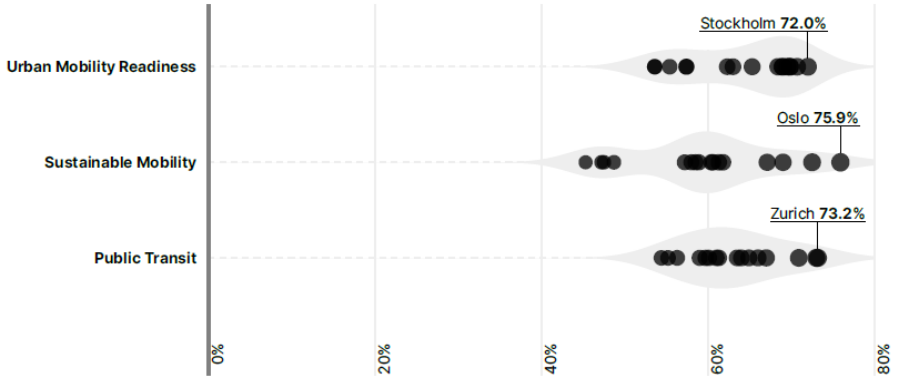


Source: The 2022 Urban Mobility Readiness Index, Oliver Wyman

4.2.2. Europe cities

The European cities dominate the upper ranks of the 2022 Urban Mobility Readiness Index, showcasing highly sustainable mobility networks driven by extensive public transit usage and widespread adoption of electric vehicles, especially notable in Scandinavian cities. Stockholm, Helsinki, and Oslo securing the top spot for Sustainable Mobility, have made substantial investments in charging infrastructure. They have also implemented ambitious consumer incentives to promote electric vehicle usage, leading to a notable increase in the region's market share. The success of Oslo's incentives has been so impactful that public authorities are contemplating gradually phasing them out. Figure 5 shows the distribution of scores for the three highest cities in Europe: urban mobility readiness, sustainable mobility, and public transit.

Figure 5 Distribution of Europe cities' scores in percentage.



Source: The 2022 Urban Mobility Readiness Index, Oliver Wyman

4.2.3. Middle East and Africa

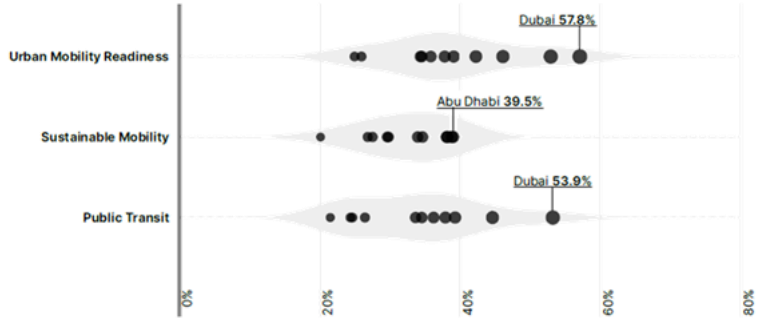
While in the Middle East, many cities are going through a development period. African towns still have some catching up to do regarding mobility. However, some cities, like Dubai, Doha, Riyadh, and Jeddah, are progressing in the Urban Mobility Readiness Index. This is mainly because they have invested a lot in mass transit infrastructure.

Dubai's local authorities are actively working towards establishing a public transportation system that can compete with global cities. They are also investing in transportation options such as a

fully automated metro and trials for urban air mobility. A mass transit system in Riyadh is being constructed and is expected to start operating in 2023. This system has the potential to increase significantly the usage of transportation and support the region's growth.

Despite these investments, cars still dominate transportation in the Middle East, leading to the usage of non-motorized forms of transport. However, one positive aspect is that shared mobility services have gained popularity in the region and have helped reduce congestion levels. Figure 6 shows the distribution of scores for the three highest cities in the Middle East and Africa, which include urban mobility readiness, sustainable mobility, and public transit.

Figure 6 Distribution of Middle East and Africa cities' scores in percentage



Source: The 2022 Urban Mobility Readiness Index, Oliver Wyman

4.2.4. The Summary

North American cities, notably San Francisco, excel in urban mobility readiness due to solid infrastructure and operational efficiency driven by cutting-edge technology like autonomous driving systems. European cities, particularly Scandinavian ones, lead in sustainable mobility with extensive public transit usage and widespread adoption of electric vehicles.

In the Middle East, cities such as Dubai, Doha, Riyadh, and Jeddah are progressing in the Urban Mobility Readiness Index, investing significantly in mass transit infrastructure, including automated metro systems and urban air mobility trials. Despite car dominance, shared mobility services are gaining popularity, reducing congestion.

African cities are in a developmental phase, while the global urban mobility landscape reflects diverse strategies and challenges across regions, emphasizing the importance of tailored approaches to enhance transportation systems and sustainability.

In the context of Dubai as one of the local Emirates in UAE, the city demonstrates a commitment to innovative mobility solutions, earning it the 30th position in the Urban Mobility Readiness Index, 39th in Sustainable Mobility, and 29th in public transit. The city's focus on new projects like urban air mobility and scooter-sharing contributed to these rankings. Despite investments in a multimodal app and automated metro operations aiming for net-zero emissions by 2050, car ownership remains popular due to the city's expansive geography. Challenges include limited bike lanes, car-free zones, and residents' reluctance to adopt cycling or walking, partly due to high summer temperatures.

4.3. What is the UMII Framework

According to UMII (2021), The framework initiated by Dubai (RTA) in 2015 and led by UITP employs a multidisciplinary framework to explore how cities globally foster innovation to tackle urban transport challenges. The primary goals of UMII are to share knowledge, gather insights, and inspire city administrations to lead mobility innovations for better, safer, healthier, quieter, cleaner, and happier cities. The report emphasizes the following key points:

4.3.1. Framework Goals:

1. Share knowledge and gather insights into global urban transport innovation.
2. Inspire and energize city administrations to learn, experiment, implement, and lead mobility innovations.
3. Contribute to transforming mobility systems towards sustainability and citizen-centric solutions.

Enablers of Innovation:

1. Experimentation is a crucial approach to facilitating the adoption of new solutions.

2. Living Labs and pilot projects as methods for multi-stakeholder design and experimentation.
3. Innovations include a wide range of solutions, not limited to technological advancements, encompassing mobility modes, services, infrastructures, data utilization, planning processes, and regulatory or institutional enablers.

4.3.2. Contextual Nature of Innovations:

1. Innovations should address real-life problems in their societal context.
2. The report emphasizes that innovations need not be universally applicable, acknowledging the contextual nature of solutions.
3. Anticipation of regulatory needs and citizen acceptance is crucial, with a focus on integrating market-driven innovations into existing systems.

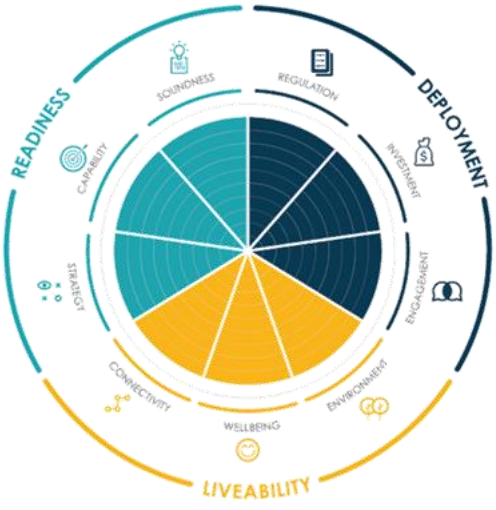
4.3.3. Report Focus:

1. Highlights lessons from innovative cities worldwide.
2. Provides evidence on how mobility innovations can serve as transformative steps towards an inclusive, sustainable, and resilient future vision of mobility.

4.4. The UMII Framework Pillars:

In line with findings from the 2021 UMII report, the realm of urban mobility is undergoing significant transformation, with the UMII framework pinpointing three key trends that set apart leading cities within this dynamic context. Figure 7 shows the main pillars of the UMII framework:

Figure 7 showing the main pillars of UMII



Source: UMII report 2021

4.4.1. **Readiness:** According to the UMII framework, readiness includes three main pillars: Strategy, Soundness, and Capability.

4.4.1.1. **Strategy:** The analysis focuses on how various stakeholders in a city perceive innovation in urban mobility. It delves into the driving forces behind the strategy, the collaborative process to achieve a shared vision, and the ownership of the strategy. Additionally, it examines whether the strategy is translated into specific actions. The assessment utilizes indicators to explore aspects such as the city's approach to innovation in mobility, stakeholder engagement in strategy development, the presence of a vision with informed goals and objectives, integration of innovation for emergency scenarios or resilience in the transport system, and the methods for implementation and monitoring of the strategy (UMII, 2021).

4.4.1.2. **Soundness:** The concept of soundness focuses on the importance of data in driving innovation. It explores how a city utilizes data to shape its strategies and promotes the collection, processing, and sharing of data to advance mobility solutions. Key factors to consider are the types of data collected and how it is collected, stored, processed, and utilized in alignment with the city’s strategy. Moreover, it is essential to evaluate whether the city encourages external stakeholders to use this data through its strategy (UMII, 2021).

4.4.1.3. **Capability:** The assessment of Capability in urban development focuses on how a city enhances its internal capacity for innovation and utilizes the skills of external stakeholders. This involves evaluating the maturity of the open innovation ecosystem. The indicators for this include determining if a specific department, team, or role is responsible for advancing the future mobility innovation strategy within the city. It also examines how the strategy owner involves external stakeholders to acquire the necessary skills for implementing the mobility innovation strategy. Additionally, the evaluation

considers whether the city possesses the capabilities required to test and pilot innovative ideas through a 'Living Lab' platform (UMII, 2021).

4.4.2. **Deployment:** According to the UMII framework, deployment includes three main pillars: Regulation, Investment, and Community Engagement.

4.4.2.1. **Regulation**: Within the city, it is scrutinized to understand the obstacles hindering introducing innovation and the extent to which existing powers are utilized to address these challenges. This level also evaluates how alterations in the regulatory environment impact the emergence of new business models. It encompasses indicators assessing key aspects, such as identifying and overcoming regulatory, policy, or legislative barriers to innovation in urban mobility. Additionally, it examines examples of innovative mobility projects that initially faced challenges related to regulation, policy, or legislation and explores how these challenges were surmounted.

4.4.2.2. **Investment**: The evaluation of urban mobility assesses cities' financial commitment to support R&D projects and their willingness to take risks in innovation investments. It also examines the incentives to encourage third-party innovation and how the city maximizes investment to amplify available funds. The indicators within this lever evaluate specific features, including allocating a dedicated budget for urban innovation activities, providing financial incentives for third-party innovation, and the city's strategies for attracting funding for innovative mobility projects.

4.4.2.3. **Community Engagement**: Engagement in environments explores how cities interact with individuals, such as residents, commuters, tourists, and businesses. It centers around incorporating feedback from these users to make decisions to enhance services and promote innovation. This approach uses measures to assess factors like how city authorities engage with citizens and businesses to facilitate communication with stakeholders and leverage information provided by citizens to shape strategies, innovative initiatives, and future decision-making processes.

4.4.3. **Livability:** According to the UMII framework, livability includes three main pillars: Connectivity, Well-being, and Environment.

4.4.3.1. **Connectivity**: assesses the quality of a journey in the transportation system. It considers how well different modes of transportation are integrated, how easy it is to switch between them, and how simple it is to navigate both digitally. This evaluation covers factors, including integrating mobility services across the city, implementing ticketing systems for various modes of transport, and the level of intermodal integration in the town.

4.4.3.2. **Well-being**: The city's well-being assessment involves examining the accessibility and sustainability of mobility options, considering users' travel patterns. It encompasses factors such as road safety, transport system equity, and accessibility as indicators of overall happiness. Key considerations include evaluating the safety, affordability, and accessibility of the transport system, inclusivity of various mobility services, availability of innovative tools for female users' safety, and the modal split of commuters using alternative mobility services.

4.4.3.3. **Environment**: When assessing a city's performance, we primarily look at three factors: air pollution, noise levels, and the availability of natural spaces. This evaluation considers the city's use of technology to improve air quality, its measures to reduce noise pollution, and monitoring and communication with residents regarding noise issues. Furthermore, we also consider the extent of natural areas within the city.

4.5. The Analysis:

4.5.1. London City:

Transport for London (TFL) serves as the integrated transport authority for Greater London, aligning with the mayor's 2018 strategy. The extensive 300-page plan prioritizes the Healthy Streets Approach, emphasizing health and personal experience in city planning. Key goals include reducing car dependency, promoting active travel, achieving 'Vision Zero' for road safety, integrating suburban rail, and adhering to Good Growth principles for urban regeneration and development. The strategy envisions 80% of trips

being sustainable by 2041, fostering healthier lifestyles and inclusive designs. Table 1 shows London City's performance assessment per the UMII framework.

Table 1 shows London City's performance assessment per the UMII framework.

Dimensions	Pillars	Assessment result
Readiness	Strategy	London's Cycling Action Plan aims to be a global cycling leader, prioritizing an inclusive environment. However, current cycling rates and child-focused goals lag. Future iterations may enhance resilience against flash flooding in transport systems.
	Soundness	TfL has pursued a data-driven approach over the past two decades, emphasizing collection, interoperability, and sharing. It integrates data considerations into procurement, aiming for customer benefits, operational efficiency, and system resilience. Real-time data facilitates traveler redirection during network failures, and TfL encourages open data standards when feasible.
Deployment	Regulation	TfL actively engages with decision-makers to overcome legislative barriers to innovation. Their strategy involves early engagement, route development, and evidence creation. Successes include e-scooter and HGV legislation yet navigating land use with 32 boroughs poses scaling challenges.
	Community Engagement	TfL prioritizes early and open stakeholder engagement during design to prevent unintended consequences. Clear communication addresses concerns and ensures innovation aligns with Londoners' needs.
Livability	Environment	TfL prioritized pedestrian and cyclist space. I was making these changes permanently and needed formal consultations with residents.
	Well-being	London's dense population poses challenges in addressing disadvantaged groups' needs and ensuring safety. Despite efforts, environmental indicators like pollution remain low.

Source: UMII report 2021

4.5.2. Singapore City:

The Land Transport Authority (LTA) of Singapore is responsible for overseeing the land transport infrastructure in the city-state with a focus on creating a transportation system that prioritizes the needs of its people. The Land Transport Master Plan has set forth a vision for the future, aiming to create a city where all amenities within a 45-minute

commute and neighborhoods are easily accessible within 20 minutes. Furthermore, there is an emphasis on adopting energy sources by 2040 alongside leveraging technology to improve public transportation and ensure a transportation system that is safe and inclusive and promotes the overall well-being of its residents. Table 2 shows Singapore City's performance assessment per the UMII framework.

Table 2 shows Singapore City's performance assessment per the UMII framework.

Dimensions	Pillars	Assessment result
Readiness	Capability	In Singapore's transport/innovation department, women constituted 24.5% in 2020, revealing gender inequality. Balancing genders can enhance the 'Transport for All' vision, fostering inclusive mobility.
	Soundness	Singapore's Land Transport Data Mall offers public access to diverse datasets, fostering over 100 apps through open data and encouraging innovation and inclusivity.
Deployment	Regulation	Singapore's LTA adopts a holistic approach to innovation, collaborating with regulators and policymakers, allocating a dedicated budget, and encouraging public input.
Livability	Well-being	Singapore ensures excellent public transport accessibility for physically impaired individuals, utilizing visual and audio technologies, offering emergency assistance points, and Demand Responsive Transport.

Source: UMII Report 2021

4.5.3. Amman City:

Amman is currently facing a problem with its transportation system, which heavily relies on cars and road networks. To overcome this challenge, the city has adopted a Smart City approach incorporating technologies like artificial intelligence and significant data innovation to address urban planning issues. Amman's Smart City initiative aims to improve residents' quality of life by applying practical technology solutions. Smart Mobility is a critical aspect of the Smart City roadmap, one of the directions outlined in the strategy developed in February

2021. The following Table 3 shows the assessment of Amman city performance as per the UMII framework:

Table 3 shows the assessment of Amman city performance as per UMII framework.

Dimensions	Pillars	Assessment result
Readiness	Strategy	Amman tackles urban mobility challenges with a Smart City strategy, emphasizing AI and big data for practical urban planning solutions since 2021.
	Soundness	Amman lacks public data access and integrated platforms. An open data policy can foster transparency, encouraging collaboration among city stakeholders.
Deployment	Regulation	Amman Smart City strategy identifies regulatory gaps. Recommendations include addressing hindrances to mobility projects, fostering innovative services, and updating regulations.
Livability	Environment	Amman sees a rise in hybrid/electric vehicle adoption, fueled by appealing incentives like tax exemptions. The government and GAM prioritize electric fleets.
	Well-being	Amman's transit lacks accessibility for vulnerable groups. Terminal conditions, lengthy waits, and insufficient information pose safety risks, especially for women. Introduce services and tools for improved inclusivity and safety.

Source: UMII report 2021

4.5.4. Dubai City:

The Roads and Transport Authority (RTA) manages transportation, infrastructure, and traffic in Dubai and the UAE. They aim to become a leading provider of sustainable mobility by developing and overseeing top-notch integrated transportation systems. By prioritizing innovation, the RTA supports Dubai’s vision through policies embracing technological advancements and playing a role in shaping the future of transportation. Table 4 shows Dubai City's performance assessment per the UMII framework.

Table 4 shows Dubai City's performance assessment per the UMII framework.

Dimensions	Pillars	Assessment result
Readiness	Capability	RTA created the Knowledge and Innovation Department to oversee innovation, fostering a culture and tools aligned with stakeholders' needs.

	Soundness	Dubai relies on diverse data, accessible through Dubai Pulse, for strategic decisions. While static transport datasets exist, incorporating real-time data and user feedback enhances innovation possibilities.
Deployment	Investment	Dubai allocates a specific budget for urban innovation, spanning projects like efficient lighting, the Dubai Intelligent Traffic Systems Centre, and more. Engaging citizens, academia, and industry experts is crucial. The city addresses female travelers' safety with dedicated metro carriages. The Urban Mobility Innovation Index 2021 highlights Dubai's Autonomous Strategy and Zero Emission Plan, managing innovation project risks through collaboration, research, and testing.
	Community Engagement	Actively involve users through diverse channels like social media, consultations, focus groups, and surveys, leveraging innovative digital platforms for enhanced engagement and informed decision-making.
Livability	Environment	Efforts to shift from traditional to electric vehicles in Dubai encompass public and private transportation. Active mobility may enhance sustainable transit, but defined strategies are needed.
	Well-being	Dubai's Public transport infrastructure is built per the Universal Design Code (DUDC) for disability accessibility. Pre-DUDC facilities have been upgraded. RTA offers disability services and gender-specific transport provisions.

Source: UMII report 2021

4.5.5. Boulder City

Boulder, Colorado, is often used as a point of comparison because it shares similarities with Ras Al Khaimah (RAK). Located near the Rocky Mountains, 25 miles northwest of Denver, Boulder is known for its natural beauty, including the famous Flatirons rock formations. The city has a blend of areas, residential neighbourhoods, and beautiful green spaces. As far as I know, Boulder has a population of 100,000 who are well-educated and deeply committed to the environment. Regarding transportation, Boulder has implemented initiatives to promote sustainability and alternative modes of travel. They have created a bicycling environment with a network of paths and offer public transit

services through the Regional Transportation District (RTD). Additionally, they encourage car-sharing and ride-sharing platforms as part of their commitment to reducing emissions. Boulder also promotes transportation by promoting vehicles and investing in renewable energy sources. The city focuses on creating mixed-use areas easily accessible by transportation, walking, or cycling. Furthermore, Boulder actively involves its community in transportation planning to ensure that policies align with needs and preferences. Table 5 shows the assessment of Boulder City's performance per the UMII framework.

Table 5 shows the assessment of Boulder City's performance per the UMII framework.

Dimensions	Pillars	Assessment result
Readiness	Strategy	The Boulder Comprehensive Plan (BVCP) aims to embody community values in transportation, considering it as an essential public asset aligned with citywide initiatives. Critical BVCP values for transportation include sustainability as a guiding principle for environmental, economic, and social objectives, robust city and county collaboration, fostering excellent neighborhoods and public spaces, environmental stewardship, and climate action. Additionally, emphasis is placed on cultivating a vibrant economy rooted in Boulder's quality of life and economic strengths. The plan advocates for an all-mode transportation system, prioritizing easy and accessible non-car options for everyone, and underscores the importance of physical health, safety, and overall well-being.
	Soundness	The city is targeting the (BVCP) to improve data and transparency.
Deployment	Regulation	The city has policies and regulations defining locations to support mixed land uses and developing highly connected mobility hubs, especially on the east side of Boulder. In addition, it has a comprehensive urban transportation strategy.
	Investment	The city prioritizes transportation investments, recognizing that investments that achieve multiple priorities maximize community benefit. High Priority – Travel safety for people using all modes, such as Vision Zero improvements; system maintenance, such as street and bridge repair; system operations, such as signal enhancements. • Medium priority – System efficiency and optimization, such as enhancement of pedestrian, bicycle, and transit systems; electric vehicle charging infrastructure and electrification of fleets; neighborhood speed

		management, and person-carrying capacity improvements (rather than adding capacity for cars). • Lower Priority – Quality of life improvements, such as sound walls.
Livability	Environment	The city continues the development of a complete and equitable all-mode transportation system accommodating all users, including people with mobility impairments, youth, older adults, non-English speakers, and low-income persons. The city will implement the Low-Stress Walk and Bike Network to create safe and comfortable travel. Environment for all users.
	Well-being	The city will expand and manage parking districts. On SUMP principles (shared, unbundled, managed, and paid) to support transportation, GHG reduction, and broader sustainability goals, including economic vitality and neighborhood livability.

Source: BOULDER Transportation Master Plan 2019

4.5.6. RAK City

The Ras Al Khaimah Transport Authority (RAKTA) is a pivotal organization overseeing transportation in the emirate. Responsible for implementing policies, regulations, and initiatives, RAKTA ensures efficient and integrated transportation systems. Focusing on modernization and sustainability contributes to developing and enhancing Ras Al Khaimah's transportation infrastructure. Table 6 shows the assessment of RAK city performance as per the UMII framework.

Table 6 shows the assessment of RAK city performance as per the UMII framework.

Dimensions	Pillars	Assessment result
Readiness	Strategy	The Ras Al Khaimah Transport Authority has developed its general strategy for 2023-2027 to support its directions to enhance the transportation system. It has also expanded its strategy for green transportation and its Vision 2040, which emanates from the Ras Al Khaimah government's Strategy 2030.
	Soundness	Rakta adopted its digital transformation strategy, which included intelligent and digital transformation in all its AI-based services. The authority was also one of the first entities in the Emirates to turn to cloud storage to facilitate data access.
Deployment	Regulation	Rakta has developed many internal policies and regulations that promote and encourage mass

		transportation and guidelines for developing and enhancing transportation infrastructure, including its comprehensive transportation plan for 2023-2030.
	Investment	The RAK focused its comprehensive transportation plan on developing different scenarios for investment and financing to implement reforms and projects to enhance the transportation infrastructure.
Livability	Environment	The Authority developed a green mobility strategy, which it recently launched within the COP 28 activities held in the Emirate of Dubai, where it focused its strategy on promoting green mobility and reducing dependence on traditional vehicles. It also developed solar-powered stopping stations as one of the sustainable solutions to enhance the transportation infrastructure.
	Well-being	RAK provides sustainable transportation solutions to support all segments of society, including allowing transportation for people with special needs and older people at half price and the standard transportation tariff. It has also reduced ticket prices to 50% for university students to promote and encourage mass transportation.

4.5.7. UITP Mena Urban Mobility Report

According to (CTE), the MENA Transport Report 2020/2021 examines 13 countries and 37 cities in the MENA region. It comprises two sections: the first, featuring regional overview maps and benchmarking chapters, provides a macro-level analysis of the region's performance, focusing on themes like traditional public transport, new mobility services, and initiatives related to digitalization and decarbonization. The second part delves into individual country and city chapters, offering a detailed overview of public transport authorities, strategies, existing services, and ongoing/planned projects in passenger transport, covering traditional modes as well as emerging services like bus-on-demand, ride-hailing, and electronic bike-and scooter-sharing.

4.5.7.1. Regional Public Transport

Table 7 shows the PT modes/services operating in various regional locations. This indicates that, in the main, the provision of types of PT mode are similar although at a different scale of provision. The main variance is in the larger areas, with Dubai and Qatar having developed metro and tram systems. However, both areas have populations of

more than 1.5 million. In contrast, RAK today is relatively small, with a population in the 2015 census of only 345,000, which is insufficient for such Mass Transit systems.

Table 7 shows the Regional Public Transport PT modes/services.

Location	Metro	Tram	BRT	Buses	On Demand	E-scooter	E-bike	Taxi
Ras Al Khaimah								
Ras Al Khaimah City								
Sharjah								
Abu Dhabi City								
Al Ain City								
Dubai								
Ajman								
Qatar								
Bahrain								
Kuwait City								

Source: UITP Mena Report and consultant's research 2021

4.5.7.2. INTERNATIONAL BENCHMARKING

The regional benchmarking has been expanded to international areas, as shown in Table 8, which summarizes. Type of Public Transport (PT) Services and Restraint Measures Table 6-4 shows more details on the international comparisons, including Mode share for PT, Population, LRT/Tram km, Metro/Rail km, Bus passengers, LRT/Tram passengers, Metro/Rail passengers, and Car ownership per 1000.

Table 8 shows the international benchmark Public Transport PT modes/services.

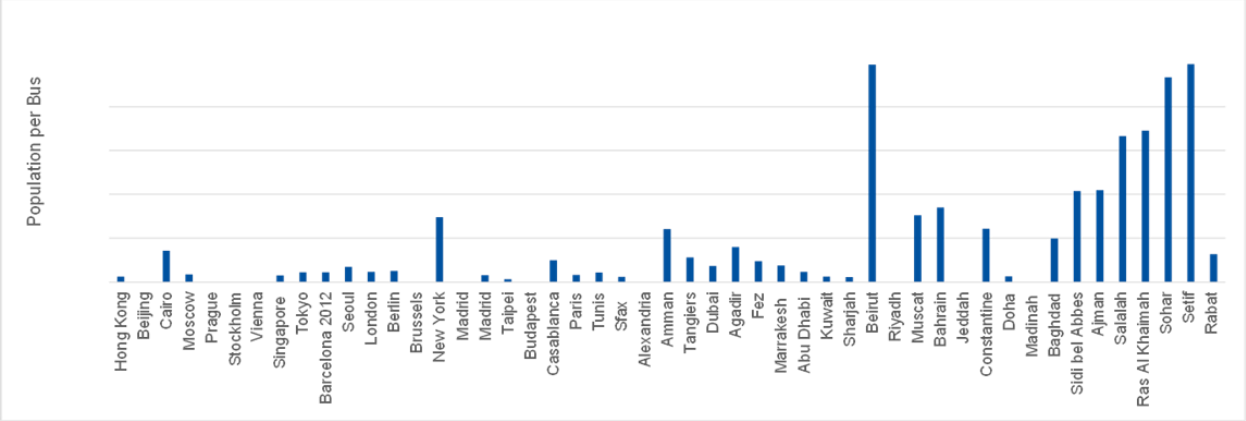
City	Population	LRT / Tram	Metro / Rail	BUT	Buses	Micro Mobility	Traffic Restraint
Hong Kong	7,413,000						Tolling
Singapore	5,312,000						Car Ownership Control and Road Pricing
London	20,693,000					E-Bike	Congestion Pricing and Low Emission Zones and Car Parking Control
Brussels	1,154,635						
New York	18,604,000					E-bike	
Sfax	594,725						
Amman	3,900,000						
Dubai	3,411,200					E-Bike E-scooter Bus On Demand	Tolling and Parking Charges
Abu Dhabi	1,807,000					E-Bike, E-scooter Bus On Demand	Tolling and Parking Charges
						E-bike, E-scooter Bus On	

Doha	718,000					Demand	
Ras Al Khaimah	345,000					E-bike E-scooter	

Source: UITP Mena Report 2021

Figure 8 shows the population per bus operated, ordered by the percentage of commuters using public transport (PT%) mode share to show the relative values. As expected, the meager numbers of people per bus occur in the high PT% mode share areas.

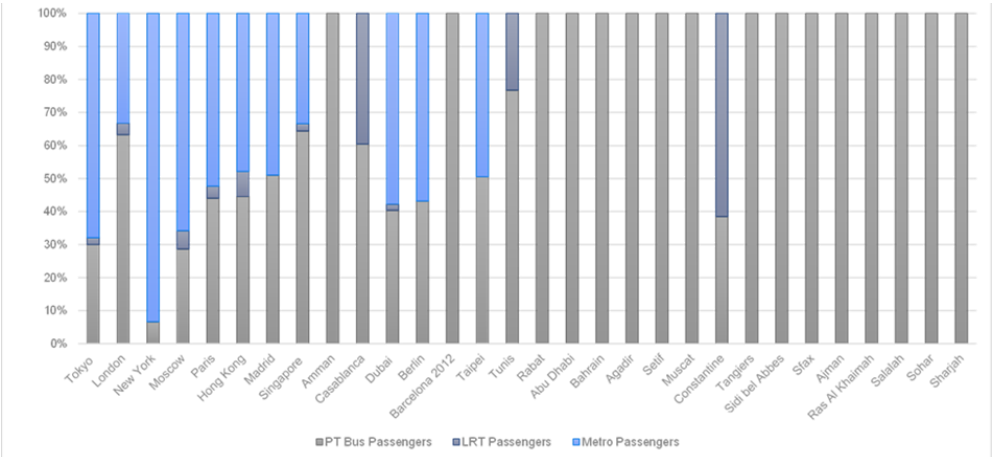
Figure 8 shows the population per bus operated, ordered by the PT% mode share.



Source: UITP Mena Report 2021

Figure 9 shows the composition of the PT in terms of bus, LR, and Metro, with the cities being ordered from left to right by population size. This shows that Mass Transit, i.e., Metro and Tram, are predominantly encountered in larger cities with populations of over 2.5 million people as they require large patronage numbers to justify the very high investment in such systems. Regarding RAK, it is evident that the PT system will currently be centered around bus provision. However, a critical factor for the longer term will be the population growth, which has in recent RAKSTM studies predicted to reach slightly over One (1) million people, which is still likely to be short of the consideration of Metro systems but could enable consideration of LRT systems.

Figure 9 shows Public Transport Composition (Bus/LRT/Metro)

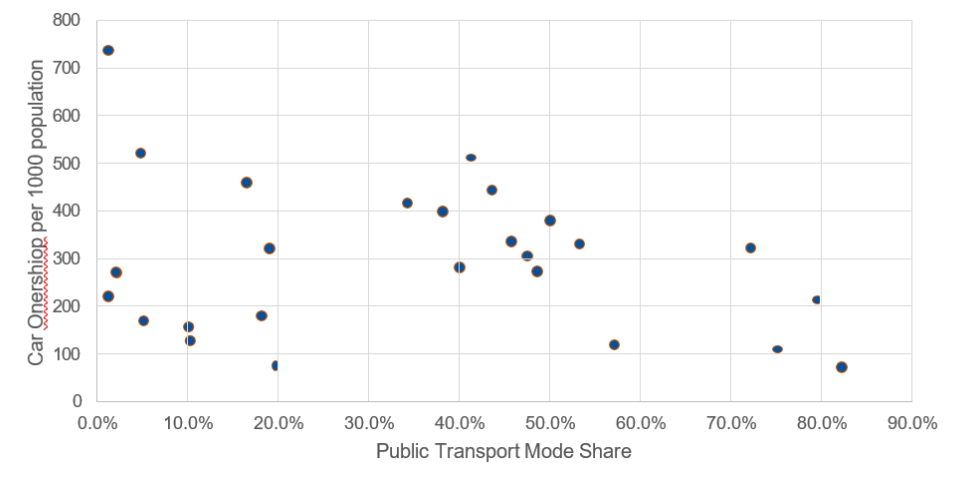


Source: UITP Mena Report 2021

Figure 10 shows the relationship between PT% mode share and car ownership, and while there is considerable variation, there is a decreasing car ownership rate as PT% mode share increases. A key question is the extent to which the linkages are because of policy measures or a direct result of income differentials and car affordability.

This is a critical question in Ras Al Khaimah as car running costs are generally low compared to other areas; for example, the average fuel cost per liter in RAK is only 47% of that in the UK, where fuel taxes exist. In addition, parking charges are prevalent in the UK and can be very high for all-day commuter parking, as much as 50AED in the case of central London. Aside from simply making PT more extensive and accessible, there is also often a need to apply associated measures that increase the cost of using a car to encourage people to use the improved PT system.

Figure 10 shows Relationship between Car Ownership and PT Mode Share

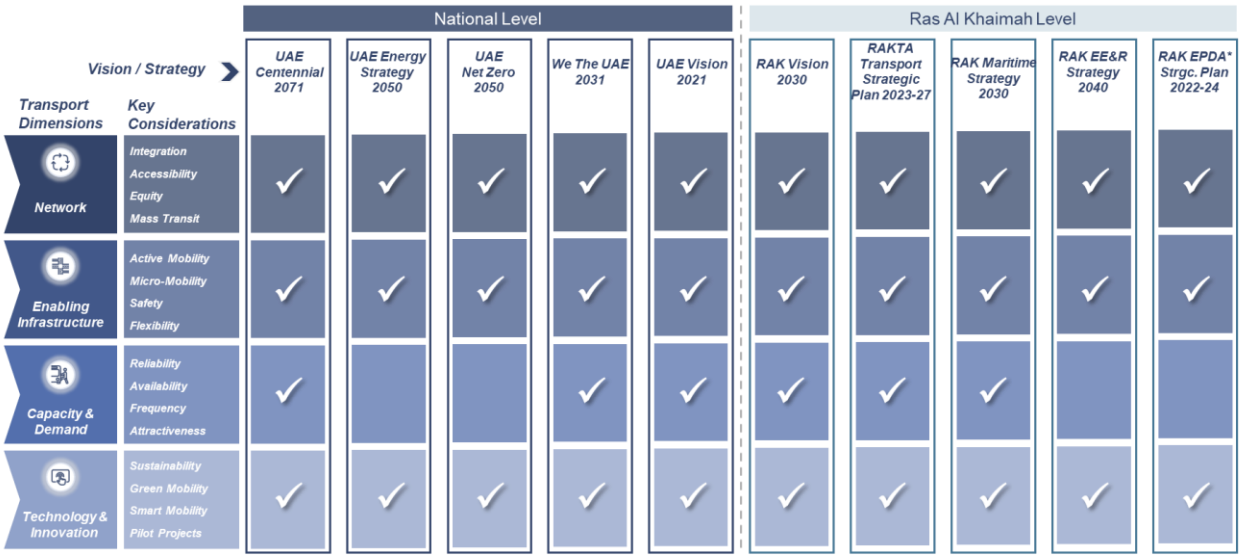


Source: UITP Mena Report and consultant's research 2021

4.6. The Urban Mobility Strategies of RAK

Figure 11 below presents a comprehensive assessment of RAK Mobility, examining its integration with both national and local strategies in RAK across various transportation dimensions: Network, Enabling Infrastructure, Capacity Demand, and Technology and Innovation.

Figure 11 shows comprehensive assessment of RAK Mobility



Source: RAKTA Strategic Plan 2023-2027

4.6. Evolution of the transportation system

In this section, I will examine and assess the transportation systems in various cities for a more comprehensive insight into the potential transition of modern urban areas toward sustainable mobility. The cities under consideration for review comprise London, Singapore, and Dubai.

4.6.1. London

London's transportation system has historically been well-developed and comprehensive, catering to the diverse needs of its large and bustling population. The Transport for London (TfL) oversees the city's transportation network, encompassing various modes of transport such as buses, trains, trams, the London Underground, cycling infrastructure, and river services. Like Dubai, London faces challenges related to congestion, environmental impact, and the need to promote sustainable transportation.

Road Network Enhancement:

London has an extensive road network that is continually being enhanced and upgraded. The city has implemented measures to improve traffic flow, reduce

congestion, and enhance road safety. Initiatives include the creation of dedicated bus lanes, cycle lanes, and pedestrian zones in critical areas.

Public Transportation System Development:

The London Underground, commonly known as the Tube, is a vital component of the public transportation system. TfL also manages an extensive bus network, Docklands Light Railway (DLR), Overground, and Tram link services. Continuous efforts are made to expand and improve these services to accommodate the growing population and enhance connectivity.

Pedestrian and Cyclist Networks:

London is committed to promoting walking and cycling as sustainable modes of transportation. The city has invested in cycling infrastructure, including dedicated bike lanes, bike-sharing schemes, and initiatives to enhance pedestrian safety. Pedestrian-friendly zones have been established in various parts of the city.

Formulation of Policies and Legislation:

London has implemented congestion pricing to manage traffic in the city center. Additionally, measures are in place to encourage the use of public transport and reduce reliance on private cars. Initiatives like the Ultra Low Emission Zone (ULEZ) aim to improve air quality and reduce emissions.

Intelligent Transportation Technologies:

London has embraced intelligent transportation technologies to enhance the efficiency of its transportation system. This includes real-time information systems for public transport, contactless payment options, and data analytics to optimize traffic flow and public transport services.

Traffic and Safety Awareness:

TfL places a strong emphasis on traffic and safety awareness. Campaigns and initiatives are regularly launched to educate the public about safe and responsible transportation practices. This includes awareness programs for pedestrians, cyclists, and drivers.

4.6.2. Singapore

Singapore's transportation system is characterized by a comprehensive and integrated approach emphasizing efficiency, sustainability, and innovation. The Land Transport Authority (LTA) oversees the planning and implementation of various modes of transport, ensuring a seamless and well-connected network that caters to the population's diverse needs.

Road Network Enhancement:

Singapore has a well-developed road network is continuously upgraded and expanded to accommodate the growing population. The city-state is known for its Electronic Road Pricing (ERP) system, which manages traffic congestion through dynamic tolls based on real-time demand. This innovative approach helps regulate traffic flow and reduce congestion.

Public Transportation System Development:

Singapore's public transportation system is highly efficient and well-integrated. The Mass Rapid Transit (MRT) system is the backbone of the public transit network, complemented by an extensive bus network and light rail systems. The system is designed to provide seamless connectivity, making it easy for commuters to transfer between different modes of transport.

Pedestrian and Cyclist Networks:

Singapore places a strong emphasis on pedestrian-friendly infrastructure and cycling networks. The city-state has developed well-maintained sidewalks, pedestrian bridges, and dedicated cycling paths. Initiatives like the Park Connector Network (PCN) encourage walking and cycling for both recreational and commuting purposes.

Formulation of Policies and Legislation:

Singapore has implemented various policies to alleviate congestion and promote sustainable transportation. In addition to ERP, policies include the Certificate of Entitlement (COE) system, which regulates the number of vehicles on the road and incentives for using public transport. These measures contribute to a well-managed and sustainable transportation ecosystem.

Intelligent Transportation Technologies:

Singapore is a pioneer in the integration of intelligent transportation technologies. This includes real-time information systems for public transport, smart traffic management systems, and autonomous vehicles in designated areas. These technologies enhance overall system efficiency and provide a more seamless commuting experience.

Traffic and Safety Awareness:

The LTA places a strong emphasis on traffic and safety awareness. Public campaigns and educational initiatives are regularly conducted to promote responsible commuting behavior and enhance road safety. The goal is to create a culture of awareness and adherence to traffic regulations.

4.6.3. Dubai

Dubai's Roads and Transport Authority (RTA) has implemented a proactive and systematic strategy to address evolving challenges and enhance the overall quality of life in the Emirate. The foundation of this approach lies in a comprehensive and integrated Strategic Transport Plan, carefully crafted to assess existing challenges and formulate a targeted action plan. This plan is designed to optimize public transport and the existing road network, reflecting a commitment to sustainable and efficient transportation.

Like London, Dubai has undergone a paradigm shift from individual car use to public transportation, a notable achievement for the Middle East's first city. This shift required a fundamental reassessment of transport policies and legislation, focusing on eliminating financial incentives favoring individual automobile usage, particularly in areas where high-quality public transit has been implemented. The recalibration also extends to promoting walking, biking, and transit use, especially in proximity to public transit stations, fostering a more sustainable and integrated approach to commuting.

The RTA's sustainable approach involves managing travel demand through policies and legislation encouraging mass transit commuting over single-occupant vehicles. Beyond infrastructure projects, the strategic transportation plan encompasses a balanced and integrated strategy across six major domains:

Road Network Enhancement:

Dubai has prioritized the continuous improvement of its road network to ensure smooth traffic flow, reduce congestion, and enhance overall road safety. This includes the development of modern road infrastructure and the implementation of intelligent traffic management systems.

Public Transportation System Development:

The public transportation system in Dubai has seen significant development, with a focus on the integration of various modes of transport. Initiatives such as the Dubai Metro, buses, and water transport contribute to an efficient and interconnected public transit network.

Pedestrian and Cyclist Networks:

Like London, Dubai is committed to enhancing pedestrian and cyclist networks. This involves the creation of dedicated pathways, pedestrian-friendly zones, and promoting cycling infrastructure to encourage sustainable modes of transport.

Formulation of Policies and Legislation:

Dubai's transportation strategy includes formulating policies and legislation to alleviate congestion and promote sustainable transportation. This may involve incentives for using public transport, congestion pricing, and regulations to encourage environmentally friendly practices.

Intelligent Transportation Technologies:

Dubai has embraced intelligent transportation technologies to enhance the efficiency of its transportation system. This includes real-time tracking for public transport, intelligent traffic signals, and other innovations to improve overall system performance.

Traffic and Safety Awareness:

The RTA strongly emphasizes traffic and safety awareness through campaigns and initiatives. These efforts aim to educate the public about safe and responsible transportation practices, contributing to a culture of reliable commuting.

4.7. The comparison between (RAK) and Boulder City

Table 9 compares (RAK) and Boulder City, Colorado, regarding transportation systems, infrastructure, and strategies.

Table 9 The comparison between RAK and Boulder

Comparison terms	RAK City	Boulder City
Transportation System		
Public Transportation	Buses are the mode of transportation in RAK, and efforts are underway to expand the infrastructure to meet the increasing needs of the population.	Boulder has invested in a public transportation system that includes buses and a bike-sharing program aiming to encourage commuting options. The city is renowned for its dedication to promoting cycling and walking. Boulder has made investments in creating bike lanes and pedestrian-friendly infrastructure.
Transportation Infrastructure		
Road Infrastructure	RAK has made investments in road infrastructure to ensure connectivity between residential, industrial, and commercial areas	Alternative Transportation: Boulder emphasizes modes of transportation, like biking and walking, to alleviate traffic congestion while promoting healthier lifestyles. Smart Transportation Solutions: The city actively explores transportation solutions, such as utilizing traffic management systems and advanced technology to enhance efficiency. Sustainable Practices: Sustainability is at the core of Boulders' values, evident in their transportation choices that prioritize minimizing impact.
Transportation Strategies		
Sustainable Transportation	RAK is actively working towards integrating transportation solutions such as buses while promoting eco-friendly practices.	Eco-Friendly Initiatives: Boulder City prioritizes eco strategies for transportation, encouraging the use of vehicles and other sustainable options to reduce carbon footprint.
Infrastructure Development	Continual investment in transportation infrastructure and digitalization is a strategy to support growth and development within the emirate.	Collaboration with Technology: The city actively seeks partnerships with technology companies to implement transportation solutions that enhance mobility for all residents.
Integration with Regional Networks	RAK aims to strengthen its connectivity by integrating its transportation systems with	Boulder actively involves its community in developing transportation plans to make sure

	networks, facilitating trade and tourism.	they align with the resident's needs and preferences.

To summarize, both Ras Al Khaimah and Boulder City prioritize transportation, invest in improving infrastructure, and strive to enhance connectivity. However, their strategies may vary depending on economic and cultural factors.

4.8. The Finding

In Singapore, an efficient Mass Rapid Transit (MRT) system links the city seamlessly, complemented by an extensive network of buses covering the entire island. Taxis and a pedestrian-friendly infrastructure enhance accessibility.

London boasts the famous London Underground, a widespread bus network, and national rail services connecting the city to surrounding areas. Black cabs and ride-sharing services are standard, while efforts to improve cycling infrastructure are evident.

Amman relies on public buses and shared taxis called "services" for city transportation. Private taxis and car rentals offer additional options for getting around.

Dubai features a modern metro system, buses covering various routes, accessible taxis, and ride-sharing services. Water taxis and traditional bras add to the transportation choices, and the Dubai Tram connects critical attractions.

In Ras Al Khaimah, taxis and a public bus system serve transportation needs. Car rentals are available, and walking and cycling are feasible in specific areas. However, there is a need for more investment in transportation infrastructure, including bicycle and walking paths and electric vehicle infrastructure, to encourage sustainable mobility. Ras Al Khaimah should develop future policies to promote mass transportation, considering the current dominance of private vehicles.

Comparing Ras Al Khaimah to Boulder, Colorado, it is noted that Boulder may serve as a model for developing a sustainable transportation system due to geographical and population similarities. Boulder's comprehensive transportation plan positions it competitively on a global scale.

Chapter 5: Conclusion and Recommendations

5.1. The Conclusion

This research critically evaluated Ras Al Khaimah's urban development policies, primarily focusing on achieving sustainability through effective transportation systems. The overarching question guiding this study was: What is the optimal urban development policy to help achieve sustainability in RAK? Additionally, sub-questions sought to delve into specific aspects of the transportation landscape, addressing the current state of transportation, key benefits and challenges of sustainable transportation, and identifying the most viable sustainable transport option for RAK. The following illustrates how research discussions and findings address the research questions:

RQ1: What is the current state of transportation in RAK?

The current state of transportation in Ras Al Khaimah is characterized by a limited scope, primarily relying on four bus routes and an extensive taxi fleet. Pedestrian infrastructure, while generally in good condition, faces challenges in terms of accessibility. Introducing micro-mobility services, such as e-scooters and e-bicycles, provides a glimpse into potential solutions.

RQ2: What are sustainable transportation's key benefits and challenges in RAK?

Comparisons with Abu Dhabi and Dubai highlight the unique characteristics of Ras Al Khaimah's transportation system. Challenges include limited bus routes, pedestrian accessibility issues, and a nascent micro-mobility service. Opportunities for improvement lie in addressing these challenges, expanding bus routes, and enhancing pedestrian infrastructure.

RQ3: What is the most viable sustainable transport option for RAK?

The research recommends aligning with international benchmarks, particularly the average of 750 buses per million in population recommended by the International Public Transport Association. Applying this to Ras Al Khaimah's context implies the need for approximately 300 buses, rising to 600 by 2030. Additionally, the evaluation of neighboring cities suggests 25 bus routes, increasing to 50 by 2030, focusing on internal routes.

The findings underscore the importance of aligning urban mobility policies with sustainability goals and international best practices. Ras Al Khaimah's existing policies favor private vehicle usage, hindering the development of an integrated public transport system. Recommendations emphasize the need for strategic enhancement, data-driven decision-making, stakeholder collaboration, and policy alignment to encourage sustainable mobility.

Moreover, Comparisons with global cities reveal that Ras Al Khaimah lags in sustainable mobility and integrated transport systems. The results advocate for emulating successful strategies from cities like London and Singapore, investing in sustainable modes of transport, and establishing a framework to anticipate and adopt future trends in urban mobility. Collaborating with international organizations and investing in technology-driven solutions are essential to achieving these goals.

Finally, through its policies, strategic initiatives, and commitment to mass mobility and green initiatives, Ras Al Khaimah has the potential to shape a future where sustainable transportation is not only a necessity but also a defining characteristic of its identity and success. The recommended improvements go beyond functionality; they aim to establish a harmonious network that caters to the population's diverse needs while minimizing environmental harm.

This dissertation has highlighted the gaps in Ras Al Khaimah's transportation systems and emphasized their potential for transformative change. The suggested improvements, aligned with sustainability goals, position Ras Al Khaimah as a pioneer in cultivating a resilient and forward-thinking approach to mobility. As the Emirate continues implementing these projects, it is poised to shape a future where sustainable

transportation becomes necessary and a defining characteristic of its identity and success.

5.2. The Recommendations

Based on a literature review and the benchmark analysis of sources and studying successful strategies, it seems practical to consider the following recommendations across two main areas: Proposed Projects and Enabling Policies.

5.2.1. The Proposed Projects

To accelerate the readiness for urban mobility by the year 2030 and to keep pace with the best global practices for sustainable cities in transportation systems, it is possible to implement several projects, including transportation infrastructure projects. Table 10 shows the list of projects:

Table 10 The Proposed Projects

Pillars	Projects
Intracity & Intercity Transit	Implement 30-minute peak and 60-minute off-peak headways on the public bus routes.
	Improve passenger infrastructure at existing transit stops.
	Formally develop Transit Station.
Active Transport & Micro Mobility	Mobility hubs at transit transfer points to support safe, convenient mode shift from primary transit services to active transportation, micro-mobility, and on-demand modes
	Implement an active transportation corridor.
On-Demand Transport	On-Demand Transport
	Establish formalized taxi stands at critical locations.

5.2.2. The Enabling Policies

There is a need to focus on developing several policies to ensure compliance with global best practices and accelerate the transition to sustainable mobility. Table 11 shows the recommended guidelines:

Table 11 The Enabling Policies

Pillars	Recommended Policies
Transport System Policies	**Encourage Public Transport Use and Multimodality** By focusing on three policy levers to increase transit ridership: - Enhance the reliability and frequency of service, - Ensure affordability, and - Make public transport competitive with other modes (e.g., private automobiles) through parking limits, higher automobile taxes, or tolling
	Promote Walkability and Micro mobility. Adopting measures to promote walking and walkability (e.g., planning guidelines and communication campaigns) ensures micro-mobility vehicles' safe and effective deployment.
Transit Operation Policies	**Improve Public Transport Services.** Establishing a series of planning principles and guidelines applicable through the Emirate to help improve the quality of service and enhance the user experience.
	Strengthen Passenger Rights and Obligations. By assuring that existing regulations meet the requirements of its expanding public transport system and are aligned with international best practices.
Land Use & Funding Policies	**Support Transit-Oriented Development** By shaping land use around transit corridors into walkable neighborhoods and commercial districts that reduce the need for automobiles, and thereby help reduce greenhouse gas emissions, conserve land and natural resources, promote healthy lifestyles, and build a sense of community. In parallel, implement “value capture” mechanisms to fund future infrastructure investments.
	Leverage Private Sector Participation. Use a combination of dedicated funds and innovative private-sector contracting schemes to help finance, deliver, and operate public transport projects. Notably, the policy should balance the profit-making requirements of the private sector with the need to provide services that may not be financially sustainable (i.e., revenue lower than costs).
Sustainable & Smart Policies	**Adopt Environment-Friendly Solutions.** Adopt a series of measures and regulations to encourage the adoption of green mobility solutions to reduce the environmental impact of transportation across the Emirate.
	Introducing Smart Mobility Services. Implement pilot projects to test the feasibility of new technology solutions to enhance the efficiency of transport operations, improve safety standards, and strengthen intermodal integration.

5.2.3. The Planning & Monitoring Tools recommendations

This part will outline short, medium, and long-term recommendations. Additionally, I will identify the stakeholders responsible for implementation, along with suggestions for planning and monitoring tools.

5.2.3.1 Planning & Monitoring Tools

In the following, I will suggest fundamental tools for measuring, planning, and monitoring each objective in transportation planning and enhancement. These objectives span various domains: safety and accessibility, equity, efficiency, and reliability. Each goal is designed to tackle a particular challenge within the transportation sector. By formulating suitable metrics and applying relevant monitoring techniques, transportation planners can assess performance, pinpoint areas for enhancement, and make informed decisions to achieve desired outcomes.

5.2.3.1.1. Safety and Accessibility

Table 12 Safety and Accessibility

Objective	KPIs	Monitoring Tools	Source
Improve vulnerable roadway user safety by minimizing conflicts between motors.	No. of fatal/serious injury crashes involving vulnerable roadway users	Police accident reports	RAK Police
	Perception of safety among vulnerable roadway users	User surveys	
Improve accessibility for people of determination, including persons with physical, visual, audible, cognitive, or other disabilities.	Percentage of roadway network with complete pedestrian facilities (e.g., footpaths, multi-use paths)	Land use GIS maps	RAK Municipality
	Percentage of roadway intersections, midblock crossings, and grade-separated crossings that are fully accessible to people of determination	Land use GIS maps	RAK Municipality
Integrate walkability into all aspects of transportation planning and design, as nearly all	Percentage of roadway network with complete pedestrian facilities (e.g., footpaths, multi-use paths)	Land use GIS maps	RAK Municipality

journeys begin and end with a walking trip.	Percentage of roadway intersections, midblock crossings, and grade-separated crossings that are fully accessible to people of determination	Land use GIS maps	RAK Municipality
	Percentage of the pedestrian network with passive or active solar cooling (e.g., shading or other treatments)	Land use GIS maps	RAK Municipality
	Density of formalized pedestrian crossings on the roadway network	Land use GIS maps	RAK Municipality
	Walking mode share (commute trips)	Surveys	RAKTA
	Walking mode share (all trips)	Surveys	RAKTA
Streamline travel by establishing seamless connections between modes	The proportion of bus stations, bus stops, waterborne transit stations, and taxi stands with micro-mobility services (e.g., bike share, scooter share) and secure bicycle parking	Land use GIS maps	RAK Municipality
	The Proportion of bus stations, bus stops, waterborne transit stations, and taxi stands with passenger infrastructure such as weather protection and route, payment, and real-time arrival information.	Land use GIS maps	RAK Municipality

5.2.3.1.2. Equity

Table 13 Equity

Objective	KPIs	Monitoring Tools	Source
Prioritize investments benefiting historically underserved populations, particularly	The proportion of roadway network with complete pedestrian facilities (e.g., footpaths, multi-use paths) in areas with higher concentrations of youth, seniors, lower-income residents, service industry workers, and people of determination	Land use GIS maps	RAK Municipality
	The proportion of the pedestrian network with passive or active solar cooling (e.g., shading or	Land use GIS maps	RAK Municipality

those with limited travel options.	other treatments) in areas with higher concentrations of youth, seniors, lower-income residents, service industry workers, and people of determination		
	The proportion of transit, taxi, and micro-mobility services providing payment options for unbanked populations and people without smartphones	Service user statistics	RAKTA
Improve multimodal links between population and employment centers, such as labor camps and service-related jobs.	Commute-to-work mode shares (drive-alone, transit, taxi/rideshare, walking, bicycling, micro-mobility services, employer shuttles)	Surveys	RAKTA
	Average transit corridor travel time compared with drive-alone travel time	Land use GIS maps	RAK Municipality
	Proportion of roadway network with complete pedestrian facilities (e.g., footpaths, multi-use paths)	Land use GIS maps	RAK Municipality
	Density of micro-mobility services (e.g., bike/scooter share docking stations)	Land use GIS maps	RAK Municipality
	Transit ridership	Public transit user statistics	RAKTA
	Micro mobility ridership	micro-mobility user statistics	RAKTA
Elevate the role of transit, walking, bicycling, and other affordable modes to minimize financial burdens to residents.	Proportion of roadway network with complete pedestrian facilities (e.g., footpaths, multi-use paths)	Land use GIS maps	RAK Municipality
	The proportion of residents within 800 meters of a transit stop on a high-frequency transit route	Land use GIS maps	RAK Municipality
	Annual per capita transportation expenditures (proportion of income)	Land population surveys Emirate statistics	Statistics Department
	Transit, walking, bicycling, and micro-mobility mode shares (commute trips)	Surveys	RAKTA
	Transit, walking, bicycling, and micro-mobility mode shares (all trips)	Surveys	RAKTA

5.2.3.1.3. Efficiency and Reliability

Table 14 Efficiency and Reliability

Objective	KPIs	Monitoring Tools	Source
Develop a fully integrated transport network providing convenient intracity and intercity linkages.	Proportion of roadway network with complete pedestrian facilities (e.g., footpaths, multi-use paths)	Land use GIS maps	RAK Municipality
	Proportion of roadway network with low-stress bikeways (e.g., footpaths, multi-use paths)	Land use GIS maps	RAK Municipality
	Average transit corridor travel time compared with drive-alone travel time	Land use GIS maps	RAK Municipality
Maximize system predictability by minimizing travel time variability	Proportion (kilometers) of fixed route transit operating in exclusive right-of-way (not in mixed traffic)	Land use GIS maps	RAK Municipality
	Average corridor transit travel time compared with drive-alone travel time	Land use GIS maps	RAK Municipality
	Frequency of collisions or incidents resulting in non-recurring congestion	Land use GIS maps	RAK Municipality
Prioritize speed and capacity upgrades on sustainable travel modes to incentivize their use.	Proportion (kilometers) of fixed route transit operating in exclusive right-of-way (not in mixed traffic)	Land use GIS maps	RAK Municipality
	Average corridor transit travel time compared with drive-alone travel time	Surveys	RAKTA
	Proportion (kilometers) of roadways with “green wave” signal technology to improve bicycle and scooter travel flow	Land use GIS maps	RAK Municipality

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